1st Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I– Semester

CourseTitle: **Mathematics**
(Course Code: 4300001)

Diploma program in which this course is offered	Semester in which offered
Automobile Engineering, Architecture Assistantship, Biomedical Engineering, Ceramic, Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics &Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Marine Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Electronics Engineering, Printing Technology, Textile Designing, Textile Manufacturing Technology, Textile Processing Technology, Computer Science & Engineering (All branches)	First

1. RATIONALE

This course of Mathematics is being introduced as a foundation which will help students in developing competency and the requisite course outcomes in most of the Diploma Engineering programs. Components of Mathematics like Algebra, Geometry, Calculus, Computer computation work as a tool to describe physical phenomena and to evaluate the merit of different possible solutions. This course is an attempt to initiate the multi-dimensional logical thinking and reasoning capabilities. It will help the students to apply the basic principles of Mathematics to solve related technology problems. The course will give the students an insight to apply and analyse the Engineering problems scientifically based on the subject of Trigonometry, Differential Calculus and Basic elements of algebra and coordinate geometry to give a comprehensive coverage at an introductory level.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

Solve broad-based technology problems using the principles of mathematics.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Interpret the function graphically, numerically and analytically**.**

b) Demonstrate the ability to algebraically analyse basic functions used in Trigonometry.

c) Demonstrate the ability to Crack engineering related problems based on concepts of Vectors**.**

d) Solve basic engineering problems under given conditions of straight lines and circle.

e) Demonstrate the ability to analyze and illustrate the Functions using the concept of Limit.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	1	-	4	30*	70	-	-	100

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES (During Tutorial Hours)

The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve the Cos.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Solve given problems of Determinant up to order 3*3.	I	1
2	Use Open source mathematical software to demonstrate the graphs of given functions with its geometrical interpretation.	I	1
3	Use Open source mathematical software to display given logarithmic functions showing basic laws.	I	1
4	Solve the given examples based on conversion of units of Angles explaining the allied angles.	II	1
5	Crack given problems based on the concept of Compound Angles, Multiple and Submultiples angles.	II	1
6	Plot the graph of sine and cosine functions with help of Open source mathematical software and justify problems related to sum and factor formulae.	II	1
7	Use the concepts of Algebra to Solve given engineering related problems based on Magnitude of a vector.	III	1
8	Apply the concept of Dot Product to solve given engineering	III	1

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	related problems.		
9	Explain the physical significance of the Cross Product and apply the concept to solve given engineering related problems.	III	1
10	Apply the concept of various forms of line, slope, intercept to solve simple problems.	IV	1
11	Use the concepts of equations of Parallel lines and Perpendicular lines to solve specified problems.	IV	1
12	Use the concept of Tangent and Normal to solve related engineering problems.	IV	1
13	Explain Limit of a function graphically and solve the specified problems.	V	1
14	Apply the Standard Formulae of Limit and crack the specified problems.	V	1
	Total		**14**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	Geometric Thinking: Comprehend geometric concepts to prove theorems by applying apt results to solve well defined Engineering problems.	
1.	Experiment with transformations in the plane.	30
2.	Define trigonometric ratios and solve problems involving right triangles.	30
3.	Apply theorems about circles.	40
Total		**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	Algebraic Thinking: Create, interpret, use, and analyze expressions, equations, and inequalities in a variety of contexts.	
1.	Represent, interpret, and solve variable expressions, equations, and inequalities.	60
2.	Write expressions in equivalent forms to solve problems.	40
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	Computer System & LCD Projector	2,3,6,10,13
2	Scientific Calculator (Display type: Natural Display Algebraic input logic: Natural V.P.A.M. Significand function: 10+2.	1,5,10

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Determinant and Function**	1a. Solve simple problems of Determinant up to order 3*3. 1b. Explain graphically the given functions. 1c. Solve simple problems using concepts of Logarithms	1.1 Determinant and its value up to 3rd order (Without properties) 1.2 Function and simple examples. 1.3 Logarithm as a function 1.4 Laws of Logarithm and related Simple examples
Unit– II **Trigonometry**	2a. Apply the concept of Compound angle, Allied angle, and Multiple angles to solve the given simple engineering problem(s) 2b. Explain the concept of Sub-Multiple and solve related problem(s). 2c. Invoke the concept of Sum and Factor formulae to solve the given simple problem(s) 2d. Investigate given simple problems using inverse Trigonometric functions.	2.1 Units of Angles (degree and radian) 2.2 Trigonometric Functions 2.3 Allied & Compound Angles, Multiple –Submultiples angles 2.4 Graph of Sine and Cosine, 2.5 Periodic Trigonometric function 2.6 Sum and factor formulae 2.7 Inverse Trigonometric function
Unit– III **Vectors**	3a. Apply the concept of algebraic operations of Vectors to solve given simple engineering problem(s) 3b. Apply the concept of Scalar and Vector product to solve specified simple problem(s) 3c. Solve problems of work done and moment of force using the concept of Vectors.	3.1 Vector, Addition, Subtraction, Magnitude and direction. 3.2 Scalar and Vector Product and it's properties 3.3 Angle between two Vectors 3.4 Applications of Scalar and Vector Product (Work Done and Moment of Force)
Unit– IV **Coordinate Geometry**	4a. Employ the equation of straight line to solve given simple problems. 4b. Apply the concept of slope and its consequences to	4.1 Straight line (Two-point form) and slope of straight line 4.2 Slope point form, Intercept form, General form of line 4.3 Condition of parallel and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	solve the given problems. 4c. Find the angle between two lines using the concept of Parallel and Perpendicular lines. 4d. Apply the concept of equation of circle with center and radius to solve the given problems. 4e. Solve problems related to general equation of circle based on tangent and normal.	perpendicular lines 4.4 Equations of Parallel lines and Perpendicular lines to the given lines 4.5 Angle between two lines. 4.6 Equation of circle with center and Radius. 4.7 General equation of circle. 4.8 Tangent and normal to a circle.
Unit– V **Limit**	5a. Analyse the characteristic of functions using the concept of Limit. 5b. Solve the given problems using standard formulae of Limit	5.1 Limit of a Function. 5.2 Standard formulae of Limit and related simple examples.

***Note**: The Unit Outcomes (UOs) need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Determinant and Function	9	4	7	5	16
II	Trigonometry	12	4	5	5	14
III	Vectors	7	4	6	4	14
IV	Coordinate Geometry	8	4	5	5	14
V	Limit	6	3	4	5	12
Total		42	**19**	**27**	**24**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

***Note**: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Identify engineering problems based on real world problems relevant to content of the unit and solve these problems in the light of free tutorials available on the internet.
b) Explore the opportunity to visit Science city, ISRO or nearby Science centres.
c) Explore the opportunity to visit Mathematics Lab Virtually.
d) Prepare charts showing formulas of multiple and sub multiple trigonometric functions.
e) Use Graphing calculator to plot the graph of functions showing Engineering applications.
f) Collect set of problems based on concept of limit with real world applications and make a presentation.
g) Communicate mathematical thinking coherently and clearly to other students, peers, and others.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L" in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Explore the possibility for understanding the Biosphere through Mathematics
g) Guide students for using data manuals.

12.SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more

COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course.The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Draw graphs of given Functions like $2x-1, x^2, \sin x, \cos x$ etc and verify using suitable Open-source software like GeoGebra, DPLOT and GRAPH.
b) Prepare the Charts of formulae for limit, Vector, Trigonometry, Co-ordinate Geometry, and Logarithm.
c) Prepare the cardboard models based on Mathematical concepts.
d) Draw various lines, circles using GeoGebra software.
e) Prepare projects on height and distance using Trigonometry.
f) Use PHET website for simulation of Vector Algebra.
g) Prepare a presentation/seminar on any relevant topic of interdisciplinary nature.
h) Prepare a write up on the Historical path of Calculus.
i) Prepare models of graphical representation for the existence of limits of given functions.
j) Prepare charts showing formulas of multiple and sub multiple trigonometric functions and its usefulness.
k) Formulate models to describe mathematical relationships and analyze data.

13.SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Mathematics (Third edition).	Croft, Anthony	Pearson Education, New Delhi, 2014. ISBN 978-81-317-2605-1
2	A Text Book of Vector Analysis	Narayan Shanti and Mittal P.K	S. Chand Publication, ISBN 978-8121922432
3	Calculus and Analytic Geometry	G. B. Thomas, R. L. Finney	Addison Wesley, 9th Edition, 1995. ISBN 978-8174906168
4	Understanding Engineering Mathematics	John Bird	Routledge; 1st edition ISBN 978-0415662840
5	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5

14.SUGGESTED LEARNING WEBSITES

a. https://www.youtube.com/channel/UCLJVrQyPYsseCf78QWCDsvA/featured
(YouTube Channel of DTEGUJ)
b. https://www.geogebra.org/?lang=en
c. https://phet.colorado.edu/
d. www.dplot.com/ - DPlot
e. www.wolfram.com/mathematica/
f. https://www.khanacademy.org/
g. www.easycalculation.com
i. www.scilab.org/ - SCI Lab
j. https://cnx.org/contents/cCXsMC7-@3.2:rOtjgdjI@5/Trigonometry
k. https://www.embibe.com/exams/real-life-applications-of-trigonometry
l. https://opentextbc.ca/calculusv1openstax/chapter/the-limit-of-a-function
m.https://www.accessengineeringlibrary.com/?implicit-login=true

15.PO-COMPETENCY-CO MAPPING

Semester I	Mathematics (Course Code: 4300001)						
	POs and PSOs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency ***Solve broad-based technology problems using the principles of mathematics.***	3	2	1	-	-	-	1
Course Outcomes CO a) Interpret the function graphically, numerically and analytically.	3	2	1	-	-	-	-
CO b) Demonstrate the ability to algebraically analyze basic functions used in Trigonometry.	3	1	1	-	-	-	1
CO c) Demonstrate the ability to Crack engineering related problems based on concepts of Vectors.	3	1	1	-	-	-	1
CO d) Solve basic engineering problems under given conditions of straight lines and circle.	3	1	-	-	-	-	-
CO e) Demonstrate the ability to analyze and illustrate the Function using the concept of Limit.	3	-	-	-	-	-	-

Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. N. R. Pandya I/C Principal (Retired) Head of Department	Government Polytechnic, Kheda	9099097990	nrpandyagp@gmail.com

2	Dr. N. A. Dani Sr. Lecturer	Government Polytechnic, Rajkot	9427184187	nilesh_a_d@yahoo.co.in
3	Mr. P. N. Joshi Sr. Lecturer	A.V.P.T.I, Rajkot	9924844699	pnj2004@rediffmail.com
4	Dr. J. S. Prajapati Sr. Lecturer	R.C.T.I, Ahmedabad	9426469752	jsprajapati26@gmail.com
5	Dr. Sachin J. Gajjar Lecturer	Government Polytechnic, Gandhinagar	9925362754	gjr.sachin@gmail.com
6	Dr. Nirav H. Shah Lecturer	Government Polytechnic, Jamnagar	9327632570	Nirav.hs@gmail.com

NITTTR Resource Person

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr. Deepak Singh Associate Professor (Mathematics) Former Head, DAS	Department of Applied Science Education, NITTTR, Bhopal	9826991961	dsingh@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I– Semester

Course Title: **COMMUNICATION SKILLS IN ENGLISH**
(Course Code: 4300002)

Diploma programme in which this course is offered	Semester in which offered
ALL BRANCHES	FIRST

1. RATIONALE

Language is the most commonly used medium of self-expression in all spheres of human life – personal, social and professional. English language has become a dire need to deal successfully in the globalized and competitive market. Competency in English is need of the hour, not only for Indian industry, but also worldwide, where diploma engineers have the employable opportunity. Therefore, the basic English skills- listening, speaking, reading and writing have become almost mandatory for employability. This course intends to make the students to develop comprehension skills, improve vocabulary, use proper grammar, acquire writing skills, correspond with others and enhance skills in spoken English. Further, it is expected that each polytechnic will provide conducive environment for acquiring proficiency in communication skills among the students through English language.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use reading, writing, speaking, listening skills to communicate effectively in English**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

- Use strategies to minimise barriers of effective communication.
- Construct grammatically correct sentences.
- Develop reading and listening skills in terms of fluency and comprehensibility.
- Compose different types of written communication.
- Communicate orally in a given situation with a purpose.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	-	2	3	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be

taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.		Approx. Hrs. required
1	Make correct sentences using tenses.	II	Any two	02
2	Compose Syntactical statements in written and Oral Communication (especially Formal Communication).	II		02
3	Make meaningful sentences using confusing words..	II		02
4	Develop listening skills through listening to recorded lectures, poems, interviews and speeches.	III		02*
5	Use antonyms and synonyms effectively in oral and written forms.	III, IV		02*
6	Use grammatically correct sentence	IV		01
7	Communicate ideas effectively and fluently in oral and written communication.	IV, V		02*
8	Apply idioms and one word substitute effectively in oral and written forms of communication.	IV, V		01
9	Articulate vowels, consonants and diphthongs correctly.	V		02*
10	Syllable and Syllable Stress	V		02
11	Speak with appropriate intonation, voice modulation, pitch, speed and volume.	V		02
12	Participate in conversations (GD /meetings etc.)	V		02*
13	Deliver the presentation effectively in the class.	V		02*
14	Communicate effectively through verbal and non-verbal means of communication.	V		02*
15	Practice online exercises for listening and reading comprehension.	V		02*
16	Perform role play and mock interview	V		02
	Total			**28**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Oral Communication

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S. No.	Sample Performance Indicators for the PrOs (Oral communication)	Weightage in %
1	Pronunciation	20
2	Use of language (simple or decorated language)	20
3	Syntax (Sub-Verb Agreement, types of sentences, Modals etc.)	20
4	Use of appropriate Vocabulary	15
5	Fluency (Ease and speed of the flow of speech)	15
6	Audibility	10
Total		**100**

Written Communication

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S.No.	Sample Performance Indicators for the PrOs (Written communication)	Weightage in %
1	Content(ideas expressed)	25
2	Use of language (Organisation of the content)	20
3	Grammar • Syntax (Sub-Verb Agreement) • Diction (choice and use of words) • Control of the basic grammatical patterns	20
4	Style • Choice of sentence structures • Use of appropriate sentence structures	20
5	Mechanics (Use of punctuations, Capitalization, paragraphing, italicizing)	15
Total		**100**

Listening skills

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S.No.	Sample Performance Indicators for the PrOs (Listening skills)	Weightage in %
1	Enthusiasm for patient listening	15
2	Attentive listening	20
3	After listening, each student has to summarize • Accuracy of facts and figures. • Description of places and situations.	40
4	Para- phrasing of the listened texts.	25
Total		**100**

Reading Skills

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S.No.	Sample Performance Indicators for the PrOs (Reading Skills)	Weightage in %
1	Reading correctly with clarity	30
2	Correct pronunciation	20
3	Comprehension of a vocabulary and deriving meaning of information	15
4	Reading speed	20
5	Drawing correct conclusion and valid inference	15
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer systems windows 7 or above with internet connectivity	All
2	Headphones with speakers	All
3	LCD Projector	All
4	Language lab software	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work well as a leader/a team member.
b) Follow ethics
c) Demonstrate human concern.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy'

should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	**Speaking Skills**	
Unit 1 **Theory of Communi-cation**	1a. Define the theory of communication 1b. State different types of communication. 1c. Explain barriers in communication	1d. Communicate effectively	**1.1** Concept of effective communication and communication skills **1.2** Basic communication model(S+M+C+R+F) **1.3** Types of communication **1.4** Barriers of effective communication
Unit 2 **Grammar**	2a. Identify different parts of speech and their usage in the sentence.	2f. Choose appropriate parts of speech for day to day communication.	**2.1 Parts of Speech** Noun, Pronoun, Verb, Adjective, Adverb and Interjection- Meaning and Examples (Recapitulation) Prepositions- In, into, On, At, for, Since, between, among, to, towards Connectors - If, Unless, Otherwise, Because, Therefore, Who, Which, Where, When, Why.
	2b. Apply correct verbs in the given sentence	2g. Use grammatically correct sentence in day to day communication	**2.2 Tenses** **2.2.1 Present Tense** (Simple, Continuous, Perfect, Perfect Continuous) **2.2.2 Past Tense** (Simple, Continuous, Perfect) **2.2.3 Future Tense** (Simple)
	2c. Use appropriate Modal Auxiliaries in a given expression.	2h. Choose appropriate Modals in situations where different modes of expressions are used.	**2.3 Modal Auxiliaries** (Can, Could, May, Might, Shall, Should, Will, Would, Must, Have to, Ought to)

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	**Speaking Skills**	
	2d. Choose the correct verb for the given subject.	2i. Use the correct verb depending on the subject in a sentence.	**2.4 Subject- Verb Agreement**
	2e. Identify basic sentence patterns of English and form sentences in correct word order.	2j. Use correct word order in their speech.	**2.5 Basic Sentence Patterns of English** (Explanation of S, V,O,A,C) S-Subject, V-Verb, O-Object, A-Adverbial and C- Complement Four Basic Sentence Patterns • S+V • S+V+O • S+V+A • S+V+C
Unit 3 **Prose and Poetry**	3a. Realise the central idea of the literary piece. 3b. Formulate sentences using new words. 3c. Enrich vocabulary through reading. 3d. Write short as well as long answers to questions. 3e. Express ideas in English in written form effectively	3f. Explain the content of the passage/story in the class. 3g. Ask appropriate questions as well to answer them. 3h. Follow oral instructions and interpret them to others. 3i. Present topics effectively and clearly. 3j. Use dictionary, thesaurus and other reference books. 3k. Describe an object or product. 3l. Use correct pronunciation and intonation. 3m. Give instructions orally.	**3.1. Prose** The Leopard- Ruskin Bond **3.2. Short Story** After Twenty Years- O Henry **3.3. Poetry** • Stopping by Woods on Snowy Evening-Robert Frost • Where the Mind is Without Fear- Rabindranath Tagore **3.4 Language components:** Language components should be integrated with: • Passages from text book/Work book. • Unseen passages Reading with correct pronunciation.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	**Speaking Skills**	
			3.5 Vocabulary Items: • Matching items (Word and its Meaning) • One-Word Substitution • Phrases and Idioms • Synonyms and Antonyms
Unit 4 **Techniques of Writing**	4a. Compose emails on given topics/ situations. 4b. Write a paragraph in words with synchronized sentence structure on the given situation / topic. 4c. Answer the questions on the given unseen passage. 4d. Summarize the given unseen passage .	4e. Face oral examinations and interviews. 4f. Grasp the main idea of any conversation and communicate accordingly.	**4.1 Email Writing** (Business) Format and Sample Enquiry, Orders and complaints Examples for Practice **4.2 Letter writing** • Types of letters, • Formats of Letters • Qualities of a good letter • Sample letters such as: - Job applications/ Cover Letter - Leave applications, Complaints, - Purchase orders, Enquiries replies etc.
Unit 5 **Mechanics of Speaking**	5a. Develop a welcome and farewell speech for the given theme/ situation. 5b. Prepare a speech for introducing a guest in the given situation. 5c. Make a weather report for the given condition .	5d. Introduce oneself with correct pronunciation, intonation, using verbal and non-verbal gestures. 5e. Speak in specified formal situations with correct pronunciation. 5f. Speak in specified informal situations with correct	**5.1 Public speaking** • Basics of Speaking • Importance of public speaking • Characteristics of good speech **5.2 Samples for Practice:** • Welcome speech • Farewell speech • Introducing oneself and another. • Discussing Weather • Disposal of E -Waste

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	Speaking Skills	
		pronunciation.	• Environmental protection through non-use of Plastic • Reduction of Noise pollution by vehicles. • Conversation with the Cashier- College/ bank • Telephonic Conversations (Formal and Informal).

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Theory of Communication	04	03	04	03	10
II	Grammar	10	07	14	06	27
III	Prose and Poetry	09	04	07	08	19
IV	Techniques of Writing	05	03	04	07	14
V	Mechanics of Speaking	0	-	-	-	-
Total		**28**	**17**	**29**	**24**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10 SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

- The experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency.
- Initiating a conversation with a new comer to your college.
- Assignments using Internet. (Online Listening/Speaking/Vocabulary based exercises and uploading their score, etc. (Teacher can decide how to use various online platforms for evaluation purpose.

- Self-learning Activities using mobile apps/internet
- Discuss current affairs in English with your friends.
- Read storybooks and learn new words and sentence structures.
- Write a brief report on current environmental issues.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) Comprehension of passage and making presentation can given to the students for ***self-learning***, but to be assessed using different assessment methods.
d) Guide students on how to address issues on environment and sustainability using the knowledge of this course

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs.Similar micro-projects could be added by the concerned course teacher:

a) Book review – students should read a book and then write his reviews about the book and present it in the class.
b) Presentation – Prepare a presentation regarding current problems of environment and present it in the class,
c) Mock interviews. – Interviews conducted by students and for the students.
d) Skit or role play- write the script and present it in the class
(can be asked to take topic related to environment and pollution)
e) Find out 20 new words out of a given story, write its synonym and use the word in your own sentence.
f) Draft a story according to a given picture.
g) You are in the village fair. Describe what is happening around you in present continuous tense. (Celebration of Annual Day – past tense. etc)
h) Write a paragraph about your first day in college.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Living English Structures	W. S. Allen	Pearson Education India 1992 ISBN: 9788131728499
2	Essentials of English Grammar and Composition	N. K. Aggrawal	Goyal Brothers Prakashan 2015 ISBN : 8183896162
3	English Grammar at Glance	M. Gnanamurali	S. Chand & Co. Ltd. 2010 ISBN : 9788121929042
4	Effective English	E. Suresh Kumar & Others	Pearson 2010 ISBN : 9788131731000
5	English Communication for Polytechnics	S. Chandrashekhar & Others	Orient BlackSwan 2013 ISBN : 8125037462
6	English Fluency Step 1 & 2	-	Macmillan 2010 ISBN : 9781405003650 9781405003667
7	Active English Dictionary	-	Longman 1991 ISBN : 8131707865
8	The Pronunciation of English	Daniel Jones	Cambridge: Cambridge University Press, 4th Edition 1956 ISBN : 0521093694
9	Ed. English Pronouncing Dictionary	James Hartman & et al.	Cambridge: Cambridge University Press.17th Edition 2006 ISBN : 0521680867
10	Effective Communication Skills	Kulbhushan Kumar	Khanna Publishing House, New Delhi (Revised Ed. 2018) ISBN : 9789382609940
11	Better English Pronunciation	J.D.O'Connor	Cambridge: Cambridge University Press 1982 ISBN : 0521231523
12	An English Grammar: Comprehending Principles and Rules	Lindley Murray	Franklin Classics (10 October 2018). ISBN : 0342097008
13	Examine your English	Margaret M. Maison	Orient Longman: New Delhi, 1964 ISBN : 812500176X
14	A Practice Course in English Pronunciation	J.Sethi & et al	New Delhi: Prentice Hall, 2004 ISBN : 9788120325944
15	Technical Communication: A Practical Approach.	Pfeiffer, William Sanborn and T.V.S Padmaja	Delhi: Pearson, 2007. ISBN : 9788131700884

14. SUGGESTED LEARNING WEBSITES

- https://learnenglish.britishcouncil.org
- http://www.free-english-study.com/
- http://www.english-online.org.uk/course.htm
- http://www.english-online.org.uk/
- http://www.talkenglish.com/
- http://www.learnenglish.de/
- https://www.cambridgeenglish.org/exams-and-tests/linguaskill/
- https://dictionary.cambridge.org/dictionary/english/
- https://www.oxfordlearnersdictionaries.com/definition/academic/
- https://learnenglishkids.britishcouncil.org/

15. PO-COMPETENCY-CO MAPPING

Semester I	**Communication Skills in English (Course Code: 4300002)**						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineer-ing Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustain-ability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency	**Use reading, writing, speaking, listening skills to communicate effectively in English**						
Course Outcomes Students will be able to: CO a). Use strategies to minimise barriers of effective communication	-	-	-	-	-	2	2
CO b) Construct grammatically correct sentences.	2	-	-	-	-	2	2
CO c) Develop reading and listening skills in terms of fluency and comprehensibility	1	-	-	-	-	-	1
CO d) Compose different types of written communication.	2	-	-	-	-	2	2
CO e) Communicate orally in a given situation with a purpose.	2	-	-	-	-	2	2

Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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GUJARAT TECHNOLOGICAL UNIVERSITY

DIPLOMA PROGRAMME

IN

ENGINEERING AND TECHNOLOGY

WORKBOOK

OF

COMMUNICATION SKILLS IN ENGLISH

IMPORTANT NOTE:

This workbook is prepared for purely academic purpose only. The authors have used various open web sources and books for content creation. The aim is to help students by providing them learning material and ample exercises for practice. This book is designed for smooth functioning of the course. The content of this text must not be used for any kind commercial purpose.

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INDEX

SECTION 1

THEORY OF COMMUNICATION

What are communication skills?

Definition:

Communication skills are the abilities you use when giving and receiving different kinds of information. Some examples include communicating new ideas, feelings or even an update on your project. Communication skills involve listening, speaking, observing and empathising. It is also helpful to understand the differences in how to communicate through face-to-face interactions, phone conversations and digital communications like email and social media.

A deep understanding of the process of communication and communication skills is essential. It is vital to the success of any individual in any business. Here we shall see some of the many types of communication.

Communication styles change from person to person. During the process of communication, a person may invoke several channels or modes or methods to convey a message. But, the process of communication doesn't only depend on the source producing or relaying information.

It also equally depends on the communication method and the manner in which the receiver understands the message. Let us first understand Basic Model Of Communication

Basic Communication Model :

The sender-message-channel-receiver (SMCR) model of communication is an expansion of the Shannon-Weaver model of communication. David Berlo created this model.

According to the Shannon-Weaver model, communication includes the following concepts: sender, encoder, channel, decoder, receiver and feedback. Furthermore, there is also concept of "noise", which affects the communication process going through the channel and makes the message more difficult to understand by the receiver. Each of those concepts are defined as follows:

Sender: the originator of message.

Encoder: the transmitter which converts the message into signals (the way message is changed into signals, for example sound waves).

C**hannel**: the signal carrier or medium

Decoder: the reception place of the signal which converts signals into message. Decoding is done by the receiver when he gets the message.

Receiver: the recipient of the message from the sender. He usually gives feedback to the sender in order to make sure that the message was properly received.

Noise the message, transferred through a channel, can be interrupted by external noise (for instance, conversation may be interrupted by thunder or crowd noise).
Feedback: The receiver can get an inaccurate message. This is why feedback from the receiver is important in case the message is not properly received. Furthermore, the noise can also affect the decoding of the message by the receiver.

Communication begins at a given point. The first step is the generation of information. The second step is to put this information or data into a medium for transmission towards the intended audience.

During this process, the initiator of the communication must pay extra attention to the nature of the information. The communication skills will determine the effectiveness of their communication.

Types:

On the basis of the communication channels, types of communications are:

A. Verbal

B. Non-Verbal

C. Visual

Verbal

This involves the use of language and words for the purpose of passing on the intended message. In general terms, Verbal Communication means communication in the form of spoken words only. But, in the context of types of communication, verbal communication can be in the spoken or the written form. Thus, the verbal form may be oral or written as discussed below.

- **Written Communication:** This kind of communication involves any kind of exchange of information in the written form. For example, e-mails, texts, letters, reports, SMS, posts on social media platforms, documents, handbooks, posters, flyers, etc.
- **Oral Communication:** This is the communication which employs the spoken word, either direct or indirect as a communication channel. This verbal communication could be made on a channel that passes information in only one form i.e. sound.
  You could converse either face to face, or over the phone, or via voice notes or chat rooms, etc. It all comes under the oral communication. This form of communication is an effective form.

Non-Verbal Communication

In this type of communication, messages are relayed without the transmission of words. The messages here are wordless messages. This form of communication mainly assists verbal communication. It supplements it with gestures, body language, symbols, and expressions.

Through these, one may communicate one's mood, or opinion or even show a reaction to the messages that are relaying. One's non-verbal actions often set the tone for the dialogue. You can control and guide the communication if you control and guide the non-verbal communication. Some of the modes of non-verbal communication are:

Physical Non-verbal Communication

This is the sum total of the physically observable. For instance, hand gestures, body language, facial expressions, the tone of one's voice, posture, stance, touch, gaze, and others. Several researchers have revealed that physical nonverbal communication constitutes about 55% of our daily communications.

These are subtle signals that are picked up as part of our biological wiring. For example, if you rest your head on your palms, it will mean that you are very disappointed or angry. Similarly, other subtle hints will convey your reaction to the presenter or your audience's reaction to you.

Paralanguage

This is the art of reading between the lines. The main kind of such communication is done with the tone of one's voice. This kind of communication amounts to almost 38% of all the communication that we do every day. Along with the tone of voice, the style of speaking, voice quality, stress, emotions, or intonation serves the purpose of communication. And, these aspects are not verbal.

Visual:

Visual communication is the transmission of information and ideas using symbols and imagery. It is one of three main types of communication, along with verbal communication (speaking) and non-verbal communication (tone, body language, etc.). Visual communication is believed to be the type that people rely on most, and it includes signs, graphic designs, films, typography, and countless other examples. Visual communication can be represented in the form of a graph, a map, a chart, a Vann diagram, a pie chart, a model, a table, or even multimedia like gifs, videos, and images.

Barrier To Communication:

There are many reasons why interpersonal communications may fail. In many communications, the message (what is said) may not be received exactly the way the sender intended. It is, therefore, important that the communicator seeks feedback to check that their message is clearly understood.

The skills of Active Listening, Clarification and Reflection may help but the skilled communicator also needs to be aware of the barriers to effective communication and how to avoid or overcome them.

There are many barriers to communication and these may occur at any stage in the communication process. Barriers may lead to your message becoming distorted and you therefore risk wasting both time and/or money by causing confusion and misunderstanding.

Effective communication involves overcoming these barriers and conveying a clear and concise message. Common Barriers to Effective Communication:

- The use of jargon. Over-complicated, unfamiliar and/or technical terms.
- Emotional barriers and taboos. Some people may find it difficult to express their emotions and some topics may be completely 'off-limits' or taboo. Taboo or difficult topics may include, but are not limited

to, politics, religion, disabilities (mental and physical), racism and any opinion that may be seen as unpopular.

- Lack of attention, interest, distractions, or irrelevance to the receiver. Differences in perception and viewpoint.
- Physical disabilities such as hearing problems or speech difficulties.
- Physical barriers to non-verbal communication. Not being able to see the non-verbal cues, gestures, posture and general body language can make communication less effective. Phone calls, text messages and other communication methods that rely on technology are often less effective than face-to-face communication.
- Language differences and the difficulty in understanding unfamiliar accents.
- Expectations and prejudices which may lead to false assumptions or stereotyping. People often hear what they expect to hear rather than what is actually said and jump to incorrect conclusions.
- Cultural differences. The norms of social interaction vary greatly in different cultures, as do the way in which emotions are expressed. For example, the concept of personal space varies between cultures and between different social settings.
- A skilled communicator must be aware of these barriers and try to reduce their impact by continually checking understanding and by offering appropriate feedback.

Note: MCQs of 07 Marks to be asked from this Unit in GTU Exam so practice MCQS.

Practice Questions:

1) What is communication?

a. Communication is the means by which we stay in touch with other people and know what is happening in the world around us

b. Communication is the expression of ourselves in the form of verbal discussion

c. Communication is the varying ways in which we express ourselves

d. Communication is the various mediums we use for interaction

e. Communication is talking, listening, and interacting

2) True of False: All communication is verbal

a. True

b. False

3) What is non-verbal communication?

a. Non-verbal communication is another term for using body language

b. Non-verbal communication is about exchanging information without speaking words

c. Non-verbal communication is another term for written communication

d. Non-verbal communication is for people who cannot speak or hear

4)Which of the following is NOT a form of non-verbal communication?

a. Touch

b. Facial expressions

c. Physical proximity

d. Skype

e. Sign language

5) Which of the following is an example of body language?

a. Facial expression

b. Eye contact

c. Posture

d. Gestures

e. All of the above

6) What is paralanguage?

a. Language for the disabled

b. How something is said, rather than what is said

c. What is said, rather than how it is said

d. When how something is said matches what is being said

e. When how something is said does not match what is being said

7) Factors that influence communication, may become what to effective communication?

a. Barriers

b. Obstacles

c. Enhances

d. Improvements

e. Challenges

8) How will you know if communication was successful?

a. The person smiles and gives open body language

b. The person answers

c. It has the desired outcome

d. The person is agreeable

e. The person tells you

9) What does effective communication require?

a. Purpose or reason

b. Strategy or way of communicating

c. Acknowledgement

d. Feedback

e. All of the above

10) What is efficient communication?

a. Talking quickly and using minimal words to get the point across

b. Spending the minimum amount of time and effort to get the communication message across successfully

c. Ensuring that the message is understood and being thorough enough to get the point across

d. Being able to convey a message with just body language and gestures

e. Being able to use jargon and abbreviations while still being understood

SECTION 2

GRAMMAR

Unit 1

PARTS OF SPEECH

The **part of speech** explains how a word is used in a sentence. The part of speech indicates how the word functions in meaning as well as grammatically within the sentence. An individual word can function as more than one part of speech when used in different circumstances. Understanding parts of speech is essential for determining the correct definition of a word when using the dictionary.

There are eight main parts of speech (also known as word classes): **nouns, pronouns, adjectives, verbs, adverbs, prepositions, conjunctions** and **interjection**

NOUN - (Naming word)

A noun is the name of a person, place, thing or idea.

Examples of nouns: Daniel, London, table, dog, teacher, pen, city, happiness, hope

Example sentences: **Steve** lives in **Sydney**. **Mary** uses **pen** and **paper** to write **letters**

Practice Exercise:

Apply suitable nouns.

1. …..is late today.

2. ….is very expensive these days.

3. He has a blue ….

4. They are very good friends. Their ….is example for many of us.

5. The …..addressed the gathering.

PRONOUN - (Replaces a Noun)

A pronoun is used in place of a noun or noun phrase to avoid repetition.

Examples of pronouns: I, you, we, they, he, she, it, me, us, them, him, her, this, those

Example sentences: Mary is tired. **She** wants to sleep. **I** want **her** to dance with **me**.

Practice Exercise:

Apply suitable pronouns.

1 .I know Mr. James. ….is a very good doctor.

2. Please look after my family members. ….have arrived here today only.

3. Dr. Ranjana was my professor. ….received many awards.

4. Have you seen ….book?

5. The peacock is a beautiful bird. ….feathers are colourful.

ADJECTIVE - (Describing word)

An **adjective** describes, modifies or gives more information about a noun or pronoun.

Examples: big, happy, green, young, fun, crazy, three

Example sentences: The **little** girl had a **pink** hat.

Practice Exercise:

Apply suitable adjectives.

1. I saw a …..truck on the road.
2. There are ….buildings in mega cities.
3. The garden has ……flowers.
4. My friend is wearing a ….shirt.
5. ….students get good marks.

VERB - (Action Word)

A **verb** shows an action or state of being. A verb shows what someone or something is doing.

Examples: go, speak, run, eat, play, live, walk, have, like, are, is

Example sentences: I **like** Woodward English. I **study** their charts and **play** their games.

Practice Exercise:

Apply suitable verbs.

1. Samarth …to college daily.
2. Children …in the garden.
3. We ….newspapers.
4. The manager ….the meeting.
5. I ….this temple everyday.

ADVERB - (Describes a verb)

An **adverb** describes/modifies a verb, an adjective or another adverb. It tells how, where, when, how often or to what extent. Many adverbs end in -LY

Examples: slowly, quietly, very, always, never, too, well, tomorrow, here

Example sentences: I am **usually** busy. **Yesterday**, I ate my lunch **quickly**.

Practice Exercise:

Apply suitable adverbs.

1. The boy ran …..
2. They sang the song …..

3. Rahul can play cricket …..

4. The teacher is teaching this topic …

5. We should listen to this news …..

PREPOSITION - (Shows relationship)

A **preposition** shows the relationship of a noun or pronoun to another word. They can indicate time, place, or relationship.

Examples: at, on, in, from, with, near, between, about, under

Example sentences: I left my keys **on** the table **for** you.

In, On, At, into , for, Since, between, among, to, towards

In:

Use 1: When talking about time, we use 'in' when referring to an unspecific time of the day, a month, a season or a year.

- I always brush my teeth **in** the morning.
- My birthday is **in** June.
- It's always cold **in** winter.
- My brother was born **in** 1999.

Use 2: When talking about places, 'in' is used to indicate a location or place. Here are a few examples:

- "Mumbai is **in** India.
- I am **in** my room.

ON

Use 1: The word 'on', when talking about time, is for specific dates and days.

- He was born **on** September 24th.
- I go to the gym **on** Mondays and Wednesdays.

Use 2: When talking about places, 'on' is used when we are speaking about a surface. Something is on the surface of something else.

For example:

- The papers are **on** the coffee table.
- "I left the keys **on** the counter."

AT

Use 1: When talking about time, 'at' is used for a specific time.

- I will see you **at** 8:00 pm.
- My interview is **at** 3:00 pm.

Use 2: When talking about places, ‘at’ is used to indicate a specific place.

- We are meeting **at** the cafe.
- The football game is **at** the stadium.

INTO:

Used for showing movement: entering a place, building, or vehicle

- Hundreds of athletes marched into the stadium for the opening ceremony.
- She got into her car and drove away.

FOR:

It describes duration. It means “From the start of the period to the end of the period. so it is used for suggesting period of time.

- He has been living in Ahmedabad for several months .
- Usha has worked here for 10 years.

SINCE:

It defines a point in time in the past. It means “From a point in the past until now.”

- He has been watching TV **since 7 pm**.
- Mohan had been writing a book **since 2010**

BETWEEN:

Between is usually used with **two** separate and distinct things.
For example:

- The treasure is between the palm tree and the hut.
- Our holiday house is between the mountains and the sea.

AMONG :

Among is used with separate and distinct things **more than two**. It is used to portray the idea of being in a group or in the midst of a group. For example:

- I want to live among like-minded people.
- Share these sweets among yourselves.
-

TO :

Use 1. It is used to indicate a destination or direction:

- .Does he want to come to the park with us?

Use 2. It is used to indicate time

- Her train arrives at quarter to five.

TOWARDS:

It means in the direction of somebody/something

- They were heading towards the garden.

Sample Exercise:

1. He lives --- Hyderabad.
2. He started --- six --- the morning.
3. . The child has been missing --- yesterday.
4. The mail train is due --- 3 P.M.
5. He travelled thirty kilometres --- two hours.
6. the flower pot was kept….the shelf …the room.
7.. --- last month I have seen him but once.
8. The four friends shared the food ….themselves.
9. I saw him running ….the market.
10. The boy jumped .. the river to save the child.

CONJUNCTION - (Joining word)

A conjunction joins two words, ideas, phrases or clauses together in a sentence and shows how they are connected.

Examples: and, or, but, because, so, yet, unless, since, if.

Example sentences: I was hot and exhausted but I still finished the marathon.

Connectors - ,

If, Unless, Otherwise, Because, Therefore, Who, Which, Where, When, Why.
If & Unless
It shows Condition. if + present simple+ modal verb with future meaning

- If the weather improves, we'll go for a walk.
- Rama will go if Hari goes.

Unless means something similar to 'if … not'

- We'll go to the coast tomorrow unless it rains.
- Grievances cannot be redressed unless they are known.

Otherwise:
It is used to show what the result will be if the thing or condition, mentioned before, does not occur.

- Take your umbrella, **otherwise** you will get wet.

Because:
It connects the result of something with its reason.

- She spoke quietly because she didn't want her friend to hear.

Therefore:
It indicates the cause or result of a situation.

- I studied for long hours, therefore I got very high marks from the final exams.

Who
It is used to introduce a new part of a sentence about a **person** that was mentioned before.

- Mr. Mathur, who is a professor is known to me.

Which
It is used to introduce a new part of a sentence about a **thing** that was mentioned before.

- The book which you bought yesterday is very useful.

Where

It is used to introduce a new part of a sentence about a **place** that was mentioned before.

- The place where players are staying is a five star resort.

When:

It is used to introduce a new part of a sentence about **time** that was mentioned before

- The time when you called me, I was in a meeting.

Why:

It is used to introduce a new part of a sentence about **reason** that was mentioned before

- The officer told us the reason why he was in urgency to leave.

Practice exercise:

Join the sentence groups using suitable connectors.

1. He passed the exam. He had a good teacher.
2. I do not eat meat. I do not eat eggs.
3. She is poor. She is honest.
4. I can not tell you the reason. I will not attend the function.
5. I felt ill. I went on working.
6. Rohit scored a century. India won the match.
7. The car was badly damaged in the accident. It needs repair.
8. We feel bored. We go to the movies to relieve our boredom.
9. Mohit must give in. He must also apologize. Jatin will not forgive him otherwise.
10. The children were playing hide-and-seek.. The rain came down suddenly.

INTERJECTION - (Expressive word)

An interjection is a word or phrase that expresses a strong feeling or emotion. It is a short exclamation.

Examples: Ouch! Wow! Great! Help! Oh! Hey! Hi!

- Wow! I passed my English test.
- Great!
- Ouch! That hurts

Summary chart

Parts Of Speech

NOUN

Name of a person, place, thing or idea.

Examples: Daniel, London, table, hope
- ***Mary*** uses a blue ***pen*** for her ***notes***.

PRONOUN

A pronoun is used in place of a noun or noun phrase to avoid repetition.

Examples: I, you, it, we, us, them, those
- ***I*** want ***her*** to dance with ***me***.

ADJECTIVE

Describes, modifies or gives more information about a noun or pronoun.

Examples: cold, happy, young, two, fun
- The ***little*** girl has a ***pink*** hat.

VERB

Shows an action or a state of being.

Examples: go, speak, eat, live, are, is
- I ***listen*** to the word and then ***repeat*** it.

ADVERB

Modifies a verb, an adjective or another adverb. It tells how (often), where, when.

Examples: slowly, very, always, well, too
- ***Yesterday***, I ate my lunch ***quickly***.

PREPOSITION

Shows the relationship of a noun or pronoun to another word.

Examples: at, on, in, from, with, about
- I left my keys ***on*** the table ***for*** you.

CONJUNCTION

Joins two words, ideas, phrases together and shows how they are connected.

Examples: and, or, but, because, yet, so
- I was hot ***and*** tired ***but*** still finished it.

INTERJECTION

A word or phrase that expresses a strong emotion. It is a short exclamation.

Examples: Ouch! Hey! Oh! Watch out!
- ***Wow!*** I passed my English exam.

Practice Exercise:

To solve this exercise, you have to identify the noun, pronoun, verb, adverb, adjective, preposition, conjunction, interjection in the given sentences.

Tom went to market to buy books (_____).

He went to the market but (_____) did not buy new books.

I **liked** (_____) **him** (_____) better than he likes me.

A smart girl was dancing **quickly** (_____).

She (_____) eats apples in the morning daily.

When he was **sitting** (_____) on the grass, a snake bit him.

You (_____) caught him by his arm.

A **rich** (_____) lady bought a **beautiful** (_____) necklace.

Hurrah! (_____) I have passed the examination.

The cat is sitting **under** (_____) the chair.

Alas! (_____) I could not receive you.

The body of the cage is made of **iron**. (_____)

It is not **your** (_____) pen; it is hers.

There is still some milk **in** (_____) the jug.

Jimmy is **performing** (_____) his duties diligently.

The drawing made by you is **almost** (_____) perfect.

I shall not go **unless** (_____) you allow.

The road is **to** (_____) go by.

The flowers smell **sweet**. (_____)

He **frequently** (_____) goes to the beach.

UNIT 2. TENSES

In grammar, tense is a category that expresses time reference with reference to the moment of speaking. Tenses are usually manifested by the use of specific forms of verbs, particularly in their conjugation patterns. It is very essential to have knowledge of tenses for correct use of a language to establish effective communication.

There are three types of Tenses- **Present, Past and Future.**

Example:

- We watch movies every weekend. - Present Tense
- He wrote an application for that job yesterday. - Past Tense
- You will complete the project by next month. – Future Tense

Present Tense – The verb in present tense refers to the present time.

Past Tense- The verb in past tense refers to the past time.

Future Tense- The verb in future tense refers to the future time.

The tense of a verb shows not only time of action but also the state of action referred to. Each of these Tenses has four sub tenses-

1) **Simple,**
2) **Continuous,**
3) **Perfect and**
4) **Perfect Continuous Tense.**

Simple or Indefinite Tense:

Here the verb specifies the simple action, without anything being said about the completeness or incompleteness of the action.

Sub Tense	Person	Singular	Plural
Present	First person	I speak	We speak
	Second person	You speak	You speak
	Third person	He / She / It speaks	They speak
Past	First person	I Spoke	We spoke
	Second person	You spoke	You spoke
	Third person	He / She / It spoke	They spoke
Future	First person	I shall speak	We shall speak
	Second person	You will speak	You will speak
	Third person	He / She / It will speak	They will speak

Continuous/Progressive Tense:

Here the verb indicates incomplete or continuous action.

Sub Tense	Person	Singular	Plural
Present	First person	I am speaking	We are speaking
	Second person	You are speaking	You are speaking
	Third person	He / She / It is speaking	They are speaking
Past	First person	I was speaking	We were speaking

	Second person	You were speaking	You were speaking
	Third person	He / She / It was speaking	They were speaking

Perfect Tense:

Here the verb shows that the action is completed or perfect.

Sub Tense	Person	Singular	Plural
Present	First person	I have spoken	We have spoken
	Second person	You have spoken	You have spoken
	Third person	He/she/it has spoken	They have spoken
Past	First person	I had spoken	We had spoken
	Second person	You had spoken	You had spoken
	Third person	He/ she/ it had spoken	They had spoken

Perfect Continuous Tense:

Here the verb shows that the action started in past and still it is in progress.

Sub Tense	Person	Singular	Plural
Present	First person	I have been watching	We have been watching
	Second person	You have been watching	You have been watching
	Third person	He/she/it has been watching	They have been watching

USES OF TENSES :-

Present Tense [Simple Present Tense]

It is used:

i. To express a habitual action or an action happens regularly.
Examples:
- The manager gets up at five and starts work at seven
- Umesh practices the piano every day.

ii. For universal or general truth.
Examples:
- The earth turns 360º every day.
- Antarctica is covered with ice.

iii. In narrative such as sports events or demonstrations (substitute for the simple past). Examples:
- Virat catches the ball and he throws it to the wicket.
- First I put some butter in the pan and turn on the cooker.

iv. To express a future event that is part of a fixed timetable.
Examples:
- The train leaves at 03.00 pm sharp.
- The flight is at 07.00 tomorrow morning.

v. To state the facts and things in general that is always true.
Examples:
- India is a rich source of herbs.
- Gold isn't liquid at room temperature.

vi. In exclamatory sentences beginning with 'here' and 'there'.
Examples:
- There goes your trainer!
- Here comes the train you are waiting for!

vii. To introduce quotations.
Example:
- Swami Vivekananda says, "Arise, awake and do not stop until the goal is reached".

viii. Instead of the simple Future Tense in clauses of time and condition
Examples:
- I shall wait till you finish your lunch.
- If you heat water to 100 degrees, it boils.

Present Tense [Present Continuous Tense]

It is used:

i. To indicate an action that is happening at the moment of speaking.
Examples:
- I am just leaving office. I'll be home in an hour.
- Please be quiet. The children are sleeping.

ii. To indicate an action which may not happening at the time of speaking.
Examples:
- Aren't you teaching at the university now?
- At two in the afternoon, we are eating lunch.

iii. For definite future arrangements.
Examples:
- We are going to the beach at the weekend.
- I am not going to the party tonight.

iv. For habits that are not regular, but that happen very often. (an adverb like 'always', 'continuously' or 'constantly' are used)
Example:
- You are continuously losing your keys.
- She is constantly missing the train.
- Adhiraj is always smiling.

v. Verbs which refers to state rather than actions or progress, are not normally used in the continuous form in the present tense:
a) Perceptions: feel, smell, hear, taste, see
b) Emotions: want, wish, envy, fear, dislike, hate, hope, like, love regret, hope, refuse.
c) Thinking: think, suppose, believe, agree, consider, trust, remember, forget, know, understand, imagine
d) Appearing: appear, look, seem.

Present Tense [Present Perfect Tense]

It is used:

i. To indicate an action completed in the recent or immediate past (with just). Examples:
   - I have just finished my work.
   - He has just taken the medicine.

ii. To indicate a past action happened at an unspecified time.
   Examples:
   - I have been to France three times.
   - Madhuri has never travelled by train.
   - Manisha has studied two foreign languages.

iii. To show that something started in the past and has continued up until now. Examples:
   - Rashmi has been in England for six months.
   - Priya has loved chocolate since she was a little girl.

The adverb and adverbial phrases with unfinished time expressions can be used in Present Perfect such as: ever, never, once, many times, several times, before, so far, this month, this year, this week, today, already, yet, etc but not with specific past /finished time expressions such as: yesterday, one year ago, last week, when I was a child, when I lived in Japan, at that moment, that day, one day, etc.

Perfect Continuous Tense (Present Perfect Continuous Tense)

It is used

i. To express actions which started in the past and continue to the present. We often use this with 'for' and 'since'

- I've been living in London for two years.
- She's been working here since 2004.
- We've been waiting for the bus for hours.

ii. To express actions which have recently stopped and have a result, which we can often see, hear, or feel, in the present. We don't use a time word here. The action is over but the effect can be seen.

- I'm so tired, I've been studying.
- I've been running, so I'm really hot.
- It's been raining so the pavement is wet.

Past Tense [Simple Past Tense]

It is used:

i. To express the idea that an action started and finished at a specific time in the past. Examples:
   - I didn't see a play yesterday.
   - Did you have dinner last night?

ii. Sometime the specific time may not be mentioned. It can be implied by context. Example:
   - I didn’t sleep well (last night).

iii. To describe a past habit
   Examples:
   - They never went to school, they always skipped class.
   - Did you play a musical instrument when you were a kid?

Past Tense [Past Continuous Tense]-

It is used:

i. For an action going on at some time in the past.
Examples:
- Kavya was enjoying the games at funfair
- Stuti was preparing for IIT entrance exam.

ii. The past continuous and simple past are used together when a new action happened in the middle of longer action. Simple past used for later action.
Examples:
- While I was writing the email, the computer suddenly went off.
- What were you doing when I called you?

iii. It is also with 'Always', 'continuously' 'continually' or 'constantly' for persistent habit in the past.
Examples:
- She was always coming to class late
- I didn't like them because they were continuously complaining.

Past Tense [Past Perfect Tense]-

It is used:

i. To indicate a completed action before a certain point of time in the past.
Examples:
- When we arrived, the film had started.
- I had never seen such a beautiful beach before I went to Miami.

ii. To express the idea that something occurred before another action in the past. Examples:
- When I reached home, my mother had left for the office.
- I had written the letter before he arrived.

Future Tense [Simple Future Tense]-

It is used:

i. To talk about facts in the future time which we cannot control.
Examples:
- My uncle will turn forty this Sunday
- It will rain this week.

ii. To indicate an action that we think, expect, hope or believe will happen in the future. Examples:
- I think Brazil will win the World Cup.
- I'm sure you will enjoy the games.
- Probably, it will rain today.

iii. To indicate an action that we decide to do at the time of speaking
Examples:
- The task is not completed; I will complete it by evening.
- It is raining. I will take an umbrella.

Sample Exercises:

Rewrite the following sentences using correct form of verbs given in bracket.

1) When you arrive tonight, we…….. (go) out for dinner.

2) Whenever we meet, we …….. (plan) a trip.
3) The sun …….. (shine) brightly.
4) Vijay …….. (wait) for me when I arrived.
5) I promise I …….. (not/tell) him about the surprise party.
6) Shikhar Dhawan …….. (score) a century in the last match.
7) I …….. (get) hungry. Let's go and have something to eat.
8) . …….. (have) you ever …….. (visit) the U.S. before your trip in 2006?
9) Who …….. (invent) the bicycle?
10) Yesterday evening the phone …….. (ring) three times while we …….. (have) dinner.
11) When I met you last time, you …….. (think) of moving to a new flat.
12) She only understood the movie because she …….. (read) the book.
13) Can you …….. (help) me move this heavy table?
14) Hello Nitya, I …….. (not/see) you for ages. How are you?
15) We can go out now. It …….. (not/rain) any more.
16) He …….. (go) to that place every year.
17) There I…….. (notice) how important it…….. (be) to speak English nowadays.
18) And I…….. (already begin /) to read the novel.
19) If I …….. (pass) my exams successfully, I…….. (start) an apprenticeship in September.
20) While I …….. (do) the language course, I …….. (meet) lots of young people from all over the world.

UNIT 3. MODAL AUXILIARIES

An Auxiliary verb is a verb which helps or supports the main verb to form its tense, voice or mood. They are basically helping verbs and there are two types of Auxiliaries:

Primary & Modal.

[1] Primary Auxiliaries

a) Be (am, is, are ,was, were)

- I am a doctor.
- He was given a prize by the principal.
- They are doing their work.
- They were working here last year.

b) have (has, had) [Possession]

- We have a flat in Ahmedabad.
- Dr Tanna has a car.
- She had no money.

c) do (does, did) (Questions & Negative)

- What do you want from me? I don't have enough money.
- Does he go school on time?
- Did he complete his work?

[2] Modal Auxiliaries are used to express various moods and attitudes like permission, ability, duty, advice, suggestion, possibility …

SHALL

- He shall leave for Ahmedabad tomorrow. (Future)
- You shall be punished if you are late again. (Threat)
- You shall go out of the class. (Command)
- She shall have a prize. (Promise)
- Shall we have a cup of coffee?(Suggestion/ Proposal)
- Shall I carry your luggage? (to offer service)

SHOULD

- We should obey our elders. (Duty)
- We should keep promises.(Obligation)
- She should be in laboratory now. (Probability)

WILL

- He will come tomorrow. (Future)

- Will you lend me a pen, please? (Polite Request)
- I will speak to your customer care. (Threat)
- You will not go without my permission. (Command)
- I will teach you English (Promise)
- I will meet my target. (Determination)
- I will come to see you tomorrow. (Willingness)

WOULD

- Would you lend me your scooter, please? (Politeness)
- I wish you would get good marks.(Desire)
- I would like to have some coffee (likes/dislikes)
- I would rather stay at home than watching movie. (preference)

CAN

- She can speak English fluently. (Ability)
- We can walk 5 kms a day. (Capacity)
- Ramesh can come tomorrow. (Permission)
- She can be at home. (Possibility)

COULD

- I could run fast, when I was young. (Ability in Past)
- Could you help me in my assignment? (Request / Politeness)

MAY

- The guest may come. (Possibility)
- May I Come in Sir ? (Permission)
- It may rain today. (Uncertainty)
- May God bless you! (Wishes/Blessings)

MIGHT

- He might not come (Rare Possibility)
- Mayank has not come to school today. He might have missed the bus. (Possibility of Past)

MUST

- I must get the first prize. (Determination)
- He must have attended the meeting. (Certainty)
- You must pass mid semester exam. (Compulsion.)
- You must do your homework regularly. (Necessity)
- You must not speak loudly in the hospital. (Prohibition.)

Note:- have to/has to also suggests compulsion and necessity. Had to is used to show feeling of compulsion in past.

- I have to submit an assignment tomorrow.
- I had to submit the assignment yesterday though I was not much satisfied with my work.

NEED

- You need to go to a doctor.(Necessity)
- You need not study as the examination is over (absence of Necessity)

OUGHT TO

- We ought to love our neighbours. (Duty / Obligation / Desire)

Sample Exercise:

[1] Fill in the blanks with appropriate modal auxiliary:

1. On Saturdays, we …….go to school in informal dress.
2. Varun …… go for a vacation this summer.
3. When I was young, I …… swim across Ganga.
4. You ……not raise your voice.
5. I ……. to work hard to improve my performance.

[2] Fill in the blanks with appropriate modal auxiliary:

1) ……..we play football? (Permission)
2) The astrologer ….. leave the village as he lied to people. (compulsion)
3) The Indian Eleven ……. be disheartened. (Absence of Necessity)
4) ……we go to their help? (suggestion)
5) She ……come tomorrow.(Possibility)
6) ……have your book? (Permission)
7) Tomorrow ….. be a holiday. (Future)
8) Do not put off till tomorrow what you …. do today. (Ability)
9) He ….not tell a lie before me. (Desirability)
10) You …..come whenever you like. (Permission)
11) ……..god help you. (Blessing)
12) We …….honour our parents . (Moral obligation)
13) ……. You please let me have your book? (Polite request)
14) You …. Carry out government orders. (Compulsion)

15) He tried hard but … not lift it. (Past ability)
16) People …….. to vacate the village, as the flood has crossed the danger mark. (Necessity)
17) I ……borrow from this library very soon. (Ability)
18) We ……help the needy. (Desirability)
19) …….I carry your luggage? (Permission)
20) You …..not go until you finish this assignment. (Prohibition)
21) She ….. climb the hill when she was in college. (past ability)
22) ……..you teach my brother phonetics, please? (polite request)
23) I …….. read French. (ability)
24) They …..not enter the kitchen with shoes. (prohibition)
25) …….we have a cup of tea?(suggestion)
26) You ….. write assignment in this book. (permission)
27) We …… to take our umbrella as it is raining. (necessity)
28) We ….. take bath in the morning daily. (desirability)
29) Your wrist watch is almost new. You ……. Buy another one. (absence of necessity)
30) You ….. smoke at a petrol pump. It is highly inflammable. (negative obligation)
31) ……. You sweep my drawing room? (polite request)
32) No one …….. carry explosives in the train. (negative prohibition)

UNIT 4. SUBJECT VERB AGREEMENT

Subject – Verb Agreement means the harmony between the subject of the sentence and the verb. The verb always follows the subject of the sentence.

1. A finite verb must agree its subject in person and number.

Examples:

- I am reading a book.
- He is playing.
- The child is playing.
- The children are watching cartoons.

2. The Error of Proximity:

In cases where subject and verb are separated by a long phrase or a clause, the verb agrees with the real subject and not the noun or pronoun placed next to it.

Examples:

- The apples in the basket are fresh.
- The strong bond of affection between the two cousins was obvious.
- The joys one experiences in one's childhood are beyond description.

3. The Introductory '*There':*

In a sentence beginning with *there*, the verb agrees with the real subject that follows *there.*

Examples:

- There is no proof of his involvement in this case.
- There are major flaws in your argument.

4. Two or More Nouns or Pronouns joined by 'And'

(a) Subject consists of two or more nouns or pronouns joined by and- PLURAL Verb.

Examples:

- He and I were given the responsibility of the stage.
- Hard work and sincere efforts are the key to success.

(b) The nouns refer to the same person or thing –SINGULAR Verb

Examples:

- The director and producer of the movie was present there.
- Rice and curry is his favorite dish.

(c) The nouns convey the same meaning, placed together only for emphasis-Singular verb

Examples:

- The honour and the glory of my country is uppermost in my mind.
- The power and influence Gandhiji exerted over the Indian masses was really great.

5. Subject consists of two nouns or pronouns joined with as well as, together with, along with, in addition to: verb agrees with the first subject

Examples:

- Mr. Das as well as his friends has escaped unhurt.
- You as well as I are responsible for our losses.
- The captain with othe team members was given a hearty welcome.

6.Two subjects joined with not only, but also: Verb agrees with the latter subject

Example:

- Not only the principal but also the teachers have played an important role.

7. Two subjects joined with…or, neither…has .nor verb agreed with the latter subject.

Examples:

- Either you or Gaurav is responsible for the mistake.
- Neither Gaurav nor you are responsible for the mistake.

8. One subject singular and the other plural

The pattern is: **Either /Neither+ Singular sub +or/nor + Plural sub. Plural verb**

Examples:

- Either he or his parents are going to attend the marriage.
- Neither the moon nor the stars are shining today.

9. **Either, Neither, Each, Everyone, One of the -Singular Verb**

Examples:

- She does not care what either of her parents says.
- Neither of these two students has done well.
- Each of the students has to submit the assignment.
- Everyone in the family has been questioned.
- One of the books is going to win the Booker Prize.

10. None refers to amount or quality - Singular Verb

Example:

- None of the work was done.
  - **None followed by plural noun or pronoun: Verb usually plural but can be singular**

  Examples:

- None of the stories are interesting.
- None of his stories has appealed the audience.

11. Much, More, Little, Less - Singular Verb

Examples:

- Much of my anxiety is over.
- More than half of the time is over.
- Little has been achieved so far.
- Less of my time is now wasted on attending to phone calls.

12. A lot of, a great deal of, plenty of, most of, some of, refer to amount or quantity

Singular Verb Examples:

- A lot of time was wasted on preliminary enquiries.
- Plenty of help was available.
- Lots of food was distributed to the poor.

➢ **A lot of, a great deal of, plenty of, most of, some of refer to number.**

Plural Verb Examples:

- Lots of people are taking part in the marathon.
- Plenty of shops accept payments by a credit card.

Sample Exercise:

[1] Fill in the blanks:-

1. The sound of bells ……..(was, were) heard all over the neighborhood.
2. Sincere effort not more advice …. (is, are) the need of the hour.
3. Some of the work (remain, remains) to be done.
4. Either the captain or the bowler …. (is, are) at fault.
5. The teacher along with the students (have, has) gone on picnic.
6. Neither of the candidates (was, were) suitable.
7. The teacher as well as the students (was, were) present on the ground.
8. She, not you (have, has) given the right answer.

[2] Pick the right verb:-

1. His use of clauses and connectors (is/are) appalling.
2. One of the students in my class (own/owns) a motorcycle.
3. There (was/were) several; people in the adjoining room.
4. The deputy along with thirty miners (were/was) killed.
5. The pump including the motor and the hose (cost/costs) Rs. 10,000/-.
6. Either the sand or the cement (is/are) bad.
7. The chief engineer accompanied by two executive engineers (is/are) coming today.
8. Each of the boxes (weigh/weighs) 10 kgs.
9. None if the gas (has/have) been consumed.
10. Either Ram or his brother (work/works) as a manager here.
11. None of them (attends/attend) to their work these days.
12. Some of the work (remain/remains) unfinished.
13. Some of the pipes (run/runs) for several miles.
14. All the oil (has/have) been stolen.
15. All the laborers (is/are) tribals.
16. Apple pie and custard (is/are) my favourite dish.
17. Some people (dislikes, dislike) travelling by sea, as it (make, makes) them sea-sick.
18. The Thirty-Nine steps (was, were) written by John Buchan.
19. The secretary and the member (has, have) come to visit the institute today.
20. The trouble with these guys (is,are) their rustic approach.

21. A lot of good we take (is/are) wasted.
22. A large amount of money he invested (was/were) lost.
23. Some more milk (is/are) needed.
24. None of these dishes (is/are) to my taste.
25. Only a few students (is/are) likely to fail.
26. A little dust (is/are) visible.
27. A lot of money (has/have) been spent on buildings.
28. None of the children (is/are) intelligent.
29. The president and the secretary (were/was) arrested.

UNIT 5 Basic Sentence Patterns of English

Sentence: A sentence is a textual unit consisting of one or more words that are grammatically linked.

Here we will study basic four patterns of English. For better understanding of the same, We need to understand the following terms.

Subject: A *subject* is a part of a sentence that contains the person or thing performing the action (or *verb*) in a sentence. Traditionally the subject is the word or phrase which controls the verb in the clause.

- **The peon** rings the bell.

Verb: Verbs are words that express action or state of being. You have studied about them in parts of speech and tenses. They are action words in the sentence.

- He **runs** fast.

Object: An object is a noun, a noun phrase, or a pronoun that is affected by the action of a verb.

- Ram is reading **a newspaper**.

Adverbial: Adverbials are words that we use to give more information about a verb. They can be one word (angrily, here) or phrases (at home, in a few hours) and often say how, where, when or how often something happens or is done, though they can also have other uses..

- He speaks **fluently.**
- Lata ate breakfast **yesterday morning**.

Complement: Complement is the term used for a word or words that are needed to complete the meaning of an expression.

- Algebra is difficult.

The following are basic four patterns to make a meaningful sentence.

1. **S + V : Subject + Verb**

- He/ laughed.
- Dogs/ bark.
- We /enjoyed.

2. S+V+O: Subject + Verb+ Object

- We / received / the parcel.
- Many students / witnessed / the play.
- The police / arrested / the thief

3. S+V+A: Subject + Verb+ Adverbial

- The train / arrived / late
- It / rained / last night
- He / reads / slowly

4. S+V+C: Subject + Verb+ Complement

- They / are / players.
- I / am / an Indian.
- Her father / is / a doctor

Practice exercise

1. Identify the sentence pattern of given sentences.

1. They / worked / hard
2. It / was / a very pleasant talk
3. The winner was rewarded.
4. She / sings / a song
5. They / came / suddenly.
6. The class / became / noisy
7. People/ cried.
8. Her father / is / a doctor
9. I /refuse.
10. You/ are/ intelligent.

2. Form ten sentences of each sentence pattern.

SECTION 3

PROSE AND POETRY

Unit 1
The Leopard

Ruskin Bond

I first saw the leopard when I was crossing the small stream at the bottom of the hill.

The ravine was so deep that for most of the day it remained in shadow. This encouraged many birds and animals to emerge from cover during daylight hours. Few people ever passed that way: only milkmen and charcoal-burners from the surrounding villages.

As a result, the ravine had become a little haven of wildlife, one of the few natural sanctuaries left near Mussoorie, a hill- station in northern India.

Below my cottage was a forest of oak and maple and Himalayan rhododendron. A narrow path twisted its way down through the trees, over an open ridge where red sorrel grew wild, and then steeply down through a tangle of wild raspberries, creeping vines and slender bamboo.

At the bottom of the hill the path led on to a grassy verge, surrounded by wild dog roses. (It is surprising how closely the flora of the lower Himalayas, between 5,000 to 8,000 feet, resembles that of the English countryside.)

The stream ran close by the verge, tumbling over smooth pebbles, over rocks worn yellow with age, on its way to the plains and to the little Song River and finally to the sacred Ganges.

When I first discovered the stream it was early April and the wild roses were flowering—small white blossoms lying in clusters.

I walked down to the stream almost every day, after two or three hours of writing.

I had lived in cities too long, and had returned to the hills to renew myself, both physically and mentally. Once you have lived with mountains for any length of time, you belong to them, and must return again and again.

Nearly every morning, and sometimes during the day, I heard the cry of the barking deer. And in the evening, walking through the forest, I disturbed parties of pheasant. The birds went gliding down the ravine on open, motionless wings. I saw pine martens and a handsome red fox, and I recognized the footprints of a bear.

As I had not come to take anything from the forest, the birds and animals soon grew accustomed to my presence; or possibly they recognized my footsteps. After some time, my approach did not disturb them.

The langurs in the oak and rhododendron trees, who would at first go leaping through the branches at my approach, now watched me with some curiosity as they munched the tender green shoots of the oak. The young ones scuffled and wrestled like boys, while their parents groomed each other's coats, stretching themselves out on the sunlit hillside. But one evening, as I passed, I heard them chattering in the trees, and I knew I was not the cause of their excitement.

As I crossed the stream and began climbing the hill, the grunting and chattering increased, as though the langurs were trying to warn me of some hidden danger. A shower of pebbles came rattling down the steep hillside, and I looked up to see a sinewy, orange-gold leopard poised on a rock about twenty feet above me.

It was not looking towards me, but had its head thrust attentively forward, in the direction of the ravine. Yet it must have sensed my presence, because it slowly turned its head and looked down at me.

It seemed a little puzzled at my presence there; and when, to give myself courage, I clapped my hands

sharply, the leopard sprang away into the thickets, making absolutely no sound as it melted into the shadows.

I had disturbed the animal in its quest for food. But a little after I heard the quickening cry of a barking deer as it fled through the forest. The hunt was still on.

The leopard, like other members of the cat family, is nearing extinction in India,and I was surprised to find one so close to Mussoorie. Probably the deforestation that had been taking place in the surrounding hills had driven the deer into this green valley; and the leopard, naturally, had followed.

It was some weeks before I saw the leopard again, although I was often made aware of its presence. A dry, rasping cough sometimes gave it away. At times I feltalmost certain that I was being followed.

Once, when I was late getting home, and the brief twilight gave way to a dark, moonless night, I was startled by a family of porcupines running about in a clearing.I looked around nervously, and saw two bright eyes staring at me from a thicket. I stood still, my heart banging away against my ribs. Then the eyes danced away, and Irealized that they were only fireflies.

In May and June, when the hills were brown and dry, it was always cool and green near the stream, where ferns and maidenhair and long grasses continued to thrive.

Downstream I found a small pool where I could bathe, and a cave with water dripping from the roof, the water spangled gold and silver in the shafts of sunlightthat pushed through the slits in the cave roof.

'He maketh me to lie down in green pastures: he leadeth me beside the still waters.' Perhaps David had discovered a similar paradise when he wrote those words; perhaps I, too, would write good words. The hill-station's summer visitors had not discovered this haven of wild and green things. I was beginning to feel thatthe place belonged to me, that dominion was mine.

The stream had at least one other regular visitor, a spotted forktail, and though itdid not fly away at my approach it became restless if I stayed too long, and then it would move from boulder to boulder uttering a long complaining cry.

I spent an afternoon trying to discover the bird's nest, which I was certain contained young ones, because I had seen the forktail carrying grubs in her bill. The problem was that when the bird flew upstream I had difficulty in following her rapidly enough as the rocks were sharp and slippery.

Eventually I decorated myself with bracken fronds and, after slowly making my way upstream, hid myself in the hollow stump of a tree at a spot where the forktail often disappeared. I had no intention of robbing the bird: I was simply curious to seeits home.

By crouching down, I was able to command a view of a small stretch of the stream and the sides of the ravine; but I had done little to deceive the forktail, who continued to object strongly to my presence so near her home.

I summoned up my reserves of patience and sat perfectly still for about ten minutes. The forktail quietened down. Out of sight, out of mind. But where had she gone? Probably into the walls of the ravine where I felt sure, she was guarding hernest.

I decided to take her by surprise, and stood up suddenly, in time to see not the forktail on her doorstep, but the leopard bounding away with a grunt of surprise! Two urgent springs, and it had crossed the stream and plunged into the forest.

I was as astonished as the leopard, and forgot all about the forktail and her nest. Had the leopard been following me again? I decided against this possibility. Only man-eaters follow humans, and, as far as I knew, there had never been a man-eaterin the vicinity of Mussoorie.

During the monsoon the stream became a rushing torrent, bushes and small trees were swept away, and the friendly murmur of the water became a threatening boom.I did not visit the place too often, as there were leeches in the long grass.

One day I found the remains of a barking deer which had only been partly eaten. Iwondered why the

leopard had not hidden the rest of his meal, and decided that it must have been disturbed while eating.

Then, climbing the hill, I met a party of hunters resting beneath the oaks. They asked me if I had seen a leopard. I said I had not. They said they knew there was a leopard in the forest.

Leopard skins, they told me, were selling in Delhi at over 1,000 rupees each. Of course there was a ban on the export of skins, but they gave me to understand that there were ways and means. . . . I thanked them for their information and walked on,feeling uneasy and disturbed.

The hunters had seen the carcass of the deer, and they had seen the leopard's pug-marks, and they kept coming to the forest. Almost every evening I heard their guns banging away; for they were ready to fire at almost anything.

'There's a leopard about,' they always told me. 'You should carry a gun.''I don't have one,' I said.

There were fewer birds to be seen, and even the langurs had moved on. The red fox did not show itself; and the pine martens, who had become quite bold, now dashed into hiding, at my approach. The smell of one human is like the smell of anyother.

And then the rains were over and it was October; I could lie in the sun, on sweet- smelling grass, and gaze up through a pattern of oak leaves into a blinding blue heaven. And I would praise God for leaves and grass and the smell of things, the smell of mint and bruised clover, and the touch of things—the touch of grass and airand sky, the touch of the sky's blueness.

I thought no more of the men. My attitude towards them was similar to that of the denizens of the forest. These were men, unpredictable, and to be avoided if possible.

On the other side of the ravine rose Pari Tibba, Hill of the Fairies: a bleak, scrub-covered hill where no one lived.

It was said that in the previous century Englishmen had tried building their houseson the hill, but the area had always attracted lightning, due to either the hill's location or due to its mineral deposits; after several houses had been struck by lightning, the settlers had moved on to the next hill, where the town now stands.

To the hillmen it is Pari Tibba, haunted by the spirits of a pair of ill-fated loverswho perished there in a storm; to others it is known as Burnt Hill, because of its scarred and stunted trees.

One day, after crossing the stream, I climbed Pari Tibba—a stiff undertaking, because there was no path to the top and I had to scramble up a precipitous rock-facewith the help of rocks and roots that were apt to come loose in my groping hand.

But at the top was a plateau with a few pine trees, their upper branches catching the wind and humming softly. There I found the ruins of what must have been the houses of the first settlers—just a few piles of rubble, now overgrown with weeds,sorrel, dandelions and nettles.

As I walked through the roofless ruins, I was struck by the silence that surrounded me, the absence of birds and animals, the sense of complete desolation.

The silence was so absolute that it seemed to be ringing in my ears. But there wassomething else of which I was becoming increasingly aware: the strong feline odour of one of the cat family.

I paused and looked about. I was alone. There was no movement of dry leaf or loose stone. The ruins were for the most part open to the sky. Their rotting rafters had collapsed, jamming together to form a low passage like the entrance to a mine;and this dark cavern seemed to lead down into the ground.

The smell was stronger when I approached this spot, so I stopped again and waited there, wondering if I had discovered the lair of the leopard, wondering if the animal was now at rest after a night's hunt.

Perhaps he was crouching there in the dark, watching me, recognizing me,knowing me as the man who walked alone in the forest without a weapon.

I like to think that he was there, that he knew me, and that he acknowledged my visit in the

friendliest way: by ignoring me altogether.

Perhaps I had made him confident—too confident, too careless, too trusting of thehuman in his midst. I did not venture any further; I was not out of my mind. I did not seek physical contact, or even another glimpse of that beautiful sinewy body, springing from rock to rock. It was his trust I wanted, and I think he gave it to me.

But did the leopard, trusting one man, make the mistake of bestowing his trust on others? Did I, by casting out all fear—my own fear, and the leopard's protective fear —leave him defenseless?

Because next day, coming up the path from the stream, shouting and beating drums, were the hunters. They had a long bamboo pole across their shoulders; and slung from the pole, feet up, head down, was the lifeless body of the leopard, shot in the neck and in the head.

'We told you there was a leopard!' they shouted, in great good humour. 'Isn't he afine specimen?'

'Yes,' I said. 'He was a beautiful leopard.'

I walked home through the silent forest. It was very silent, almost as though thebirds and animals knew that their trust had been violated.

I remembered the lines of a poem by D. H. Lawrence; and, as I climbed the steepand lonely path to my home, the words beat out their rhythm in my mind: 'There was room in the world for a mountain lion and me.'

Glossary:

Ravine: Narrow Valley

Sanctuary: Shelter

Curiosity: Interest

Extinction: Loss

Pasture: Grazing Land

Precipitous: Steep

Denizens: A person, animal, or plant that lives or is found in a particular place

Glimpse: Sight

Ex: 1. Choose the correct option:

1. The author first saw the leopard when …
   (a) he was climbing the hill (b) it was caught by hunters (c) he was crossing the stream (d) he was going after forktail
2. When the author discovered the stream, it was month of …
   (a) May (b) June (c) February (d) April
3. The … was a regular visitor of the stream.
   (a) Forktail (b) Tiger (c) lion (d) sparrow
4. Leopared skins are sold in ….
   (a) Delhi (b) Kolkatta (c) Lucknow (d) Mumbai
5. ….. is called *Hill of Fairies*
   (a) Pari Hill (b) Angel Tibba (c) God Hill (d) Pari Tibba

Ex: 2. Answer the following questions:

1. Describe the valley where the leopard lived.
2. Why did the author return to mountains?
3. Why didn't his approach disturb the birds and animals?
4. What happened when the leopard sensed the author's presence?
5. What did the author do to find forktails's home?
6. What was the hunters' advice to the author?
7. What was the author's attitude towards men?

Suggested Speaking Skills Topics (For 30 Marks of PA in LAB)

1. Beauty of Nature
2. Cruelty towards Animals
3. Environment Conservation

UNIT 2 After Twenty Years

O'Henry

The policeman on the beat moved up the avenue impressively. The impressiveness was habitual and not for show, for spectators were few. The time was barely 10 o'clock at night, but chilly gusts of wind with a taste of rain in them had well nigh depeopled the streets.

Trying doors as he went, twirling his club with many intricate and artful movements, turning now and then to cast his watchful eye adown the pacific thoroughfare, the officer, with his stalwart form and slight swagger, made a fine picture of a guardian of the peace. The vicinity was one that kept early hours. Now and then you might see the lights of a cigar store or of an all-night lunch counter; but the majority of the doors belonged to business places that had long since been closed.

When about midway of a certain block the policeman suddenly slowed his walk. In the doorway of a darkened hardware store a man leaned, with an unlighted cigar in his mouth. As the policeman walked up to him the man spoke up quickly.

"It's all right, officer," he said, reassuringly. "I'm just waiting for a friend. It's an appointment made twenty years ago. Sounds a little funny to you, doesn't it? Well, I'll explain if you'd like to make certain it's all straight. About that long ago there used to be a restaurant where this store stands--'Big Joe' Brady's restaurant."

"Until five years ago," said the policeman. "It was torn down then."

The man in the doorway struck a match and lit his cigar. The light showed a pale, square-jawed face with keen eyes, and a little white scar near his right eyebrow. His scarfpin was a large diamond, oddly set.

"Twenty years ago to-night," said the man, "I dined here at 'Big Joe' Brady's with Jimmy Wells, my best chum, and the finest chap in the world. He and I were raised here in New York, just like two brothers, together. I was eighteen and Jimmy was twenty. The next morning I was to start for the West to make my fortune. You couldn't have dragged Jimmy out of New York; he thought it was the only place on earth. Well, we agreed that night that we would meet here again exactly twenty years from that date and time, no matter what our conditions might be or from what distance we might have to come. We figured that in twenty years each of us ought to have our destiny worked out and our fortunes made, whatever they were going to be."

"It sounds pretty interesting," said the policeman. "Rather a long time between meets, though, it seems to me. Haven't you heard from your friend since you left?"

"Well, yes, for a time we corresponded," said the other. "But after a year or two we lost track of each other. You see, the West is a pretty big proposition, and I kept hustling around over it pretty lively. But I know Jimmy will meet me here if he's alive, for he always was the truest, stanchest old chap in the world. He'll never forget. I came a thousand miles to stand in this door to-night, and it's worth it if my old partner turns up."

The waiting man pulled out a handsome watch, the lids of it set with small diamonds.

"Three minutes to ten," he announced. "It was exactly ten o'clock when we parted here at the restaurant door."

"Did pretty well out West, didn't you?" asked the policeman.

"You bet! I hope Jimmy has done half as well. He was a kind of plodder, though, good fellow as he was. I've had to compete with some of the sharpest wits going to get my pile. A man gets in a groove in New York. It takes the West to put a razor-edge on him."

The policeman twirled his club and took a step or two.
"I'll be on my way. Hope your friend comes around all right. Going to call time on him sharp?"

"I should say not!" said the other. "I'll give him half an hour at least. If Jimmy is alive on earth he'll be here by that time. So long, officer."

"Good-night, sir," said the policeman, passing on along his beat, trying doors as he went.

There was now a fine, cold drizzle falling, and the wind had risen from its uncertain puffs into a steady blow. The few foot passengers astir in that quarter hurried dismally and silently along with coat collars turned high and pocketed hands. And in the door of the hardware store the man who had come a thousand miles to fill an appointment, uncertain almost to absurdity,with the friend of his youth, smoked his cigar and waited.

About twenty minutes he waited, and then a tall man in a long overcoat, with collar turned up to his ears, hurried across from the opposite side of the street. He went directly to the waiting man.

"Is that you, Bob?" he asked, doubtfully.

"Is that you, Jimmy Wells?" cried the man in the door.

"Bless my heart!" exclaimed the new arrival, grasping both the other's hands with his own. "It's Bob, sure as fate. I was certain I'd find you here if you were still in existence. Well, well, well--twenty years is a long time. The old gone, Bob; I wish it had lasted, so we could have had another dinner there. How has the West treated you, old man?"

"Bully; it has given me everything I asked it for. You've changed lots, Jimmy. I never thought you were so tall by two or three inches."

"Oh, I grew a bit after I was twenty." "Doing

well in New York, Jimmy?"

"Moderately. I have a position in one of the city departments. Come on, Bob; we'll go around to a place I know of, and have a good long talk about old times."

The two men started up the street, arm in arm. The man from the West, his egotism enlarged by success, was beginning to outline the history of his career. The other, submerged in his overcoat, listened with interest.

At the corner stood a drug store, brilliant with electric lights. When they came into this glare each of them turned simultaneously to gaze upon the other's face.

The man from the West stopped suddenly and released his arm.

"You're not Jimmy Wells," he snapped. "Twenty years is a long time, but not long enough to change a man's nose

from a Roman to a pug."

"It sometimes changes a good man into a bad one," said the tall man. "You've been under arrest for ten minutes, 'Silky' Bob. Chicago thinks you may have dropped over our way and wires us she wants to have a chat with you. Going quietly, are you? That's sensible. Now, before we go on to the station here's a note I was asked to hand you. You may read it here at the window. It's from Patrolman Wells."

The man from the West unfolded the little piece of paper handed him. His hand was steady when he began to read, but it trembled a little by the time he had finished. The note was rather short.

"Bob: I was at the appointed place on time. When you struck the match to light your cigar I saw it was the face of the man wanted in Chicago. Somehow I couldn't do it myself, so I went around and got a plain clothes man to do the job."

JIMMY.

."

Glossary:

on the beat: usual path of a policeman on duty
avenue : road with trees on both sides
habitual : usual
intricate : complicated
chilly: very cold
gust: sudden violent rush of wind
pacific: peaceful
thoroughfare: a street much used by traffic and open at both ends
swagger: walk in a proud manner
vicinity: surroundings, neighbourhood
reassuringly: comfortingly and without any fear
torn down: pulled down, demolished
oddly: strangely
chum: close friend
chap: fellow, man
dragged out: caused to last an unnecessarily long time in
bustling around: moving around quickly
turns up: comes up, arrives
plodder: person who works slowly but earnestly
groove: way of living that becomes a habit
twirled: turned round quickly
club: heavy stick with one thick end
drizzle: rain in many fine drops
astir: in a state of excitement
dismally: gloomy
lasted: existed for more time
egotism: practice of talking about oneself
chat: friendly talk

Sample Exercises:

Ex: 1. Choose the correct option:

1. The location of the story is near ….
   (b) Dehradun (b) Mussoorie (c) Shimla (d) Dharmashala
3. Where was the man standing?
   (b) Near general store (b) near medical store (c) near bus stand (d) near hardware store
4. When was the appointment made ?
   (a) Before 20 years (b) before 15 years (c) after 20 years
   (d) before 10 years
5. The man was waiting for his _____.
   (b) wife (b) friend (c) brother (d) customer
6. The man and his friend Jimmy belong to _____ city.
   (a) New York (b) London (c) Mumbai (d) Paris
7. What was the time of appointment?
   (a) 12 o'clock (b) 11 o'clock (c) 10 o'clock (d) 9 o'clock
8. What did the tall man handed over to Bob?
   (a) A book (b) a bag (c) a chocolate (d) a note
9. Who wrote the note?
   (a) Bob (b) Jimmy (c) Vera (d) O'Henry

Ex: 2. Answer the following questions:

8. How did the policeman move up the avenue?
9. How was the weather that night?
10. What did the stranger say to the policeman?
11. What was there in place of the store at that spot twenty years ago?
12. Who was the stranger's friend?
13. Where did they take the last dinner?
14. What kind of man was his friend Jimmy?
15. What did Bob tell the man in the overcoat?
16. Was he really his friend Jimmy Wells?
17. Why was Bob under arrest?
18. Whose note was handed over to Bob in the end?

Suggested Speaking Skills Topics (For 30 Marks of PA in LAB)

1. Friendship
2. What is more important- duty or relations?
3. The choice between Right and Wrong .

UNIT 3 Stopping by Woods on a Snowy Evening

Robert Frost

Whose woods these are I think I know.
His house is in the village though;
He will not see me stopping here
To watch his woods fill up with snow.

My little horse must think it queer
To stop without a farmhouse near
Between the woods and frozen lake
The darkest evening of the year.

He gives his harness bells a shake
To ask if there is some mistake.
The only other sound's the sweep
Of easy wind and downy flake.

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep

Glossary:

Woods : an area of land covered with thick growth of trees
Queer: beyond or deviating from the usual or expected
Farmhouse: a house attached to a farm
Frozen: turned into ice
Harness: an arrangement of leather straps fitted to a draft animal
Flake : a crystal of snow
Promise: a verbal commitment to do something in the future
Sleep : euphemisms for death

Sample Exercise:

Q.1 Where was the speaker going? What stopped him on the way?
Q.2 What according to the speaker will surprise the horse?
Q.3 What does the speaker wish to convey through the phrase "fill up with the snow"?
Q.4 What does the poet says about the owner of the woods?
Q.5 What are the sights and sounds that the poet experiences in the woods?
Q.6 What promises do you think the poet has to keep?
Q.7 What message do the last paragraph convey?
Q. 8 What is the role played by the horse in this poem?

Q. 9 Write a short note on :

(1) Description of nature

(2) Central idea of the poem

UNIT 4 Where the Mind is Without Fear

Rabindranath Tagore,

"Where the mind is without fear

and the head is held high,

where knowledge is free.

Where the world has not been broken up into fragments by narrow domestic walls.

Where words come out from the depth of truth,

where tireless striving stretches its arms toward perfection.

Where the clear stream of reason has not lost it's way

into the dreary desert sand of dead habit.

Where the mind is led forward by thee

into ever widening thought and action.

In to that heaven of freedom, my father,

LET MY COUNTRY AWAKE!"

—

Glossary:

Fragments- pieces

Head is held high- self respect

Domestic- pertaining to family.

Striving – try hard, motivated.

Tireless - without getting tired

Stream: river

Dreary: dull

Reason: intellect

Dead habit: old customs

Desert – dry area of land

Awake- to get up from sleep

Sample Exercise:

Q.1 What is meant by "mind is without fear and head is held high". Tick the correct answer.

(i) to be fearless and self respecting

(ii) to be proud of one's high position .

(iii) to stand straight and be carefree.

Q. 2. What does the poet mean by “where knowledge is free”?

Q.3. The ‘domestic walls’ are usually associated with safety, comfort and love.What is the meaning of ‘narrow domestic walls’? Choose the correct answer.

(i) small houses which make us feel cramped

(ii) ideas which are petty and narrow-minded.

iii) a house divided into rooms by walls.

Q.4. What according to the poet do people tirelessly strive towards?

Q.5. How does the poet describe the old habit?

Q.6 How does the poet describe ‘heaven of freedom’?

Q.7. Who does the poet address as ‘thee’ and my father?

Q.8 What kind of freedom does the poet desire for his country?

Q.9 Write a short note on the central idea of the poem.

SECTION 4

Email Writing

The email writing format is the same for each of the categories, though the choice of words and language differ depending upon the type of email. One can use friendly and casual language in informal emails. The language used in formal emails should be professional, clear, and formal.

The email writing format is

Email Format

Let us look at the important **steps to follow** when writing a formal email.

1. Subject line

Grab attention with the subject line. The first part of an email which your recipient sees is the subject of the email. If you do not put it well, you risk having your email not opened until later or at all. Here are some things to keep in mind:

- Make the subject line **specific, simple, and to the point**. For example, instead of *'The internship report you asked for'*, write, *'Internship Report, {date/week/month}'*.
- The subject line should be **short**. Ideally, your subject line should stand around six words.
- Keep the most **important and informative words in the beginning** of the subject line.
- Use **markers** like *Fwd, Reply, Urgent*, or *Notice* to further narrow down the subject. It informs your reader about the nature of your email.

Some of the examples of good subject lines in formal emails can be:

- Marketing Budget, October 2018
- List of New Freelancers
- Job Application for the Post of XYZ
- Leave Application
- Query Regarding the Missing Information in the Document
- Contract Agreement - XYZ Assignment

2. Salutation

Each email is directed towards someone. Start your formal email with addressing the recipient in a manner fitting the relationship you have with them.

For people you are unfamiliar with or do not know the names of, use '*To Whom It May Concern*' or '*Dear sir/madam*'.
For senior officials, stick to their designation or follow it with their name, for example, '*To the Manager*', '*Dear Dr. Ghosh*', or '*Dear Ms. Kapoor*'.
Among colleagues, it may be appropriate to simply precede the name with a '*Hi*'.
Do not skip the salutation and always be respectful. Never use nicknames or just surnames or first names in a formal email.

3. Body of the email

The body text is the main part of your email. It is important to follow a certain pattern when writing the body of your email.

- The **opening paragraph should set the tone and reason** for your email. Introduce yourself if you are a stranger to the person you are writing to, and jot down why you are writing to them.
- For example, you can begin with '*My name is Abc, and this email is with reference to Xyz.'* or '*This is with reference to the marketing budget as discussed in the meeting.*'
- **Elaborate on your concern, question, or response** as comprehensively as possible. Write in a way that is easy to understand, but at the same time, do not lose your point in providing unnecessary information. Say only what is required.
- The **closing of the email** should also support the nature of your email. If you are asking a question, close with something like '*Hope to have an answer from you soon*', or *'Looking forward to hearing from you soon*', and if you are addressing a question, end with '*Hope I have sufficiently answered your query/doubts.'*
- Signature
- These are the last words of your email, capable of forming a lasting impression on your reader.

- Sign off with a simple word or phrase, which conveys respect. Safe choices are *'Best regards', 'Warmly', 'Sincerely', 'Kind regards'*, or simply *'Thanks'*.
- If you are writing to someone for the first time or someone who is not an immediate colleague or senior, use your full name.

- Furnish your name with contact information. Your phone number and/or work address are enough.
- If you are writing on behalf of or as an employee of an institution, make sure to mention it along with adequate contact details
- To make your signature even more effective, you may also choose or design an attractive (but not flashy) template.

Formal Email Samples

Formal emails are sent in a whole variety of situations. While they use the same rules, they may have to be modified according to their purpose.

Now that you are familiar with the format of a formal email, let us have a look at few email samples.

Email sample 1: A request

Subject: Extension on Report Deadline

Dear Mr./Ms. {Recipient's sir name},

I am writing this to request you for an extension on the XYZ project report which is due on {date}. My mother has taken ill unexpectedly, and I must leave for home tonight. I'm afraid it will take me a week before I can return to the office and complete the report.

Kindly grant me an extension till {date} for the same. I promise to deliver the project report by then.

Sincerely,
{Your name}
{Phone number}

Sample Emails

1.Inquiry

Question: Draft an email to make an inquiry for raincoats and umbrellas from a wholesaler in Mumbai .

To: rambrellasuppliers@gmail.com

From: tirupatiagency@gmail.com

Subject: Inquiry for different varieties of raincoats and umbrellas.

Dear Sir,

We would like to buy raincoats and umbrellas (product) for the next monsoon. You are a leading manufacturer of raincoats and umbrellas. We have also visited your website and we are interested in starting business with you.

We would like to see your company catalogue which has details of all the products that you manufacture. We would like to have all the details of different models and sizes of your products we intend to sell them during the coming rainy season.

Let us know the prices of your products and the rate of discount you allow Please inform us the time you will take to deliver the goods.

We hope to receive a prompt reply to this inquiry.

Thank You

Yours sincerely,

_____(Name)

2. Reply to inquiry

Question: You have received an inquiry for raincoats and umbrellas Draft a suitable reply.

To: tirupatiagency@gmail.com

From: rambrellasuppliers@gmail.com

Subject: reply to inquiry for different varieties of raincoats and umbrellas.

Dear Sir,

We have received your mail regarding the inquiry for different raincoats and umbrellas. We appreciate your interest in our products.

We have attached our company catalogue of all our products that we manufacture and price list with this mail.

We shall allow you 30% discount on the prices of these products. We can supply your goods within 10 days of receiving the order. You have to settle the account within 15 days of receiving the goods.

Please note that we will give you 3% extra rebate if your order exceeds Rs. 500000.

We are keen on executing your order quickly and carefully.

Thank You

Yours sincerely,

_____ (Name)

3. Placing an order

Question: Place an order of Air conditioners for your newly constructed branch office.

To: kabirworld21@gmail.com

From: gujaratagro@gmail.com

Subject: order for air conditioners for new office

Dear Sir,

We have received your mail reply to our inquiry about the air conditioners .We are thankful to you for your prompt reply.

We have studied the specification of the air conditioners and have found that it is according to our need. The terms and conditions of business stated by you are suitable to us. So, we request you to supply us 15 air conditioners as shown below:

Sr.No	Type	capacity	Quantity	Unit Price	Total Price
1	Voltas AC with inverter	1.5 ton	3	35000	105000
2	Voltas AC with inverter	2.0 ton	5	52000	260000
3	Voltas AC without inverter	1..5ton	2	33000	66000
4	Voltas AC without inverter	2.0 ton	5	50000	100000
				Total	531000

Please note that the air conditioners ought to be installed before 15th May 2021 since our new office is to start functioning from 18th May 2021..

Thank You

Yours sincerely,

_____(Name)

4. Complaint: Delay in Delivery of goods

Question: You have placed an order for table and ceiling fans for coming summer season. But the order has not been executed even after one month. Draft the complaint to the supplier about delay in delivery of goods.

To: newindia@gmail.com

From: Gujaratelectronics@gmail.com

Subject: complaint for delay in delivery of fans.

Dear Sir,

We refer to our order dated 2nd April 2021 for Usha Table and Ceiling Fans. We have specially instructed you to supply them before 18th April 2021but we are sorry we have not yet received the goods.

We had ordered the goods for the coming summer season. The delay in delivery of our order has caused great loss to our business.

We, therefore , request you to supply them within 7 days of receiving the mail. If you fail to do so, we shall be compelled to cancel our order.

We look forward to your prompt and positive response..

Thank You

Yours sincerely,

_____(Name)

5. Adjustment to above Complaint.

New India Electrical Suppliers have received a complaint from Gujarat Electronics, Ahemdabad about delay in delivery of goods. Draft a suitable reply.

To: Gujaratelectronics@gmail.com

From: newindia@gmail.com

Subject: reason for delay in delivery of fans

Dear Sir,

We have received your mail regarding delay in delivery of your order for table and ceiling fans. We are sorry for the inconvenience caused to you due to this delay.

The workers and staff in our office were on strike so the administrative work was badly paralyzed . Due to this we could neither execute your order nor intimate you about the delay in delivery.

However, the strike has been called off now. We hope we shall be able to dispatch the goods with four or five days. We trust you will understand our position and cooperate.

Thank You

Yours sincerely,

_____ (Name)

Complaint: shortage in goods

Question: You have placed an order for 500 compass boxes. But the consignment had only 475 boxes. Draft a complaint to the supplier.

To: omegainstruments@gmail.com

From: swastikstationers@gmail.com

Subject: complaint for shortage in number of boxes..

Dear Sir,

We are thankful to you for executing our order no. 24/A dated 20th April 2021 for500 Camel Compass boxes. However, we are sorry to point out that the execution of the order has not been as careful as it ought to be.

Our shop assistant has opened the container of compass boxes. He has reported that there are 475 compass boxes in it instead of 500.

Please make the necessary adjustment. We are sure that you will execute our orders more carefully in future.

Thank You

Yours sincerely,

_____(Name)

Adjustment to above Complaint.

Omega Instruments have received a complaint from Swastik Stationers that he has received 475 instead of 500 ordered by him. Draft a suitable reply.

To: swastikstationers@gmail.com

From: omegainstruments@gmail.com

Subject: adjustment for remaining 25 boxes

Dear Sir,

We have received your mail on 25th May 2021. We regret to note that you have received 475 Compass Boxes instead of 500 against your order no.24/A of 20th April 2021 .

We have dispatched the remaining 25 compass boxes by Maruti Couriers. You will receive them tomorrow evening.

We request you not to judge our services by this isolated incident. We shall try to render consistently efficient services in future.

Thank You

Yours sincerely,

_____ (Name)

Complaint: damaged goods

Question: You have placed an order for 250 Flower Vases. But you found that the consignment had 23 flower vases in damaged condition. Draft a complaint to the supplier.

To : duraguardglasses@gmail.com

From: suhasininovelties@gmail.com

Subject: complaint for damaged flower vases.

Dear Sir,

We have received 250 flower vases against our order no. 76/C dated 20th June 2021. However, when our shop assistant opened the box, he found 23 vases in damaged condition.

This damage is due to the fact that you have not packed the goods in thermocoal lined boxes according to our instructions.

Please send us 23 new flower vases. Alternatively permit us to adjust their price in the settlement of the invoices.

Thank You

Yours sincerely,

_____(Name)

Adjustment to above Complaint.

Duraguard Glasses Limited have received a complaint from Suhasini Novelties that he has received 23 flower vases in damaged condition. Draft a suitable reply.

To: suhasininovelties@gmail.com

From: duraguardglasses@gmail.com

Subject: adjustment for damaged flower vases

Dear Sir,

We have received your mail on 25th July 2021. We are sorry to note that you have received 23 flower vases in damaged condition out of total 250 in the consignment against your order no.76/C of 20th June 2021 .

We accept our liability in this matter . We have enclosed a credit note for Rs. 2300 along with this mail against 23 damaged flower vases.

We regret the trouble caused to you in this transaction. We assure you to execute your orders more carefully in future.

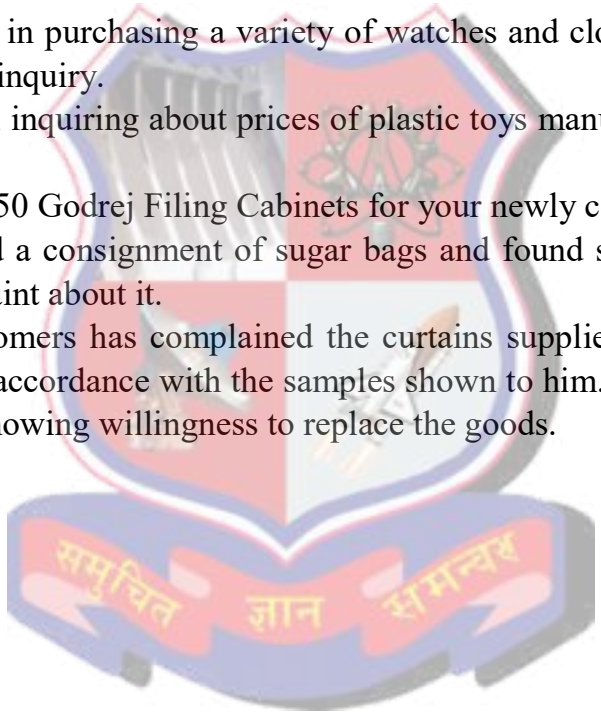
Thank You

Yours sincerely,

_____ (Name)

Exercise:

1. You have placed an order for 15 HP scanners to National Systems Limited, but received only 12 scanners. Draft an email to the supplier complaining about it.
2. Draft an email asking for the illustrated catalogue and quotation of certain electronic goods required by your firm.
3. Draft a complaint to Swagat Furnitures asking for compensation as you found some of the pieces of furniture delivered in the damaged condition.
4. The Book Store in your college requires 15 copies of Oxford Advanced Dictionary. Place an order for it.
5. The proprietor of sports goods manufacturing company has received a complaint from one of their customers regarding non-execution of his order in stipulated time. Draft a suitable reply.
6. You are interested in purchasing a variety of watches and clocks from Quartz Palace. Draft an email for inquiry.
7. You have an email inquiring about prices of plastic toys manufactured by you. Draft a reply.
8. Place an order for 50 Godrej Filing Cabinets for your newly constructed office.
9. You have received a consignment of sugar bags and found shortage in weight .Draft an email to complaint about it.
10. One of your customers has complained the curtains supplied by you are of inferior quality and not in accordance with the samples shown to him. Draft a reply expressing your regrets and showing willingness to replace the goods.



Business Letters

A **business letter** is a letter from one company to another, or between such organizations and their customers, clients, or other external parties. The overall style of letter depends on the relationship between the parties concerned. Business letters can have many types of content, for example to request direct information or action from another party, to order supplies from a supplier, to point out a mistake by the letter's recipient, to reply directly to a request, to apologize for a wrong, or to convey goodwill. A business letter is useful because it produces a permanent written record, and may be taken more seriously by the recipient than other forms of communication.

Qualities of a Good Letter:

The 7 Cs of business communication which make it are:

1. Clarity
2. Correctness
3. Conciseness
4. Courtesy
5. Concreteness
6. Consideration
7. Completeness

#1: Clarity

Practicing clarity in your communication ensures that the message is received accurately. You should know what you wish to say and how to say it. Use language that can be easily understood, and resist the temptation to include unnecessary information.

Example:

Instead of saying, “We have considered the consequences of the existing policy on the hiring strategies we employ with our human resources department and updated them accordingly,” say, “We have updated our hiring policy.”

#2: Correctness

You must communicate with correctness – correct grammar, language, data, etc. In written communication, you should proofread before sending.

Example:

“You may enter the building during opening hours but must show relevant I.D.”

Immediately, the recipient of this information has two questions:

- “What are the opening hours, and what ID is considered relevant?

Correctness in this communication is conveyed by saying, “You may enter the building during the opening hours of 9am to 5pm daily, but must show your employee identity card.”

#3: Conciseness

Never use more words than is necessary. Brevity is more easily understood, though you must avoid discourtesy. Concise messages save you and the recipient time, too. To be concise, follow these rules:

- Eliminate unnecessary words

- Use action verbs
- Remove repetition

Example:

“As a matter of fact, during the month of June, all employees must ensure that they wear appropriate clothing to ensure they stay cool while the air-conditioning is being repaired.”

Becomes:

“Indeed, during June, employees must wear appropriate clothing to stay cool while the air-conditioning is repaired.”

#4: Courtesy

Employ courtesy when communicating. This shows you respect the recipient and helps to build goodwill. You must ensure that you are sincere, thoughtful, and do not use discriminatory language.

Example:

“I don’t appreciate how your team ignores requests for collaboration from my team. The work we do is equally as important as your work. Could you make certain that your team collaborates more readily from now on?”

Such a message is unlikely to encourage a negative response. Instead, a more effective approach would be:

“I understand that your team is extremely busy and receives many requests to collaborate on project work. However, my team is working a highly urgent project with enormous mutual benefits. I would greatly appreciate if you could ask your team to collaborate more effectively with mine to move this project forward faster. If there is any help that we can provide to make this happen, please let me know.”

#5: Concreteness

Concrete communication is specific, clear, and meaningful. It avoids vagueness, uses available facts and figures to add authenticity, and builds around an active voice.

Example:

An example would be poor communication of underperformance during a one-to-one. You might say, “Your sales numbers are on the low side. They need to be improved to at least the team’s average.”

Give your employee concrete direction with evidence and an active voice:

“Your sales conversion rate is below 50%. You must improve this to the team average of 65% or higher.”

#6: Consideration

Be considerate with your messaging by putting yourself in the position of the recipient. Focus on communicating to ‘you’, considering needs and issues experienced by the recipient.

Example:

Imagine that you are unable to pay a promised bonus. How do you communicate this?

“We are unable to pay bonuses now. The business is awaiting payment from a major client. Once this payment is received, we can consider paying contractual bonuses as soon as is practicable.”

This could be better conveyed as follows:

“Unfortunately, we are not presently in the position to pay your bonus. However, as soon as our major client has settled their account, we will pay any bonuses owed to you. We’re sorry about this delay, but are sure you understand our need for positive cash flow and the long-term benefits this will deliver to you.”

#7: Completeness

Your message should be complete, delivering all the facts needed for the recipient to make an informed decision. Incomplete messages often receive poor responses.

To ensure your communication is complete, ask if it answers the what, when, why, who, where, and how.

Example:

"You haven't completed the task that I set you," is a message full of ambiguity. Instead, make sure you include all relevant facts:

"The data analysis for client ABC that I asked for on March 5 should have been completed by today. Will you have it finished this afternoon?"

Format:

A business letter must include:

1. Address

The address of the person receiving the correspondence includes a formal name, street address, city, state, and pin code.

2. Date

The date is put for any business communication.

The date is a critical piece of information documenting when the correspondence was sent.

This is important for correspondence that may be kept for future reference.

3. Subject Line

This indicates the subject of the letter so the receiver gets the idea what is the letter about.

4. Salutation

The salutation is the formal way of addressing the person.

Common salutations are *Dear* or *To Whom It May Concern*.

5. Introduction

The first few sentences of a letter are introductory.

The introduction section introduces the subject of the letter.

It is a summary in a sentence or two that explains the goal of the letter.

For example, an introduction may be something like:

I am writing today to further explore a vendor relationship with XYZ Corporation.

6. Body of the Letter

The body of the letter is where the bulk of the information is shared.

The body of the letter explains in detail all aspects of what is being communicated.

This would include detail of the information being shared.

For instance, the body may be something like this:

We understand that XYZ Corporation can provide tools for 10% less than other competitors. And, that the focus on service after the sale is amongst the best in the industry.

7. Closing

The closing of the letter summarizes what the letter was about and any next steps or action items.

This section gives the reader a heads up that the communication is coming to a close.

For instance, the closing may be something like this:

Please call me at your earliest convenience to discuss a vendor relationship and to explore if we can come to a mutually beneficial relationship. I look forward to speaking with you soon.

8. Signature

The signature section has a complimentary closing.

Examples are *Sincerely, Warmest Regards, Respectfully Yours, Very Truly Yours,* or *Cordially Yours*.

Be sure to gauge the audience when selecting a complimentary closing.

After the complimentary closing, space is left for the signature that goes above the typed name and title of the person sending the letter.


ABC Corporation
2435 West Elm Street
Small Town, USA 11223
888-987-6543
June 19, 2019
Date
James Smith
XYZ Corporation
Big Town, USA 21212
Address
Dear Jim:
Salutation
Introduction
I am writing today to further explore a vendor relationship with XYZ Corporation.
Body
We understand that XYZ Corporation can provide tools for 10% less than other competitors. And, that the focus on service after the sale is amongst the best in the industry.
Please call me at your earliest convenience to discuss a vendor relationship and to explore if we can come to a mutually beneficial relationship.
Closing
I look forward to speaking with you soon.
Sincerely,
Jack Jones
Signature
Jack Jones
ABC Corporation

Sample Letters

1. Order Letter

From

_____
_____
_____

Date: _____ (Date on Which Letter is Written)

To,

_____
_____
_____
_____

Subject: Order Letter

Dear Sir,

I am the purchase manager of XYZ Company and I am personally writing this letter to order goods for our site work. As we have been purchasing goods from you company since some time now, I am writing this letter to order material.

Along with this letter I am attaching the list of materials or goods that is needed. Please make sure you send it across in a week as the requirement is a bit urgent this time.

I hope there is enough stock left with you to complete this order of ours. Thanking you for your support and timely orders till date.

Thanking You,

Yours truly,

_____

Name and Signature

2. Complain letter

From

_____ (your name)
_____
_____ (your address)

Date _____ (date of writing letter)

To

_____ (name of recipient)
_____ (designation)
_____ (name of organization)
_____ (address)
_____

Dear Sir/Madam,

I purchased a ….(mention item with specifications) from your store on …(mention date) . The piece is on …. warranty (mention duration) . It was delivered on …(mention delivery date, if any), and your representative familiarized me with its operation on …(mention date), …(briefly explain the problem faced with the piece and repairs undertaken if any).

Since the piece is on warranty …, I request you to kindly …(mention how you want concerned authority to assist you). I am enclosing a copy of …(mention documents you are enclosing along with the letter). I am hoping for immediate action taken regarding this issue.

Thanking You
_____ (your name)

3. Leave Application

Sender's name and address:

Date:

Receiver's name and address:

Subject: Sick Leave application

Respected Mr. /Mrs. [Name of the recipient] (or Sir/Madam),

I am writing this application to notify you that I am suffering from severe viral infection and therefore, I need sick leave from work. I caught this infection last night and I will not be able to come to the office for at least [number of days]. As notified by my doctor, it is best that I take rest and recover properly before resuming work. The letter from the doctor is also attached for your reference.

Kindly grant me a leave for [number of days] days.

.

I hope you will understand and grant me a leave for aforementioned period. Waiting your approval.

Yours Sincerely,

[Your Name]

[Signature]

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I &II – Semester
Course Title: **Applied Physics**
(Course Code: 4300004)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering, Ceramic Technology, Civil Engineering, Environment Engineering, Fabrication Engineering, Mechanical Engineering, Mechatronics Engineering, Mining Engineering, Chemical Engineering, Textile Manufacturing Technology, Marine Engineering, Printing Technology	First
Metallurgy Engineering, Plastic Engineering, Textile Processing Technology	Second

1. RATIONALE

Physics is branch of science mainly deals with interaction of energy and matter and considered as the mother of all engineering disciplines. Diploma engineers (technologists) have to deal with various materials while using/ maintaining machines. More over the basic knowledge of principles of physics helps diploma students to lay foundations of core engineering courses. The laws and principles of physics, formulae and knowledge of physical phenomena and physical properties provides a means of estimating the behavior of things before we design and observe them. This course of applied physics has been designed as per program requirements to help students to study the relevant core engineering courses. The complicated derivations have been avoided and micro projects are introduced. This course will help the diploma engineers to use/apply the basic concepts and principles of physics solve well designed engineering problems and comprehend different technology-based applications.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use principles of physics to solve broadly defined engineering problems**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.
b) Solve various engineering problems by the concept of linear momentum and circular motion.
c) Apply basic concepts of properties of matter in solving engineering problems efficiently.
d) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.

e) Use the concept of waves and sound waves for various acoustics and other engineering applications involving wave dynamics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Use Vernier caliper to measure the dimensions of a given object.	I	02*
2	Use micrometer screw gauge to measure diameter of a given wire and determine volume of a given metallic piece.	I	02
3	Use Hooke's law to determine force constant of a given spring.	III	02
4	Use Searle's method to determine Youngs modulus of the given metallic wire.	III	02*
5	Use capillary rise method and travelling microscope to determine the surface tension of a given liquid.	III	02*
6	Use Stokes' law to determine the viscosity of a given liquid (e.g., glycerin).	III	02
7	Use different types of thermometers to measure temperature of a hot bath and convert it into different scales.	IV	02*
8	Use Searle's method to measure the coefficient of thermal conductivity of a given metallic rod.	IV	02
9	Use Searle's method to determine the coefficient of linear expansion of the given metallic rod.	IV	02
10	Determine acceleration due to gravity 'g' by using simple pendulum.	V	02
11	Use sonometer to find the frequency of given tuning fork.	V	02
12	Use resonance tube to determine velocity of sound in air at room temperature.	V	02*
13	Use ultrasonic interferometer to determine the velocity of ultrasonic waves in different liquids.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
14	Use electrical vibrator to find the frequency of AC mains.	V	02
	Total		28

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Vernier caliper analog - least count 0.02 mm	1, 4
2	Micrometer screw gauge analog (0-25 mm) – least count 0.01mm	2, 4
3	Rigid support, spring, 20 g hanger, six 20 g slotted weight, fine pointer, vertical wooden scale, hook	3
4	Young modulus apparatus (Searle's pattern): two aluminum graduated scales mounted on pillar supports, two pointers with clamps for attaching to specimen, brass and steel rod, cord and hook for carrying weight.	4
5	Travelling microscope - high magnification power, stainless steel scale with Vernier least count - 0.02 mm for taking the recordings, horizontal scale graduated up to 20 cm, vertical scale graduated up to 15 cm.	5
6	One meter high and 5 cm broad glass cylindrical jar with millimeter graduations along its height, steel balls	6

S. No.	Equipment Name with Broad Specifications	PrO. No.
7	Hot water bath	7
8	Mercury filled glass thermometer 0-110 °C, Mercury filled glass thermometer 0-250 °C. digital food thermometer, bimetallic thermometer.	7
9	Searle's thermal conductivity apparatus - made up of pure copper and outer boxes are of wooden polished material, 04 thermometers, steam generator, measuring cylinder, constant water level tank, pinch cork, rubber tube	8
10	Linear expansion apparatus, steam generator, rubber tubing, metal rods of aluminum, iron, copper, brass, and steel.	9
11	A bob	10
12	A sonometer with set of tuning forks, two sharp edge wedges and a weight box.	11
13	Resonance tube apparatus, tuning forks of different frequencies, rubber pad, thermometer	12
14	Stop watch (least count = 1/100 s)	8, 10
15	Clamp with stand.	5
16	0.5 kg hanger, 0.5 kg slotted weight.	4
17	Hot plate (1800 W)	8, 9
18	Ultrasonic interferometer - gold plated quartz crystal, operating voltage - 220 Volt, display - analog, frequency - 2MHz with position control	13
19	Electrical Vibrator, uniform cord, weight pan, weight box, pulley, meter scale, sensitive balance	14

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Follow safe practices
d) Handle equipment carefully
e) Practice energy saving processes.
f) Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Units and Measurements**	1.a Explain Physical quantities and their units. 1.b Convert unit of a given physical quantity in one system of units into another systems of units. 1.c Explain method to measure the dimensions of given object by using relevant instruments. 1.d Estimate errors in the measurement. 1.e Apply the concept of Least count, errors and significant figures to solve the given problems.	1.1 Measurement and units in engineering and science 1.2 Physical quantities; fundamental and derived quantities 1.3 Systems of units: CGS, MKS and SI, definition of units (only for information and not to be asked in examination), interconversion of units MKS to CGS and vice versa, Requirements of standard unit 1.4 Vernier caliper, Micrometer screw gauge 1.5 Accuracy, precision and error, estimation of errors - absolute error, relative error and percentage error, error propagation, significant figures
Unit – II **Circular motion**	2.a Apply the concept of linear momentum and its conservation to explain recoil of gun and rockets propulsion. 2.b Apply the concept of centripetal and centrifugal forces to solve given engineering problems.	2.1 Force, momentum, law of conservation of linear momentum, its applications such as recoil of gun, rocket propulsion, impulse and its applications 2.2 Circular motion, angular displacement, angular velocity, angular acceleration and their interrelation 2.3 Centripetal and centrifugal forces examples: banking of roads and bending of cyclist
Unit– III **General Properties of Matter**	3.a Explain the Hooke's law, stress-strain curve and moduli of elasticity. 3.b Explain surface tension, cohesive and adhesive forces. 3.c Apply Ascent formula to determine surface tension of	**3.1 Elasticity** 3.1.1 Deforming and restoring Force 3.1.2 Stress-Strain with their types 3.1.3 Hooke's law 3.1.4 Moduli of elasticity, Young's modulus, Bulk modulus, Shear modulus

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	the given liquid. 3.d Explain viscosity, coefficient of viscosity, terminal velocity and Stokes' law. 3.e Apply the concept of viscosity in explaining hydraulic system. 3.f Explain types of fluid motion and Reynold number	3.1.5 Stress-Strain curve **3.2 Surface Tension** 3.2.1 Surface tension; concept and units 3.2.2 Cohesive and adhesive forces 3.2.3 Molecular range and sphere of Influence 3.2.4 Laplace's molecular theory 3.2.5 Angle of contact, Ascent Formula (No derivation) 3.2.6 Surface energy 3.2.7 Applications of surface tension 3.2.8 Effect of temperature and impurity on surface tension **3.3 Viscosity** 3.3.1 Viscosity and its SI units 3.3.2 Newton's law of Viscosity 3.3.3 Viscous force, velocity gradient and coefficient of viscosity and its SI units, free fall of an object through viscous medium and terminal velocity 3.3.4 Types of fluid motion, stream line and turbulent flow, critical velocity, Reynold's number 3.3.5 Stokes' law 3.3.6 Effect of temperature on viscosity 3.3.7 Applications of viscosity in hydraulic systems
Unit– IV **Heat and Thermometry**	4.a Distinguish between heat and temperature. 4.b Explain modes of heat transmission. 4.c Explain various temperature scales and conversion between them. 4.d Explain heat capacity and specific heat. 4.e Explain types of thermometers and their uses. 4.f Apply the concept of coefficient of thermal conductivity to solve	4.1 Heat and temperature 4.2 Modes of Heat transfer: Conduction, Convection and Radiation 4.3 Temperature measurement scales: Kelvin, Celsius and Fahrenheit and interconversion between them 4.4 Heat capacity and specific heat 4.5 Types of thermometers: Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer and their uses.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	Engineering problems. 4.g Explain expansion in solids and coefficient of linear expansions in solids.	4.6 Coefficient of thermal conductivity and its engineering applications. 4.7 Expansion of solids, coefficient of linear expansion
Unit– V **Wave motion and its applications**	5.a Explain wave and wave motion with example. 5.b Distinguish between longitudinal and transverse waves. 5.c Explain frequency, periodic time, amplitude, wave length and wave velocity 5.d Explain sound waves, light waves and their properties 5.e Explain amplitude, phase, phase difference and wave equation. 5.f Explain principle of superposition of waves, interference and beat formation. 5.g Explain reverberation, reverberation time, echo, noise and coefficient of absorption of sound. 5.h Apply Sabine's formula to calculate reverberation time. 5.i Explain ultrasonic waves and their properties. 5.j Explain engineering and medical applications of ultrasonic waves.	5.1 Waves, wave motion, and types of waves: longitudinal and transverse waves 5.2 Frequency, periodic time, amplitude, wave length and wave velocity and their relationship 5.3 Properties of sound and light waves. 5.4 Phase, phase difference and various terms of wave equation $(y = Asin(\omega t + \varphi))$ [derivation of equations of velocity and acceleration is not required] 5.5 Superposition of waves, Interference: constructive and destructive interference ,conditions for stationary interference pattern, beat formation 5.6 Reverberation, reverberation time, echo, noise and coefficient of absorption of sound 5.7 Sabine's formula (derivation not required) for reverberation time, methods to control reverberation time and their applications 5.8 Ultrasonic waves and their properties, applications of ultrasonic waves in the field of engineering and medical

***Note**: The UOs need to be formulated at the 'Applcation Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

- 'Definition of units' is only for information and not to be asked in examination.
- Students can be introduced to system of units other than SI, MKS, CGS unit systems.
- Application level based numerical should be given at the time of instructions and assessment in each unit
- Derivation of Ascent formula is not required only statement and related terms have to be explained at the time of instruction and assessment.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Units and Measurements	08	4	4	5	13
II	Circular motion	06	3	3	4	10
III	General Properties of Matter	12	4	7	9	20
IV	Heat and Thermometry	08	3	4	6	13
V	Wave motion and its applications	08	4	5	5	14
Total		**42**	**18**	**23**	**29**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare model to demonstrate concepts of physics.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Measure physical quantities using smart phone.
e) Prepare showcase portfolios.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L" in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability using the knowledge of this course

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14** - **16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Measurement: Measure physical quantities using smart phone applications.
b) Prepare proto type Vernier Calipers of given least count.
c) Collect wires and sheets of different gauges from market and estimate errors in measurements using analog and digital Vernier Calipers.
d) Elasticity: Prepare working model to demonstrate the stress – strain behavior of different wires of different thickness and material.
e) Viscosity: Collect 3 to 5 liquids and prepare a working model to differentiate liquids based on viscosity and demonstrate their applications.
f) Motion: Prepare model of ball rolling down on inclined plane to demonstrate the conservation of energy and motion of an object in inclined plane.
g) Waves in string**:** standing waves in string using woofer loudspeaker.
h) Noise Level measurement**:** measure noise Level at different places in campus.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Text Book of Physics for Class XI (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN 81-7450-508-3(Part-I) & ISBN 81-7450-566-0 (Part-II)
2	Text Book of Physics for Class XII (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN 81-7450-631-4 (Part-I) & ISBN 81-7450-671-3 (Part II)
3	Applied Physics, Vol. I and Vol. II	TTTI Publications	Tata McGraw Hill, Delhi, 2019
4	Concepts in Physics Vol. I and Vol. II	H C Verma	Bharti Bhawan Ltd. New Delhi, 2019 ISBN-13: 978-8177091878 ISBN-13: 978-8177092325
5	Engineering Physics	DK Bhattacharya	Oxford University Press, New

S. No.	Title of Book	Author	Publication with place, year and ISBN
		& Poonam Tandon	Delhi, ISBN:9781680158687
6	B. Sc. Practical Physics	C. L. Arora	S. Chand Publication, New Delhi, ISBN: 9788121909099
7	A Textbook of Engineering Physics	M.N. Avadhanulu, P.G. Kshirsagar, TVS Arun Murthy	S. Chand Publication, 11th edition ,New Delhi, 2018 ISBN-13: 978-9352833993
8	SEARS and ZEMANSKY'S University Physics with modern Physics	Hugh D. Young & Roger A. Freedman	Person Publication 14th Edition, USA, ISBN 10: 0-321-97361-5; ISBN 13: 978-0-321-97361-0 (Student edition)
9	Physics for Scientists and Engineers with Modern Physics	John W. Jewett & Raymond A. Serway	CENGAGE Learning, 10th edition, Boston, 2010, ISBN-10: 1337553298
10	University Physics (Volume I, II & III) (Open-source Material)	William Moebs, Samuel J. Ling & Jeff Sanny	OPENSTAX, Houston, Texas, 2016, ISBN-13: 1-947172-20-4
11	PHYSICS for SCIENTISTS & ENGINEERS with Modern Physics	Douglas C. Giancoli	Pearson, 7th edition, Delhi, 2015, ISBN-13: 978-1292057125
12	Principles of Physics	Jearl Ealker, David Halliday, Robert Resnick	Wiley India, Navi Mumbai 10th edition, 2015, ISBN-13: 978-8126552566
13	NCERT Physics	NCERT	NCERT Physics
14	Physics in Daily Life With illustrations	L.J.F. Hermans & Wiebke Drenckhan	EDP Sciences, France, 2012, ISBN: 978-2-7598-0705-5
15	Introductory Physics: Building Models to Describe Our World (Open-Source Material)	Ryan Martin, Emma Neary, Joshua Rinaldo & Olivia Woodman	Creative Commons license, 2019, GitHub

14. SUGGESTED LEARNING WEBSITES

a) https://ocw.mit.edu/courses/physics/
b) https://www.einstein-online.info/en/category/elementary/
c) https://academicearth.org/physics/
d) www.nptel.iitm.ac.in
e) http://phys23p.sl.psu.edu/phys_anim/Phys_anim.htm
f) http://www.atoptics.co.uk/
g) https://www.khanacademy.org/science/physics
h) http://www.olabs.edu.in/

i) http://vlabs.iitb.ac.in/vlab/
j) https://phet.colorado.edu/
k) http://physics.bu.edu/~duffy/vlabs.html
l) https://virtuallabs.merlot.org/vl_physics.html
m) www.datasheetcafe.com

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Applied Physics (Course Code: 4300004)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency *Use principles of physics to solve broadly defined engineering problems*	3	1	1	2	1	-	1
Course Outcomes							
CO a) Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.	3	1	1	2	-	-	1
CO b) Solve various engineering problems by the concept of linear and circular motion.	3	1	-	-	1	-	1
CO c) Apply basic concepts of properties of matter in solving engineering problems efficiently	3	1	-	2	-	-	1
CO d) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.	3	1	1	2	1	-	1
CO e) Use the concept of waves and sound waves for various acoustics and other engineering applications involving wave dynamics	3	1	1	2	1	-	1

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for no correlation with CO and PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Shri Dineshkumar V. Mehta Lecturer in Physics	Government Polytechnic, Gandhinagar	9879690825	dv_mehta@yahoo.com
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4	Shri Aditya kumar B. Patel Lecturer in Physics	K.D. Polytechnic, Patan	9979534522	graquantum@gmail.com

S. No.	Name and Designation	Institute	Contact No.	Email
5	Late Dr. Gaurang S. Patel Lecturer in Physics	Dr. S. & S. S. Ghandhy College of Engineering & Technology, Surat	9909986859	goru16686@gmail.com

NITTTR Resource Person

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr Hussain Jeevakhan Assistant Professor	Department of Applied science and education	0755-261600*360	hjeevakhan@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I – Semester

Course Title: **Engineering Drawing**
(Course Code: 4300007)

Diploma programme in which this course is offered	Semester in which offered
Mechanical, Automobile, Marine, Fabrication	First

1. RATIONALE

Engineering drawing is a way of communication for engineers. It is a graphical language that essential for communicating design ideas and technical information to engineers in industry and other professionals throughout the design process. The purpose of an engineering drawing is to clearly and accurately capture all geometric features of a product or component so that a manufacturer or engineer can produce the required item. This course aims at development of fundamental understanding and application of engineering drawing so as to develop the ability to prepare, read and interpret drawings correctly and make aware of drafting practices, symbols, codes, norms and standards generally used in industries. It covers knowledge & application of drawing instruments & also familiarizes the learner about codified symbols and principles of technical drawing as per BIS (Bureau of Indian Standards): "SP 46:2003" standards. The course also intended to develop the sense of drawing sequence and imagination in the students.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences.

- **Prepare engineering drawings using prevailing drawing standards and drafting instruments.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Use scales, drawing standards and drafting instruments as per BIS codes.
b) Construct polygons, circles and lines with different geometric conditions.
c) Construct engineering curves as per given dimensions.
d) Draw the projection of points, lines and planes under different conditions.
e) Draw orthographic views from isometric views of simple objects and vice versa.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	-	4	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve COs.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	**Use of Drawing Instruments:** Draw following as per I.S. 1a. Draw different types of lines. 1b. Draw simple 2D entities and demonstrate the use of different types of dimensioning methods. 1c. Illustrate dimensioning of circle, arc, angle, square bar, hexagonal bar, cylinder & sphere through figures. 1d. Draw vertical and inclined alphabets and numerals. 1e. Draw 1st and 3rd angle orthographic projection symbols. 1f. Draw a typical Title block. 1g. Draw Angle using T-square and Set-squares. 1h. Draw simple objects using reduced and enlarge scales.	I,II,III	12
2	**Geometric Construction:** 2a. Draw set of lines with different conditions (Four problems). 2b. Draw circle and arcs with different geometric conditions and constraints (Four problems). 2c. Draw polygons by general methods (Triangle, square, pentagon, hexagon, heptagon) (Three problems). 2d. Draw polygons by special methods (Pentagon, hexagon and heptagon) (Three problems). 2e. Draw various problems related to tangency of circle and point (Three problems).	IV	08
3	**Engineering Curves (Conic Sections)-1:** 3a. Construct ellipse using concentric circle method, four center method, arc of circle method, rectangle method, oblong method and eccentricity method. 3b. Construct parabola using rectangular method, parallelogram method, tangent method and eccentricity method. 3c. Construct hyperbola using rectangular method, oblique method and eccentricity method.	V	06

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
4	**Engineering Curves-2:** 4a. Construct cycloid. 4b. Construct hypocycloid & epicycloid. 4c. Construct involute of circle. 4d. Construct involute of polygons. 4e. Construct Archimedean spiral.	V	06
5	**Projections of Points and Lines:** 5a. Draw projection of points (For 10 various conditions). 5b. Draw projection of lines with different conditions (Seven problems).	VI	04
6	**Projections of Planes:** Draw projections of different planar entities with different conditions. (Triangle, square/rectangular, pentagonal, hexagonal and circular – One for each) (Eight problems).	VII	04
7	**Orthographic Projections:** Draw Orthographic projections of different objects (three views of each object) (Six problems).	VII	08
8	**Isometric Projections:** 8a. Draw isometric drawing from given orthographic views (Six problems). 8b. Draw free hand sketch of all above isometric drawings without using any instruments.	VIII	08
	Total		**56**

Note

i. *Note: The teacher should demonstrate -*
   - *Use of drawing instruments.*
   - *Planning and layout of drawing sheet as per IS code.*
   - *Scaling technique.*

ii. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

iii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

iv. *Teachers should encourage students for optimum use of drawing sheet space. Further, instruct them to use both sides of a drawing sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.*

v. *First angle orthographic projection and IS codes (*Engineering Drawing Practices for School and Colleges SP 46:2003*) should be followed wherever applicable.*

vi. *The dimensions of line, axes, distances, angle, side of polygon, diameter, etc. must be varied for each student in batch so that each student will have same problems, but with different dimensions.*

vii. *The sketchbook should contain data related to all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.*

viii. A hand out containing applicable standards from IS codes including title block as per IS standard should be given to each student by concerned teacher.

ix. For 25 marks Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to prepare drawings.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Drawing planning and layout (for optimum use of drawing sheet)	10
2	Use of appropriate instruments, lines, dimensioning & annotations	20
3	Completing given practice problems	30
4	Accuracy of drawing	10
4	Neatness of drawing	10
5	Timely submission of completed drawing sheet	10
6	Answering viva voce questions	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Drawing instruments for class room teaching (Large Size).	1 to 8
2	Models of various objects (Mechanical, Electrical, Civil etc.).	3 to 8
3	Set of various drawings being used by industries/developed by experienced teachers.	7, 8
4	Drawing Board (B2) & Mini Drafter.	1 to 8
5	Other Instruments: T-Square, Set square (45˚ and 30˚-60˚), Roller Scale, Protector, Drawing Compass, Dividers, Drawing Pencils (Clutch Pencil with H & 2H Lead), Lead Box (H & 2H – 0.5 or 0.7 mm) Circle Master, French Curves, Stencils (8-6-4 mm, All in One), Eraser, Drawing sheets, Drawing Pins/Clips, Sheet Container and Drawing instrument box.	1 to 8
6	Interactive board with LCD overhead projector	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices. Particularly don't use razor or blade to sharpen the pencils.
c) Follow ethical practices.
d) Maintain cleanliness.
e) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Engineering Drawing Aids**	1a. Use drawing instruments and materials effectively.	1.1 Drawing instruments and materials. 1.2 Instruments-types, specifications, method to use them and applications. 1.3 Pencils-grades, papers-grades, applications, types of points and applications. 1.4 Other materials-types and applications.
Unit – II **Planning Layout and Scaling of Drawing**	2a. Follow and apply standard practice as per B.I.S. for planning and layout. 2b. Choose appropriate scale factor for the drawing as per the given situation with justification.	2.1. I.S. cods for planning and layout. 2.2. Scaling technique used in drawing: a) Plain Scale b) Diagonal Scale
Unit– III **Lines, Lettering and Dimension-ing**	3a. Write annotations on the given drawing where ever necessary. 3b. Choose appropriate line and dimensioning style for the given Geometrical entity.	3.1 Different types of lines. 3.2 Lettering. 3.3 Dimensioning methods. a) Aligned method. b) Unilateral with chain, parallel, progressive and combined dimensioning.
Unit– IV **Geometric Construc-tion**	4a. Draw polygons, circles and lines with the given geometric conditions.	4.1 Geometric construction related with line. 4.2 Geometric construction related with angle. 4.3 Geometric construction related with circle & arc. 4.4 Construct polygons:

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		a) Hexagon: Using drawing tools. b) Polygon (Triangle, square, pentagon, hexagon and heptagon) by general method. c) Polygon (Pentagon, hexagon and heptagon) by special method.
Unit– V Engineering Curves	5a. Draw engineering curves with proficiency as per given dimensions.	5.1 Conic sections. a) Concept and understanding of focus, directrix, vertex and eccentricity and drawing of conic sections. b) Using various methods, understand construction and application of : • Ellipse. • Parabola. • Hyperbola. 5.2 Cycloidal Curves (Cycloid, Epicycloid, Hypocycloid). 5.3 Involutes of a circle and polygons. 5.4 Spiral (Archimedean spiral only).
Unit– VI **Projection of Points, Lines and Planes**	6a. Draw the projection of points, lines and planes with different conditions in first angle projection. 6b. Find out true shape and size of an inclined line or plane.	6.1 Concept of quadrant. 6.2 Reference planes, orthographic projections. 6.3 1st angle and 3rd angle projection and their symbols. 6.4 Projection of points. 6.5 Projection of lines – determination of true length and inclinations for following cases. a) Line parallel to one or both the plane. b) Line perpendicular to one of the planes. c) Line inclined to one plane and parallel to another. d) Line inclined to both the planes. 6.6 Projection of Planes. a) Type of planes. b) Projections of planar object parallel to one of the reference planes. c) Projections of planar object inclined to one reference plane

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		and perpendicular to another. d) Projections of planar object inclined to both reference planes. **Note:** Planar objects like Triangle, Square / rectangle, pentagon, hexagon and circle shape should be considered.
Unit– VII **Orthogra-phic Projection**	7a. Draw the orthographic views of objects containing lines, circles and arc geometry. 7b. Interpret given orthographic views to imagine the shape of the component.	7.1 Types of projections-orthographic, perspective, isometric and oblique: concept and applications. 7.2 Various term associated with orthographic projections. a) Theory of projection. b) Methods of projection. c) Orthographic projection. d) Planes of projection. 7.3 Conversion of simple pictorial views into Orthographic views. Illustrative problems on orthographic projection. 7.4 B.I.S. code of practice. **Note:** Problem should be restricted up to three views Front view/Elevation, Top view/Plan and Side views only. Use First Angle Method only.
Unit– VIII **Isometric Projection**	8a. Draw the isometric view from orthographic views of object/s containing lines, circles, arcs and slant surfaces.	8.1 Isometric axis, lines and planes. 8.2 Isometric scales. 8.3 Isometric view and isometric drawing. 8.4 Difference between isometric projection and isometric drawing. 8.5 Illustrative problems limited to objects Containing lines, circles and arcs shape only. 8.6 Draw all above problems with free hand sketch using pencil. (Without using any drawing instrument) 8.7 Draw orthographic and isometric views with free hand sketch of various sections used in engineering. e.g. square, circular, hollow, L, T, U, I-sections, etc.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Engineering drawing aids	0	0	0	2	2
II	Planning, layout and scaling of drawing	0	2	0	3	5
III	Lines, lettering and dimensioning	0	0	2	0	2
IV	Geometric construction	3	0	3	7	10
V	Engineering curves	6	2	0	10	12
VI	Projection of points, lines and planes	8	3	0	14	17
VII	Orthographic projections	6	0	0	12	12
VIII	Isometric projections	5	0	2	8	10
Total		**28**	**12**	**28**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Solve all problems for all sheets number 1 to 8 in sketch book (with complete data and dimensions).
b) Take one circular shape (i.e. tyre). Assume one point on circumference and mark it. Roll that shape on flat and circular surface. Observe the path of point and correlate the same with respective engineering curve.
c) Take one circular shape and string which length is equal to circumference of circle. Try to wound and unwound string on it. Observe the path of point and correlate the same with respective engineering curve.
d) List few engineering/domestic components in which involute curve is used.
e) Take two simple objects in your vicinity and sketch 3D isometric of them. Also draw 2D orthographic projections of them (all views). Try to clearly and accurately capture all the geometric features present in the selected objects.
f) Download soft copy of technical drawing of any engineering products. Read and interpret this drawing (e.g. Car, Cutting tools, gears, bearings etc.).
g) Collect the orthographic views from your facilitator, at least three objects with few missing lines. The student will try to imagine the corresponding objects, complete the views and draw these views in sketch book.

h) Explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each batch student.
i) Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that is to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers should create opportunities and provisions for ***co-curricular activities***.
f) Guide students for using BIS "SP 46:2003" standard

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Creating Digital Portfolio:** Students should Observe and **c**ollect photographs and images of industrial/domestic components/items which contain or their functioning create shapes/features like polygon, ellipse, parabola, hyperbola, cycloids, involute and spiral).
b) **Technology in education:** Refer websites related to use of virtual drawing instruments and environment like https://www.triumphcloud.com/, https://www.mathspad.co.uk/. Practice few problems using the virtual drawing instruments.
c) **Model Making:** Students should Build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap.

d) **World of work connect:** Students should collect Production drawings, Building Drawings, Layouts from nearby workshops/industries/builders/contractors and try to
- redraw types of lines used
- redraw lettering styles used
- list BIS code referred
- list the symbols/annotations/dimensioning used
- list the type of scales used. Compare the size of component on drawing sheet with actual component.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014. ISBN : 9789380358963
2	Textbook of Engineering Drawing	P.J. Shah	S.Chand, New Delhi. 2013 ISBN : 9788121941822
3	Textbook of Engineering Drawing	R K Dhawan	S.Chand, New Delhi. 2013 ISBN : 9789352837373
4	Engineering Drawing	M.B. Shah, B.C. Rana	Pearsons. 2009 ISBN: 9788131759714
5	Engineering Drawing	Basant Agrawal, C. M. Agrawal	McGraw-Hill, 2019 ISBN : 9789353167448
6	Engineering Drawing Practices for School and Colleges SP 46:2003	Bureau of Indian Standards	Bureau of Indian Standards, Government of India, Third Reprint, October 1998; ISBN:. 81-7061-091-2

14. SOFTWARE/LEARNING WEBSITES

a) https://www.youtube.com/results?search_query=engineering+drawing
b) https://www.youtube.com/c/MechanicalEnggSubjectsGTU/playlists
c) https://youtu.be/MT1T31GtGpg
d) https://youtu.be/WEwkepkv6mg
e) https://youtu.be/trJQIvatIpI
f) https://nptel.ac.in/courses/112/103/112103019
g) https://nptel.ac.in/courses/112/105/112105294
h) https://en.wikipedia.org/wiki/Engineering_drawing
i) https://www.slideshare.net/search/slideshow?searchfrom=header&q=engineering+drawing
j) https://www.scribd.com/search?content_type=tops&page=1&query=engineering%20drawing&content_types=tops,books,audiobooks,summaries,articles,documents,sheet_music,podcasts
k) http://www.cognifront.com/tools.php

15. PO-COMPETENCY-CO MAPPING

Semester I	Engineering Drawing (Course Code: 4300007)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	*Prepare engineering drawings using prevailing drawing standards and drafting instruments.*						
Course Outcomes CO a) Use scales, drawing standards and drafting instruments as per BIS codes.	3	1	2	3	-	-	2
CO b) Construct polygons, circles and lines with different geometric conditions	3	-	3	2	2	-	2
CO c) Construct engineering curves as per given dimensions	3	-	3	2	2	-	2
CO d) Draw the projection of points, lines and planes under different conditions.	3	-	3	2	2	-	2
CO e) Draw orthographic views from isometric views of simple objects and vice versa .	3	2	3	2	2	2	2

Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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NITTTR Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I & II – Semester

Course Title: Sports and Yoga
(Course Code: 4300015)

Diploma programme in which this course is offered	Semester in which offered
Civil, Environment, Automobile, Fabrication, Marine, Mechanical, Electrical, Electronics and Communication, Metallurgy, Plastics, Bio Medical, Instrumentation and Control, Power Electronics, Computer, Information Technology, CACDDM, Ceramics, Printing, Textile Design, Textile Manufacturing, Textile Processing	First
Architectural Assistantship, Mining, Chemical, Mechatronics	Second

1. RATIONALE

Physical activity is vital to the holistic development of students, fostering their physical, social and emotional health. Sports and Yoga are essential part of our life for good health and peace of mind. Yoga is considered itself as a sport which plays through your own physical ability. Yoga provides you all the benefits that you are willing to have from generic sports like badminton, football, cricket, etc. Yoga is the application of physical postures, control of breath, purification and relaxation of mind / body and spiritual principles aimed at bringing greater unity and balance to the mind and body. The use of breathing techniques known as *Pranayama* enables a person to focus on breath and helps to calm and still the mind and cultivate concentration ability. *Pranayama* can also help to energise and revitalize the body.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply sports and yoga activities to keep the body physically and mentally fit.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the following Course Outcomes (COs) achievement:

a) Practice physical activities and yoga for strength, flexibility and relaxation.
b) Use techniques for increasing concentration and decreasing anxiety for stronger academic performance.
c) Perform yoga exercises in various combination and forms.
d) Improve personal fitness through participation in sports and yoga activities.
e) Follow sound nutritional practices for maintaining good health and physical performance.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	2	0	0	0	50	0	50

This is designed to facilitate attainment of COs holistically, as there is no examination.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1.	Perform following Yoga Asanas under the guidance of yoga trainer :- • Surya Namaskar (Sun Salutation) • Tadasana (Mountain pose) • Vrikshasana (Tree pose) • Vajrasan (Hand under foot pose) • Pada-hastasana (Hand under foot pose) • Ushtrasana (Camel pose) • Dhanurashana.(Bow Pose) • Bhjangasana (Snake pose) • Halasana (Plough pose) • Shavasana/Yoga Nidra • Bhastrikai Pranayam • Kapalbhati Pranayam • Anulom Vilom Pranayam • Bhramari Pranayam	III	12*
2.	Participate in any sports activities of your choice : • Indoor sports/games (Badminton, Chess, Carrom, Table Tennis) • Outdoor sports/games (Cricket, Kabaddi, , Volley ball, Basketball, Football, Hockey)	IV	14
3.	Prepare report on any sports events including associated rules, playground specification, rules for judgement, etc.)	IV	02*
	Total		**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	-Not applicable-	Nil

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Yoga Mats/ Blankets Straps Blocks Bolsters Chairs Meditation cushions Eye pillows (tissues or washable cloth to cover them) Mat cleaning wipes Strong floorings Temperature control, fans, portable heaters (if needed) Chime, bells, or gong (for bringing people out of corpse pose, or silent meditation) Essential oil diffuser Yoga CD's CD player Lighting system that allows for dimming Effective sound system Salt lamp – they purify air and look lovely Sandbags	1
2	Sports and games accessories as per the decision of college.	2

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Follow safe practices.
b) Practice good housekeeping.
c) Demonstrate working as a leader/a team member.
d) Maintain tools/accessories/ equipment.
e) Follow ethical practices.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction to Physical fitness**	1a. Explain importance of physical education. 1b. Describe importance of Physical Fitness & Wellness 1c. Explain the components of physical fitness. 1d. Demonstrate healthy life style. 1e. Prevent health threats by changing life style.	1.1 Aims & Objectives of Physical Education 1.2 Changing trends in Physical Education 1.3 Meaning & Importance of Physical Fitness & Wellness 1.4 Components of Physical fitness 1.5 Components of health related fitness 1.6 Components of wellness 1.7 Preventing health threats through lifestyle change 1.8 Concept of positive lifestyle
Unit – II **Fundamentals of Anatomy & Physiology in sports & yoga**	2a. Explain importance of anatomy and physiology. 2b. Describe effects of exercise in various body systems. 2c. Describe concept of correct posture. 2e. Explain corrective measures for posture deformities.	2.1 Anatomy, physiology and its importance. 2.2 Effect of exercise on various body system i.e. circulatory system, respiratory system, neuro- muscular system 2.3 Concept and advantages of correct posture. 2.4 Posture deformities and corrective measures.
Unit– III **Yoga & Pranayama**	3.1 Explain importance of yoga. 3.2 Perform various pranayama for increasing concentration. 3.3 Use meditation and other relaxation techniques for improving concentration.	3.1 Meaning & Importance of Yoga Asanas, Pranayama & Meditation 3.2 Yoga & related Asanas - Sukhasana, Tadasana, Padmasana & Shashankasana 3.3 Relaxation techniques for improving concentration - Yog-Nidra

Unit– IV **Sports/ games**	4.1 Describe various warming exercises. 4.2 Select any game/sports of your choice. 4.3 Explain latest rules of any game/sports. 4.4 Describe specifications of play fields and related sports equipment.	4.1 Warming up and limbering down exercises 4.2 Tournaments- Knock out, League/ Round Robin & combination 4.3 Following sub topics related to any one Game/Sport of choice of student out of: Badminton, Chess, Carrom, Table Tennis, Cricket, Kabaddi, , Volley ball, Basketball, Football, Hockey, etc. 4.4 History of the Game/Sport. 4.5 Latest General Rules of the Game/Sport. 4.6 Specifications of Play Fields and Related Sports Equipment. 4.7 Effect of anxiety & fear on sports performance.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching/ Practical Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Physical fitness	**- Not Applicable -**				
II	Fundamentals of Anatomy & Physiology in sports & yoga					
III	Yoga & Pranayama					
IV	Sports/games					
Total						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare a list of specifications for various tools/equipment/machines used in gymnasium/indoor sports complex.
b) Undertake a market survey of local dealers for procurement of sports items/ equipment/machines.
c) Visit the sports shop and collect all relevant information about any sport item and submit the detailed report.
d) Download video clips showing correct practices for yogasanas, pranayam and any sports/games.
e) Prepare a chart showing different types of yogasanas.
f) Prepare a chart showing different types of pranayams.

g) Prepare a chart showing the field details of any sports/games.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
c) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Arrange visit to nearby yoga centre and sports complex and use of videos/animations for understanding various steps , processes related to the activities .

12. SUGGESTED MICRO-PROJECTS

- Not Applicable -

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Modern Trends and Physical Education class 11 & class 12	Ajmer Singh	Kalyani Publication, New Delhi ISBN : 9789327264319
2	Light on Yoga	B.K.S. Iyengar	Thomson's Publication, New Delhi ISBN: 8172235011
3	Health and Physical Education	V.K.Sharma	NCERT Books; Class11,12 Saraswati House Publication, New Delhi
4.	Yoga and Stress Management	Acharya Yatendra	Fingerprint Publishing ISBN: 938905303X
5.	Patanjali Yoga Sutras	Swami Vivekanand	Fingerprint Publishing ISBN: 9389567351
6.	Pranayam Rahasya	Ramdev	Patanjali-Divya Prakashan,Haridwar ISBN: 978-8189235017
7.	Yoga its Philosophy & Practice	Ramdev	Divya Prakashan, Haridwar

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14. SOFTWARE/LEARNING WEBSITES

- https://youtu.be/dAqQqmaI9vY
- https://youtu.be/c8hjhRqIwHE
- https://youtu.be/MrR04m1zoJ8
- https://youtu.be/P-jwGj7YqNM

- https://youtu.be/3p4r_ad2Y7g
- https://youtu.be/mndOIVCwFss
- https://youtu.be/J68MR3dBzto

15. PO-COMPETENCY-CO MAPPING

Semester-I & II	Sports & Yoga (Course Code: 4300015)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustain-ability & environ-ment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	Apply sports and yoga activities to keep the body physically and mentally fit.						
Course Outcomes CO a) Practice Physical activities and yoga for strength, flexibility, and relaxation.	2	-	-	-	1	-	2
CO b) Use techniques for increasing concentration and decreasing anxiety for stronger academic performance.	3	-	-	-	1	-	2
CO c) Perform yoga exercises in various combination and forms.	2	-	-	-	1	-	2
CO d) Improve personal fitness through participation in sports and yoga activities.	2	-	-	-	1	-	2
CO e) Follow sound nutritional practices for maintaining good health and physical performance.	3	-	-	-	1	-	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
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NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Prof. M.C.Paliwal, Associate Professor	Civil Engg. Education	9407271980	mcpaliwal@nitttrbpl.ac.in
2.	Dr. K.K. Jain, Professor	Mech. Engg. Education	9425017472	kkjain@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I & II – Semester

Course Title: **Engineering Workshop Practice**
(Course Code: 4301901)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering, Marine, Metallurgy, Mechatronics, Fabrication Technology, Ceramics	First
Automobile Engineering, Textile Processing Technology, Printing Technology, Textile Manufacturing Technology	Second

1. RATIONALE

Workshop practice is the backbone of the real industrial environment which helps to develop and enhance relevant technical hand skills required by the technician working in the various engineering industries and workshops. This course intends to impart knowledge of basic workshops such as fitting, sheet metal, plumbing, carpentry and welding shop to perform his/her duties in industries. Students are able to perform various operations using hand tool, equipment and machineries in various shops. Working in workshop develops the attitude of group working and safety awareness.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Prepare simple jobs as per given specification using appropriate tools, instruments and equipment following safe working and good housekeeping practices.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the following Course Outcomes (COs) achievement :

a) Use the preliminary safety measures while working in different shops of engineering workshop.
b) Select the appropriate tools/equipment required for specific job.
c) Perform various fitting and sheet metal operations to produce simple jobs.
d) Use various tools for performing plumbing and carpentry operations.
e) Perform various joining operations using welding, brazing and soldering methods.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	0	0	25*	25	50

(*): For this practical only course, 25 marks under the practical CA has two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare a general layout of workshop.	I	02
2	Perform mock drill practice for various safety equipments and common workshop tools.	I	02*
3	***Fitting shop*** **:** Prepare one simple fitting job with following operations • Marking operation as per drawing • punching operation as per drawing • filing operation as per drawing	II	04*
4	Prepare job with following operations: • chamfering operation as per drawing • sawing operation as per drawing	II	04
5	Prepare job with following operations: • drilling operation as per drawing • tapping operation as per drawing	II	04*
6	***Sheet metal shop :*** Perform various joining operations like soldering, brazing etc.	III	02
7	Prepare the report with sketch, specifications and applications of demonstrated sheet metal tools.	III	02
8	Prepare sheet metal utility job using following operations : • Cutting and Bending • Edging • Soldering • Riveting.	III	06*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	***Carpentry shop:*** Demonstration of different carpentry tools including power tools.	IV	02
10	Prepare the report with sketch, specifications and applications of demonstrated carpentry tools.	IV	02
11	Prepare one simple carpentry job involving operations like measuring, marking, cutting and assembly.	IV	06*
12	Prepare following carpentry job as per given drawing: • T-Joint, • Dovetail Joint		04*
13	***Plumbing shop:*** Demonstration of different plumbing tools and pipe fittings.	V	02
14	Prepare the report with sketch, specifications and applications of demonstrated plumbing tools and pipe fittings.	V	02
15	Prepare following plumbing job as per given drawing: • T joint pipe fitting job • elbow joint pipe fitting	V	04*
16	***Welding shop:*** Demonstration of different welding tools/machines.	VI	02
17	Prepare the report with sketch, specifications and applications of demonstrated welding tools/machines.	VI	02
18	Prepare simple job using arc welding method.	VI	04*
	Total		**56**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1.	Safety instructions	10
2.	Job sample drawing	10
3.	Selection of tool/equipment	20
4.	Sequence of operations and procedure	30
5.	Time limit	10
6.	Dimensional accuracy	10

7.	Oral test	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	**Fitting Shop** Bench vices 50/100/150 mm. Hand vice, Machine vice Marking table Surface plate Angle plate Universal scribing block Scriber Marking gauge Fitting tables Tri square Right angle Combination set V block with clamps C clamps Set of needle files Ball pane Hammer - 750 Gms. Pair of outside spring caliper- 250 mm. Pair of Inside spring caliper 150 mm. Vernier caliper Micrometer outside & inside Bevel protractor Odd leg caliper Files (smooth & rough)-round, flat, safe edge, square, knife edge, triangular, half round One pair of divider Hacksaw frame with blade 12”* 300 mm. Centre punch Dot punch Prick punch Letter punch-Number punch Flat chisel 20 mm. Set of sorted twist drills, taps and dies (with holders/wrench) Set of spanners-Fix, Ring, box, Allen and Adjustable Set of screw drivers-sorted Scraping tool Set of pliers Filler and radius gauge etc.	2, 3, 4 & 5

S. No.	Equipment Name with Broad Specifications	PrO. No.
2	**Sheet Metal Shop** Rubber mallet Wooden mallet Slip 12", 10" Slip ordinary Half moon stake Side stake Exiting stake Cross stake Funnel stake Tea & bottom stake Stake holding stand Combination pliers S.W.G Hand riveting m/c Spinning hath 6' with die Power hydraulic press m/c Riveting m/c Round stake Soldering and Brazing kits etc.	2, 6, 7 & 8
3	**Carpentry Shop** Carpentry tables Carpentry vices Bar cramp Plane machine-small ("Randha machine") Wood and metal Jack planes- 45 mm. Set of sorted wooden jack planes Smoothing plane Rebate plane Cross cut saw Compass saw Set of sorted saws Round hole saw Tenon saw 350 mm. Set of chisels-Firmer, Dovetail, Paring, and Mortise Adze tool Auger bit Hand drill with set of sorted drill bits Gimlet Small precision brace Mallet Wood rasp file Claw hammer Pincer Marking gage 150 mm.	2, 9, 10 , 11 &12

S. No.	Equipment Name with Broad Specifications	PrO. No.
	Steel rule 24” Measuring Tape 300 mm. C clamps Tri square Right angle Compass and divider Set of chisels Ball pane Hammer - 750 Gms. Hardware- nails, screws etc. Set of screw drivers Wood work punches Set of Gouges etc.	
4	**Plumbing Shop** Various samples of pipe fittings-like joints, elbows, tees, unions, bend, nipples, couplers, reducers, four way etc. of Metal and PVC Water taps, plug, ferule Pipe bending machine manual/hydraulic Pipe vice Pipe wrenches Pipe spanners Set of spanners-Fix, Ring, box, Allen and Adjustable. Set of screw drivers-sorted Set of chisels Hammers Teflon taps, cotton thread Set of dies and holders Hacksaw, pipe cutter Adhesive for PVC pipe fittings etc.	2, 13, 14 &15
5	**Welding Shop** Arc welding set with necessary accessories Welding cables Electrodes Fluxes Electrode holders Ground clamps Chipping hammer Wire brush Try Square Hammers, tongs, chisels and anvil Screw Wrench Tip Cleaner, Swage block and Personal Protective Equipment like safety gloves, face shield /screen etc.	2, 16, 17 & 18

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Follow safe practices.
b) Practice good housekeeping.
c) Demonstrate working as a leader/a team member.
d) Maintain tools/equipment.
e) Follow ethical practices.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Workshop Introduc-tion & Safety**	1a. Sketch general workshop layout 1b. Follow the preliminary safety rules in workshop including the dressing and behavioral safety manners 1c. Recognize the importance of keeping the workshop clean and tidy 1d. Demonstrate an awareness of the workshop safety rules written in the safety contact	1.1 Workshop layout 1.2 Importance of different sections/shops of workshop 1.3 Introduction to workshop safety 1.4 Personal safety 1.5 Use of tools 1.6 Workshop cleanliness 1.7 Fire precautions 1.8 Safety contract ***(See Annexure-1)***
Unit – II **Fitting Shop**	2a. Appreciate the importance of fitting operations in engineering works 2b. Select the proper fitting material for the job undertaken 2c. Indentify and use various tools/equipment used in	2.1 Introduction 2.2 Fitting tools: 2.2.1 Holding tools, 2.2.2 Striking tools, 2.2.3 Cutting tools, 2.2.4 Measuring, Marking and Testing tools etc.

	fitting shop 2d. Prepare a simple job according to the specifications	2.3 Fitting operations: 2.3.1 Method of filing, 2.3.2 Marking, 2.3.3 Sawing, 2.3.4 Chipping etc. 2.4 Materials used in fitting shop 2.5 Preparation of fitting job 2.6 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 1.*
Unit– III **Sheet Metal Shop**	3a. Appreciate the importance of sheet metal operations in engineering works 3b. Select the proper sheet material for the job undertaken 3c. Indentify and use various tools/ equipment used in sheet metal shop 3d. Prepare a simple job according to the Specifications	3.1 Introduction 3.2 Metals used in sheet metal work 3.3 Hand tools 3.4 Sheet metal joints 3.5 Soldering 3.6 Brazing 3.7 Preparation of sheet metal job 3.8 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 2.*
Unit– IV **Carpentry Shop**	4a. Appreciate the importance of carpentry operations in engineering works 4b. Select proper wood material for the job undertaken 4c. Indentify and use various tools/equipment used in carpentry shop 4d. Prepare a simple job according to the specifications	4.1 Introduction 4.2 Advantages of timber 4.3 Structure of wood 4.4 Selection of timber 4.5 Seasoning of timber 4.6 Methods of seasoning 4.7 Common defects in timber 4.8 Classification and conversion of wood 4.9 Carpentry tools 4.10 Cutting tools, Planes and Boring tools etc. 4.11 Preparation of carpentry job 4.12 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 3.*

Unit– V **Plumbing Shop**	5a. Appreciate the importance of plumbing operations in engineering works 5b. Select proper grade and type of different pipes required for the job undertaken 5c. Indentify and use various tools/ equipment used in plumbing shop 5d. Prepare a simple job according to the specifications	5.1 Introduction 5.2 Types of pipes 5.3 Pipe fittings including valves 5.4 Plumbing tools 5.5 Pipe joints 5.6 Preparation of plumbing job 5.7 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 4.*
Unit– VI **Welding Shop**	6a. Appreciate the importance of welding in engineering works 6b. Select the proper material and welding machine for the job undertaken 6c. Indentify and use various tools/ equipment used in welding shop 6d. Prepare a simple job according to the specifications	6.1 Introduction 6.2 Types of welding 6.3 Arc welding: 6.3.1 Principle of arc welding, 6.3.2 Electric arc welding 6.4 Arc welding electrodes 6.5 Fluxes 6.6 Equipments used in arc welding 6.7 Types of welded joints 6.8 Comparison between AC and DC welding 6.9 Preparation of work before welding 6.10 Advantages of welding 6.11 Disadvantages of welding 6.12 Common welding defects 6.13 Preparation of welding job 6.14 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 5.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching/ Practical Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Workshop Introduction & Safety	**- Not Applicable -**				
II	Fitting Shop					
III	Sheet Metal Shop					
IV	Carpentry Shop					
V	Plumbing Shop					
VI	Welding Shop					
Total						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare a list of specifications for various tools/equipment/machines used in the engineering workshop.
b) Undertake a market survey of local dealers for procurement of workshop tools/ equipment/machines and raw material.
c) Visit the local sheet metal trader/timber merchant/plywood merchant/fabricator, collect all relevant information and submit the detailed report.
d) Download movies showing correct practices for fitting, sheet metal work, carpentry, plumbing and welding

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability (Hand operated tools are being used which are not consuming generated energy)

g) Guide students for using data manuals.
h) Arrange visit to nearby industries and workshops and use of videos/animations for understanding various workshop process.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a utility job using various carpentry operations as per given drawing.
b) Prepare a utility job using various plumbing operations as per given drawing.
c) Prepare a utility job using various sheet metal operations as per given drawing.

Note :

- *Utility job will be assigned by the teacher.*
- *Utility Job will be completed in a group of 4 to 5 students and students have to maintain lab work manual consist of job drawing, operations details, required raw materials, tools, equipments, date wise performance record.*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Workshop Practice	H.S. Bawa	McGraw Hill Education, Noida ISBN: 978-0070671195
2	A Textbook of Manufacturing Process (Workshop Technology)	J.K.Gupt and R.S. Kurmi	S.Chand and Co. New Delhi ISBN:81-219-3092-8
3	Introduction to Basic Manufacturing Process and Workshop Technology	Rajender Singh	New Age International, New Delhi ISBN: 978-81-224-3070-7

14. SOFTWARE/LEARNING WEBSITES

- http://www.abmtools.com/downloads/Woodworking%20Carpentry%20Tools.pdf
- http://www.weldingtechnology.org

- http://www.newagepublishers.com/samplechapter/001469.pdf
- http://www.youtube.com/watch?v=TeBX6cKKHWY
- http://www.youtube.com/watch?v=QHF0sNHnttw&feature=related
- http://www.youtube.com/watch?v=Kv1zo9CAxt4&feature=relmfu
- http://www.piehtoolco.com
- http://sourcing.indiamart.com/engineering/articles/materials-used-hand-tools/

15. PO-COMPETENCY-CO MAPPING

Semester-I & II	Engineering Workshop Practice (Course Code: 4301901)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustain-ability & environ-ment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	**Prepare simple jobs as per given specification using appropriate tools, instruments and equipment following safe working and good housekeeping practices.**						
Course Outcomes CO a) Use the preliminary safety measures while working in different shops of engineering workshop.	2	-	-	3	2	-	-
CO b) Select the appropriate tools/equipment required for specific job.	2	-	-	3	-	-	-
CO c) Perform various fitting and sheet metal operations to produce simple jobs.	-	-	-	2	1	-	-
CO d) Use various tools for performing plumbing and carpentry operations.	-	-	-	1	1	-	-
CO e) Perform various joining operations using welding, brazing and soldering methods.	-	-	-	2	1	-	-

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. M.D. Mathukia, Lecturer	GP, Junagadh	9998946136	manishmathukia@gmail.com
2.	Mr. A.R. Kotadiya, Lecturer	GP, Junagadh	9429044624	amit.r.kotadiya@gmail.com
3.	Dr. H.R. Sapramer HoD	Dr. JNMGP, Amreli	9426587197	merhamir@gmail.com

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Dr. K.K. Jain, Professor	Mech. Engg. Education	9425017472	kkjain@nitttrbpl.ac.in
2.	Dr. A.K. Sarathe, Associate Professor	Mech. Engg. Education	9425392466	aksarathe@nitttrbpl.ac.in
3.	Dr. Sharad K. Pradhan, Associate Professor	Mech. Engg. Education	9300802353	spradhan@nitttrbpl.ac.in

Annexure-1

SAMPLE SEFTY CONTRACT:
(To be filled by the students and submitted to concerned faculty/staff)
-- Use for reference purposes only --

1. You have to read and sign the safety contract.
2. The safety contract says that you understand that safety is your responsibility.
3. The safety contract to be signed before you carries out any work in the workshop and if you don't observe and obey the safety rules, you will not be allowed in the workshop.

Safety Contract

Date: .....

Name of Institute: .....

Name of Course with Code: Engineering Workshop Practice (3301901)

Name of Faculty/Staff with Designation: 1.....

2. .....

3. .....

I recognize that :

1. Safety is my responsibility when using a tool.
2. Safety regulations have been provided to me.
3. The possibility of accident and injury increases if I do not follow all the safety guidelines.
4. I must act responsibly to ensure my own safety AND the safety of others in the work area.

I agree to :

1. Never work in the shop without my faculty supervision.
2. Read and practice all the safety regulations that have been distributed to me in this course or have been posted in the work areas.
3. Act in a responsible manner at all times in the workshop.
4. Follow all instructions given by the faculty.
5. Immediately report any unsafe condition or activity to my faculty.

6. Wear eye protection at all times when working with tools or working anywhere near someone who is using tools.
7. Cut or Tie back long hair, remove jewelry, secure loosed clothing, and wear safety shoes in the Workshop.
8. Clean all work areas and put equipment away before leaving the workshop.

I, _____, have read and agree with all the safety instructions.

Particulars:

Programme: ....

Batch No.: ..... Student Signature

Enrollment No.: .....

----------x----------

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I – Semester

Course Title: **Basics of Civil Engineering**
(Course Code: 4310001)

Diploma programme in which this course is offered	Semester in which offered
Mechanical, Automobile, Marine, Fabrication	First
Electrical	Second

1. RATIONALE

Now a days Industrial activities/ task to be performed by allied programs such as Automobile, Marine, Fabrication are complex in nature and involves integration of activities of core programs which are Mechanical, Electrical and Civil. Thus, they are expected to look after many activities at work place, which may be interdisciplinary, for example he/ she has to interpret and execute the task as per the drawing, select suitable material, adopt/ suggest appropriate construction activity which requires the knowledge of civil engineering. Therefore he/she is supposed to be exposed to basics of civil engineering. This course mainly encompasses the major and general areas of civil engineering considering environmental aspects; knowledge of which is required by them.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **To apply the basic principles of civil engineering to solve broadly defined engineering problems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Prepare drawing from field Survey data using Chain, Tape, Compass and /or Dumpy level.
b) Select suitable building material and construction technique.
c) Interpret various building drawing and Services.
d) Follow traffic control aids.
e) Use green and ecofriendly building technology.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
-	2	2	3	0	0	25*	25	50

(*):For this practical only course, 25 marks under the practical CA has two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15

marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

***Legends: L**-Lecture; **T –** Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C –** Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S. No.	Practical Outcomes (PrOs)	Unit No.		Approx. Hrs. required
1	Record linear and angular measurements in horizontal plane using chain, tape and compass	1		02*
2	Prepare drawing using Chain, Tape and Compass Survey Data	1		04*
3	Record measurements in vertical plane using dumpy Level.	1		02*
4	Prepare contour map using leveling data.	1		02*
5	Prepare a report on market survey of construction materials	2		04*
6	Draw a sketch of wall section showing all building components.	2	Any three	02
7	Draw Sketches of different brick masonry bonds.	2		02
8	Prepare a chart of Standards of potable water.	2		02
9	Conduct field tests on Cement.	2		02
10	Conduct field tests on Bricks.	2		02
11	Prepare a cost estimate for the given drawing.	2		02
12	Draw Utility plans of a given building (Electricals, drainage)	3	Any three	02
13	Draw Sketches of different types of Foundations	3		02
14	Draw Sketches of plumbing fixtures.	3		02
15	Prepare list of abbreviation related to civil engineering drawing.	3		02
16	Prepare drawing of symbols related to Civil engineering drawing.	3		02
17	Draw Sketches of different Traffic Signs, Road Markings and Signals.	4		02
18	Prepare a report on ecofriendly materials.	5	Any one	02
19	Draw a typical sketch of rain water harvesting.	5		02
	Total			**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs 1 to 4		
1	Operation and handling of instruments	30
2	Observations and recording	20
3	Interpretation of result and plotting and submitting	10
4	Answer the questions	20
5	Follow safe practices measures	20
Total		**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs 5 to 19		
1	Initiative of work allotted	30
2	Neatness in work done and work place	20
3	Submission of report in time	10
4	Answer the question	20
5	Follow safe practices measures	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	**Measuring Chain** (20m and 30m). The length of each linked is 200 mm. each meter is provided with circular brass ring & each five meter length is provided with brass tallies of requisite shapes each chain should be provided with 10 numbers of M.S. Arrows of 4 mm diameter bar and 40 cm. Height .As per IS 1492-1970	1,2
2	**Metallic Tape:** 30 Meter, consists of 12 to 15 mm wide Low High Accuracy 5mm + 10ppm 1mm + 1ppm Range 1 km 5 km Cost $10,000 $40,000 Data Storage none 7500 pts. Magnification 10X 30X Run-time 3 hrs. 6 hrs. . strip of either Yarn coating or linen or cloth / or plastic coating. having very fine brass or copper or bronze wires. Woven into it to prevent it from elongation and twisting Graduated in metric system. Each meter length is divided into decimeter and centimeters. It is available in various length. 30 meter length is in common use. The tape is available in a leather / suitable cover with a winding device. The Zero end of the tape is provided with a metal ring. 10 meters 15 meters 20 meters 30 meters 50 meters	1,2
3	**Ranging Rods:** Circular / Octagonal Ranging Rods preferably circular with 3 to 5 cm diameter made up of either seasoned solid bamboo stick or	1,2

S. No.	Equipment Name with Broad Specifications	PrO. No.
	metal conduit pipe of length 2 to 3 meters, with conical metallic shoe fitted at bottom & fully painted with 20 cm. long colour bands of either of the following combinations. Salient Features a) Black & White - size 2 meters b) Red & White - size 3 meters	
4	**Prismatic Compass:** consisting of brass or aluminum circular box with a diameter of 100/125 millimeter. Aluminum circle consists of a needle graduated to 30 min. (0. 50)	2
5	**Dumpy Level:** image erect, magnification 24x, length of telescope 300 mm, objective aperture 40 mm, stadia radio 02:40:00 am ,field of view 1° 30' ,resolution 0.01 cm at 100 mt plate, bubble size 12mm x 87.5 mm, sensitivity 45°/2 mm, circle diameter 75 mm(magnetic), circle graduation 1 div=1°	3,4
6	**Leveling Staff:** Made of Aluminium body Telescopic in 3 PCS, 4 meter in length packed in canvas cover, graduated in meters, dm, cm, and mm with background and black strips. 5 mm thick with suitable locking arrangement Made of Aluminium body / Metallic Body folding in 2 PCS, 4 meter in length graduated in meters, dm, cm and mm. with white background and black strips. 5mm thick with suitable folding & locking arrangement. Improved soap with pattern is made of best quality well seasoned teak wood, Telescopic in three pieces, brass fitting and glued, thus greatly increasing its strength, stability and durability, Accurately machine divided and engraved to read 5 mm. painted and polished. Size 4 meters. Long Size 5 meters. Long Size 6 meters Long.	3,4

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this course competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice of environmental friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Surveying and levelling	1a. Use surveying tools and instruments for field survey. 1b. Determine horizontal distances by chaining. 1c. Compute horizontal angles using prismatic compass. 1d. Calculate difference in levels using dumpy level. 1e. Prepare contour map of a given area.	1.1 Importance and types of Surveying & leveling 1.2 Principals of surveying. 1.3 Instrument/tools used for surveying and levelling. 1.4 Chaining and Ranging 1.5 Recording of measurements in field book. 1.6 Functions of different part of Prismatic compass 1.7 Setting and operations of compass 1.8 Methods of finding included angles from bearings 1.9 Basic terminology related to levelling 1.10 Functions of different part of Dumpy level 1.11 Different types of levelling staff 1.12 Setting of Dumpy Level 1.13 Methods of finding out the RL in level book by HI method and Rise & Fall Method with necessary check 1.14 Contour – use, characteristics 1.15 Preparations of contour sheets/ plan using survey data.
Unit – II Building Material and Construc-tion Technology	2a. Select different types of construction materials as per requirements. 2b. Test given construction materials on field for quality control. 2c. Classify various types of foundations. 2d. Explain various types of bonds in brick masonry. 2e. Estimate the cost of given simple construction works.	2.1. Common construction materials such as cement, brick, sand, aggregate, steel and water. 2.2. Properties of each materials & their acceptable standards. 2.3. Types of bricks, cement and aggregate 2.4. Field tests on bricks, cement 2.5. Functions of various components of buildings. 2.6. Classification and Types of foundations.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		2.7. Bonds in brick masonry. 2.8. Estimations and costing for simple structure (only the material cost)
Unit– III **Building Drawing and Building Services.**	3a. Interpret various types of drawings used in civil engineering. 3b. Explain building bylaws and principles of planning. 3c. Describe basics of building services. 3d. Classify various types of building services. 3e. Apply various types of services as per need of building.	3.1 Types of building drawings 3.2 Abbreviation, conventions & symbols in civil drawing for • Electric fittings • Water supply and sanitary fittings. • Material for constructions • Surveying 3.3 Building byelaws and principles of planning of residential building. 3.4 Planning of a simple residential building. 3.5 Objective and uses of building services. 3.6 Applications of services for different types of building. 3.7 Classification of building services 3.8 Types of services 3.1 Electrical 3.2 Water Supply 3.3 Drainage 3.4 Circulation 3.5 Fire Safety
Unit– IV **Basics of Transpor-tation Engineering**	4a. Explain role of transportation. 4b. Explain various modes of transportation. 4c. Explain importance of traffic signs. 4d. Explain traffic control aids.	4.1 Role of transportation in national development. 4.2 Modes of Transportation. 4.3 Introduction to road traffic and traffic control aids.
Unit– V **Green and ecofriendly Technology**	5a. Use green and ecofriendly building technology. 5b. Explain rain water harvesting. 5c. Explain various types of green building materials. 5d. Explain components of green buildings.	5.1 Rain water harvesting for buildings. 5.2 Concept of GREEN buildings 5.3 Components of GREEN building.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Surveying and levelling	6	NOT APPLICABLE as no theory exam at the end of semester.			
II	Building Material and Construction Technology	8				
III	Building Drawing and Building Services.	8				
IV	Basics of Transportation Engineering	3				
V	Green and ecofriendly Technology	3				
Total		**28**				

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare specification of surveying devices.
b) Prepare specification of various building materials by market survey.
c) Submit a report of construction work going on at site.
d) Prepare drawing of line plan of a house.
e) Prepare drawing of various services provided in a house.
f) Prepare power point on various construction stages.
g) Submit a report on traffic system in your city/town.
h) Submit a report on traffic control aids in your city/town.
i) Calculate traffic intensity in peak hours in a busy road in your city/town.
j) Give seminar on relevant topic.
k) Prepare a report of rainwater harvesting.
l) Prepare a report on green building construction.
m) Prepare showcase portfolios.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

f) Guide students on how to address issues on environ and sustainability

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a layout plan of an existing building of campus.
b) Comparison of test results obtain from different sources of drinking water with potable water standards (minimum 5 samples)
c) Prepare Report on Justifying traffic signs on particular section of roads.
d) Prepare a suggestive report on upgrading existing building into green building as per IGBC/GRIHA standards.
e) Rain water Harvesting System.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Surveying and Levelling	T.P.Kanetkar and S.V.Kulkarni	Pune Vidyarthi Griha Prakashan, ISBN13-9782508807185
2	Surveying Volume 1	B.C.Punamia, Ashokkumar Jain Arunkumar Jain,	Laxmi Publication ISBN-13: 978-8170088530
3	Engineering Material	S.C.Rangwala	Charotar Publishing House ISBN13 9788185594965
4	Building Construction	S.C.Rangwala	Charotar Publishing House ISBN13-9789385039041
5	Building Construction	Shushilkumar	Standard Publications-Delhi, 2008 ISBN 13: 9788186308868
6	Building Construction	Bindra and Arora	Dhanpat Rai & Co. ISBN-13-9788189928803
7	Traffic Engineering	L.R.Kadiyali	KHANNA PUBLISHERS ISBN-13-9788174092205
8	Water Supply and Sanitary Engineering	G. S. Birdi and J. S. Birdi	Dhanpat Rai Publishing Company (p) Ltd ISBN-13- 9788187433798
9	Building Drawing with an Integrated Approach to	CM Kale, MG Shah, SY Patki	McGraw Hill Education ISBN-13-9780071077873

S. No.	Title of Book	Author	Publication with place, year and ISBN
	Built Environment		
10	A text book on Green Building	Guttila Yugantha Jaysinghe Shehani Sharadha Maheepala	LAP Lamberd Academic Publishing ISBN13-9786138389187
11	Green building Guidence :The ultimate guide for IGBC	Karthik Karuppu	Notion Press.com ISBN-13 978-1684667291

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in

b) www.surveyofindia .gov.in

c) www.igbc.in

d) www.grihaindia.org

15. PO-COMPETENCY-CO MAPPING

	Basics of Civil Engineering (Course Code: 4310001)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency **To supervise the simple civil engineering tasks related to own branch's integrated tasks.**							
Course Outcomes CO a) Prepare drawing from field Survey data using Chain, Tape, Compass and /or Dumpy level.	3	2	-	3	-	2	1
CO b) Select suitable building material and construction technique.	3	-	-	2	1	-	1
CO c) Interpret various building drawing and Services.	2	-	-	-	-	-	-
CO d) Follow traffic control aids.	2	-	-	-	-	-	1
CO e) Use green and ecofriendly building technology	1	1	-	-	2	-	1

Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Shri Umesh.N.Pattani	Govt.Poly.,Ahmedabad	079-26301285	unpat1969@gmail.com
2	Shri Prakash.A.Pandya	R.C.Tech Inst. Ahmedabad	079-27664785	pap31067@gmail.com
3	Smt. Margee Milisia	Shri. K.J.Polytechnic, Bharuch	0264-2246402	margee.milisia@gmail.com
4	Shri Munaf Jagdu	Govt.Poly.,Ahmedabad	079-26301285	mjagadu@gmail.com
5	Shri Darshan V Patel	Govt.Poly., Himatnagar	02772-229285	darshan.2228@gmail.com

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1	Prof. M.C.Paliwal, Associate Professor	Civil Engineering	0755-2661602	mcpaliwal@nitttrbpl.ac.in
2	Prof. A.K.Jain, Professor	Civil Engineering	0755-2661600	akjain@nitttrbpl.ac.in

Induction Program for Diploma Engineering

Preamble:

As suggested in Model Curriculum of Diploma by AICTE, all students will have to undergo a mandatory induction program as part of their Diploma Programme Curriculum right at the start of the first year. The duration of the induction program will be of two weeks (12 Working Days) wherein students will undergo a wide variety of activities without actually starting with their usual classes. Normal classes will start only after the induction program is over.

This will help build confidence among the new students, instill a sense of connect and appreciation towards their institution, provide them with the comfortable environment to adjust and pick up friendship with other students, facilitate them to get to know important functionaries and faculty members of the institution, equip them with human and social values.

The Induction Program will help the new students in building social character, leadership qualities, self-confidence, creativity and appreciation for mankind and nature at large. In nutshell, the induction program is envisaged to give the new students the broader foundational experience for the life- long success.

The new students, in the process, will get to learn about various processes and procedures in place in the institution, facilities and best practices, student activities, and the culture & values prevailing in the institution. The Program is also expected to be used for rectifying some critical lacunas, for example, Communication Skills in English for those students who have deficiency in it. Such students can be identified by conducting diagnostic tests and special Proficiency Modules can be conducted for them.

The mentor-mentee groups of the students are formed with each group comprising small number of students and being associated with a faculty mentor. Then the different activities start with a healthy daily routine.

Scheme:

Sr No	Phase and Activities Heads	Weightage	Hours
1.	**Initial Phase**	**1 day (6 Hrs)**	**6**
2	**Regular Phase**	**10 Days**	**60**
a)	Physical activity	14 Hours	14
b)	Creative Arts & Culture	10 Hours	10
c)	Mentoring & Universal Human Values	8 Hours	8
d)	Literary Activity	6 Hours	6
e)	Proficiency Modules	6 Hours	6
f)	Lectures & Workshop by Eminent People	3 Hours: 3 Expert Lectures, One per Week	3
g)	Visits to local Areas or Industry	1 Day	10
h)	Co & Extra-curricular Activities in the institute	3 Hours	3
3	**Closing Phase (Feedback & Report)**	**1 Day (6 Hrs)**	**6**
	Total	**72 Hours/ 12 Days**	**72**

Phases, Modules, Activities and Guidelines:

The activity during Induction Program would have an Initial Phase, a Regular Phase and a Closing Phase. The initial and closing phases would be one day each. The following is the guidelines indicating the possible activities under each phase of the Induction Program.

Initial Phase (First Day)-6 Hrs.

Following are the activities to be carried on the first day:

- Orientation Programme
- Know your Department/Institute
- Know your university
- Know hostel and other amenities
- Information about Student Diary and Induction Program

Regular Phase (10 Days)-60 Hrs.

The Regular Phase consists of 8 days; each day is of 6 hours. It may cover any/ all the 8 different activity modules. For each module, the objectives, suggested activities and guidelines are provided herewith. Institute can form their time table according to local situation and priorities or use additional relevant activities in additional in suggested activities for each of the phases.

Module Name	Objectives	Suggested Activities
1. **Physical Activity (14 hours)**	1. Improve bone health 2. Improve cardio respiratory and muscular fitness 3. Understand the anatomy, basic biomechanical principles and terminology. 4. Examine the effect of nutrition, rest and other lifestyle factors that contribute to the better health.	1. Running/Jogging 2. Brisk Walk 3. Cycling 4. Heavy yard work 5. Swimming 6. Yoga/Pranayama 7. Aerobics 8. Outdoor Sports/Indoor Games(In addition to cricket, Volleyball, Badminton, Chess, Carom, Table Tennis, Other games like Critical Thinking, Math skill developing Games, Memory Games can be included.) 9. Calculate Body mass index of each students and explain their fitness level fromit. 10. Tree Plantation 11. Gardening

Guidelines:

- Half an hour Yoga/Pranayama followed by physical activities including various games.
- Refer this link for Yoga/Pranayama https://yoga.ayush.gov.in/public/assets/front/pdf/CYPEnglishBooklet.pdf

Module Name	Objectives	Suggested Activities
2. **Creative Arts & Culture (10 hours)**	1. Develop creativity and imagination through a range of complexactivities. 2. Improve the student's ability to control materials, tools and techniques. 3. Develop increasing confidence in the use of visual and tactile elements and materials.	1. Make a model of any physical object related to Engineering Design 2. Crafting 3. Painting 4. Sculpture 5. Pottery 6. Music 7. Dance

Guidelines:

- Use any activities leading to creative thing and practice.
- Show the video demonstrating the creative ideas and thinking.
- Show the video demonstrating phenomenon performance using innovation in different areas of humanity and social science.
- Demonstrate the story of leaders with the context of how with their creative vision, with all odds they achieved success.

Module Name	Objectives	Suggested Activities
3. **Mentoring & Universal Human Values (08 hours)**	1. Impart universal human values in students. 2. Enable students to live in harmony within themselves, with family, with society and the nature 3. Initiate the process of self-exploration and self-investigation within themselves about their understanding of happiness.	1. Mentoring for creating a learning relationship 2. Showing Motivational Movies. 3. Social Activities like visit of orphanage,old age home, blind people association, Apang Manav Mandal etc. 4. Swachchhata Mission Activities. 5. Awareness regarding environmental issues and remedies. 6. Spread awareness about blood donation, organ donation, precaution to avoid malaria in monsoon etc. 7. Discuss autobiography of legendary persons who practiced universal human values in their life and work. 8. Conduct universal human values group discussions.

Guidelines:

- Use the materials and activities covered in the FDP on Induction Program held at GTU organized by AICTE.
- The faculties trained from institute will take leadership role to rollout it at institute level.

Module Name	Objectives	Suggested Activities
4. **Literary Activity (06 hours)**	1. Inculcate the habit of active (or interactive) consumption of the best content available in literature. 2. Develop thinking skills. 3. Improve reading abilities and attitude.	1. Digital literacy and use of Internet 2. Basic Mathematics for Solving Real World Problems 3. Use of Scientific Calculator in Engineering 4. General Knowledge Quiz Competition 5. Vedic Mathematics 6. Reading/writing/speaking/listening 7. Debating/Elocution 8. Enacting a play 9. Book review 10. Digital India Portal 11. Vernacular Literature

Guidelines:

- Use the video lectures to literate students in different skills needed for day-to-day life and need.
- Motivate students to create the nature of inquiry and reading habits.
- Arrange the various competitions like Elocution, Essay writing, Storytelling, Bookreviews etc.
- Writing the review of the well-known books, movies etc. and sharing.

Module Name	Objectives	Suggested Activities
5. **Proficiency Modules (06 hours)**	1. Determining English proficiency level of students and mentoring accordingly. 2. Learn the mining vocabulary, idioms, and expressions and Understand their meanings in context. 3. Develop ability to write a paragraph about general topics by using the English language correctly. 4. Realize the importance of English language as a global business language.	1. Activity by Faculty from Communication Skills/ English from Science & Humanities/ General Departments 2. English general diagnostic test to Determine student's English proficiencylevel. 3. Mentoring students to improve in English proficiency according to his/her proficiency level based on test.

Guidelines:

- An MCQ test of **30 Marks / 30 minutes** should be conducted covering basic grammar andvocabulary.
- Group the students in three groups based on test result in three proficiency levels:
  - Unsatisfactory
  - Satisfactory
  - Good
- Following activities are to be used to uplift proficiency levels of students.
  - Motivational movies, documentary
  - Language games
  - Essay/story writing
  - Ice breaking games.
- Separate set of activities from suggested list should be used for different groups.
- Groups requiring Mentoring may be identified and informed to respective departments for their development in future
- Groups who can lead can also be identified and informed to respective departments for their development in future

Module Name	Objectives	Suggested Activities
6. **Lectures & Workshop by Eminent people (03 hours)**	1. Motivation through knowing experience of successful person / Alumni. 2. Meet and interact with eminent personalities of different fields.	1. To conduct lecture by eminent people. 2. Interaction with leaders, experts, entrepreneurs, contributors and successful personalities / alumni.

Guidelines:

- 3 expert lectures each of 1 hour for every discipline. It should be arranged at department level or Common for institute. If multiple disciplines are to be combined in an expert lecture then it may be arranged in both the weeks so as to accommodate all branches.
- External expert should be invited.
- Expert can be from academic, industry, research organization, social organization etc.
- An individual successful person in any of the field can be invited.
- The aspect to be addressed may be social / economical / engineering / entrepreneurship/ spiritual/ humanity science.

Module Name	Objectives	Suggested Activities
7. **Visit to LocalArea and Industry (1 Full day- 10 Hrs.)**	1. To familiarize students with the local area. 2. Sensitize with the different aspects of the life including social services and heritage	1. A full day visit covering at least 2 or 3 places. 2. List of possible places A. Centre of excellence B. Elite Academic Institutes C. Research institute D. Hospitals E. Industry visit F. Heritage places

Guideline and References:

- Institute can arrange visit to public, social or specifies places to give insight of the activities and overall socio-economic contribution of such places.
- The uniqueness or impact of such visits should be highlighted.

Module Name	Objectives	Suggested Activities
8. **Co & Extra Curricular Activities in the institute (03 hours)**	1. Introduce the student about innovation in different fields 2. Make students aware about innovative and modern practices and products in their own branch 3. Create awareness about support available for start-up and innovation	1. Lectures by Convener/ senior members of Gymkhana Committee. 2. Showing videos demonstrating Gymkhana Activity / Talent hunt/ Performances. 3. Introducing NSS Activity 4. Awareness regarding SSIP Scheme of Government of Gujarat 5. Awareness about Government initiatives in areas of innovations and supports for start- up, Incubation, Entrepreneurship etc.

Guideline:

- Video lectures of Gymkhana Activity / Talent hunt/ Performances
- Video lectures from leaders and innovators.
- TeDx Talks.
- Government Policy documents for different schemes.

Closing Phase (Last Day)

The closing phase is the last day of the Induction Program and covering conclusion andsummary of the Induction Program.

- **Conclusion and summary:**
- Guiding students for preparation of student report about Induction Program.
- Instruct students regarding submission and examination of the Induction Program.
- Address by HODs/Senior faculties regarding branch/discipline and career option in respective branch.

- Introduce about the engineering and its importance in life and their responsibilitiestowards the society.

General Regulations:

a) Every student has to maintain a daily diary. Format of the diary is already given.
b) After completion of the Induction program student has to prepare a report based onactivities performed during the Induction program. Diary will be attached as Appendix in Report.
c) 75% Attendance is required during Induction Program.
d) This program will be noncredit subject but it will reflect in 1st Semester Mark sheet as PASS or FAIL.
e) Institute should appoint a mentor for a group of 20 to 30 students. Mentor can take help of senior students.
f) If student gets admission transfer in other college during Induction Program the diary will be continued from previous college to new college.
g) If student gets admission in middle of the Induction Program or student gets admission after Induction Program, it is responsibility of the institute to fulfill the criteria of the Induction Program.
h) If student fails in the Induction program the student has to clear the same during subsequent Semester

Evaluation Pattern:

1. Induction Program is Mandatory course for each branch of Engineering.
2. It is mandatory for each student to clear Induction Program with PASS grade.
3. Grades for Induction Program are either PASS or FAIL and have no credits. Evaluation for Induction Program is based on the Induction Program Report prepared by a student from Student diary and student will be declared PASS or FAIL.
4. Student has to submit the Induction Program Report at the end of first semester dully approved by Mentor and HOD.
5. Evaluation of Induction Program will be done along with first Semester Term-Work Submission.
6. The evaluation is carried out by Internal Examiner from institute itself. The entry on the GTU portal will be PASS or FAIL, not marks.
7. The students who will FAIL have to reappear again after every 6 months as remedial exam.

Guidelines for Program Report:

1) Report should have minimum 15 pages.
2) Report must have One Photograph per Activity.
3) Report consists of Certificate, Index and Diary as Appendix.
4) Report should be dully signed by Mentor and HOD.
5) Index will have following sequence:

[A] The Suggestive List of activities is as mentioned below:

- ✓ Physical Activity
- ✓ Creative Arts and Culture
- ✓ Mentoring & Universal Human Values
- ✓ Familiarization with the institution, Dept. /Branch
- ✓ Literary Activity
- ✓ Proficiency Modules
- ✓ Lectures & Workshops by Eminent People
- ✓ Visits in Local Area
- ✓ Extra-Curricular Activities in the institution
- ✓ Feedback and Report on the Program

Induction Program Schedule (Suggestive only)

Note: It is presumed that the first year students are so divided into two major groups that the number of students in each group is almost equal with some branches forming part of Group-I while the rest of the branches being part of Group-II. Grouping can also be done at discipline/ department level.

The detailed suggestive program is as under:

Arrival to Hostel/ Accommodation			
Time	**Activity**	**Students' Group**	**Venue**
Whole day	Students arrive - Hostel allotment	I & II	Respective Hostels / Accommodation
DAY 1- Initial Phase- Reporting at 10.00 am in the respective Departments			
10.30 am – 12.00	Mentor-mentee groups - Introduction with-in group. ● Orientation Programme ● Know your Department/Institute ● Know your university ● Know hostel and other amenities	I	Suitable Venue as per number of mentor-mentee groups
	Screening of Institute Documentary Movie; video clips of various functions and events	II	Conference/Seminar Hall
12.00 – 01.30 pm	Mentor-mentee groups - Introduction with- in group. ● Orientation Programme ● Know your Department/Institute ● Know your university ● Know hostel and other amenities	II	Suitable Venue as per number of mentor-mentee groups
	Screening of Institute Documentary Movie; video clips of various functions and events	I	Conference/Seminar Hall
1.30 pm – 2.00 pm	Lunch	I & II	Respective Departments/ Hostels/ Mess/ canteens
2.00 pm – 5.00 pm	Institute Excursion	I & II	Around the Campus
DAY 2 to 10- Regular Phase -Timings can be changed for Physical / other Activities as per local requirements			
10.30 am – 12.00	Events from [A] are to be scheduled as per guidelines and local convenience i.e. Various activities from Regular Phase like Physical Activity Creative Arts and Culture Mentoring & Universal Human Values Familiarization with the institution, Dept. /Branch Literary Activity Proficiency Modules Lectures & Workshops by Eminent People Visits in Local Area Extra-Curricular Activities in the institution Feedback and Report on the Program	I II	Suitable Indoor/ Outdoor Venue in respective Departments as per number of mentor-mentee groups or Conference / Seminar Hall

12.00 – 01.30 pm	Events from [A] are to be scheduled as per guidelines and local convenience	II I	Suitable Indoor/ Outdoor Venue in respective Departments as pernumber of mentor-mentee groups or Conference / Seminar Hall
1.30 pm – 2.00 pm	Lunch	I & II	Respective Departments/ Hostels/ Mess/ canteens
2.00 pm – 5.00 pm	Events from [A] are to be scheduled as per guidelines and local convenience	I II	Suitable Indoor/ Outdoor Venue in respective Departments as pernumber of mentor-mentee groups or Conference / Seminar Hall
DAY 11- Visits to local Areas or Industry/ Any 1 DAY from above			
DAY 12- Closing Phase (Feedback & Report)			
10.30 am – 12.00	• Guiding students for preparation of student report about Induction Program. • Instruct students regarding submission and examination of the Induction Program.	I	Suitable Indoor/ Outdoor Venue in respective Departments as pernumber of mentor-mentee groups or Conference / Seminar Hall
	• Address by HODs/Senior faculties regarding branch/discipline and career option in respective branch. • Introduce about the engineering and its importance in life and their responsibilities towards the society.	II	
12.00 – 01.30 pm	• Address by HODs/Senior faculties regarding branch/discipline and career option in respective branch. • Introduce about the engineering and its importance in life and their responsibilities towards the society.	II	Suitable Indoor/ Outdoor Venue in respective Departments as pernumber of mentor-mentee groups or Conference / Seminar Hall
	• Guiding students for preparation of student report about Induction Program. • Instruct students regarding submission and examination of the Induction Program.	I	
1.30 pm – 2.00 pm	Lunch	I & II	Respective Departments/ Hostels/ Mess/ canteens
2.00 pm – 5.00 pm	Talent Show and Valedictory Function Principal's Address	I & II	Suitable Indoor/ Outdoor Venue in respective Departments as pernumber of mentor-mentee groups or Conference / Seminar Hall

Note:

1) Total duration of the Induction Program is two weeks i.e. 12 working days with Saturdays being working and Sundays off.
2) Sundays can be utilized for screening some Patriotic / Socially Significant Movies/ home viewing.
3) Faculty mentors would be required to obtain the feedback cum suggestions of the students of their respective groups about the Induction programme on the last day.

4) Coordinators can be assigned for various activities during the induction programme.

The suggestive template is as under:

S. No.	Name of the activity	Coordinators
1.	Visits to different departments and around the campus	HoDs
2.	Physical/Sports activities in the Sports Ground (Morning as well as Evening)	In charge of Physical Education / Sports/ Gymkhana Activity
3.	Creative Arts / Technical Workshops. Lecture Sessions or Films on Universal Human Values / Cultural / Talent hunt Activities / Performances by Classical or folk artists. Talent Show and Valedictory Function.	In charge of Technical / Cultural activities/ Gymkhana Activity
4.	Presentation cum Interactive Session with Eminent Alumni / Eminent Speaker	Training & Placement In charge of Department
5.	Universal Human Values	Suitable Faculty members
6.	Proficiency Module (English)	Faculty of English language
7.	Local Visits	Hostel Wardens / Discipline in –charge, 1Sr. & 1 Jr. Faculty
8.	Wake up call/Hostel related activities and Arrangements at Valedictory Function	Chief Wardens (Boys/Girls) Gymkhana Members

- **Schedule of local visits can be tabulated as under:**

Dates	Sections
…	…
…	…
…	…

- **Note:**

1) The faculty mentors of the respective mentor-mentee groups / sections will accompany the students on local visits.
2) The Institute buses, if there, may be made available for the purpose each day or some other/ local arrangements may be made.
3) Attendance of the students' needs to be taken at the time of departure and return.

GTU BoS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Shri U. V. Buch- BoS Member and Subject in-charge (EC)	G P Ahmedabad	9825346922	uvbuch@gmail.com

NB: The format of diary to be maintained will be as per Annexure-I

Annexure-I

Induction Program for Diploma Engineering

Format of Diary

Enrolment/Roll No: _____

Name of Student: _____

Dates from :_____ to _____			
Day	**Activities Done**	**Learning Outcomes**	**Remarks**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
Signature of the Student			
Evaluation: PASS/ FAIL			
Signature with Date of Mentor			**Signature of HoD**

2nd Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I – Semester

Course Title: **Environment and Sustainability**
(Course Code: 4300003)

Diploma programme in which this course is offered	Semester in which offered
Chemical, Mechatronics, Computer	First
Civil, Environment, Mining, Architectural Assistantship, Mechanical, Automobile, Marine, Metallurgy, Fabrication, Electrical, Electronics and Communication, Instrumentation and Control, Bio Medical, Power Electronics, IT, Textile Manufacturing, Textile Processing, Textile Design, Printing, Plastics, Ceramics, CACDDM , Computer Science and Engineering.	Second

1. RATIONALE

For a country to progress, sustainable development is one of the key factors. Environment conservation and hazard management is of much importance to every citizen of India. Considerable amount of energy is being wasted. Energy saved is energy produced. Environmental pollution is on the rise due to rampant industrial mismanagement and indiscipline. Renewable energy is one of the answers to the energy crisis and also to reduce environmental pollution. Therefore this course has been designed to develop a general awareness of these and related issues so that the every student will start acting as a responsible citizen to make the country and the world a better place to live in.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Adopt the sustainable practices to resolve the environment related issues.**

3. COURSE OUTCOMES (Cos)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Adopt relevant ecofriendly product in the given situation to protect ecosystem
b) use relevant method of pollution reduction in the given situation
c) Use of renewable resources of energy for sustainable development
d) Use the relevant techniques in given context to reduce impact due to climate change
Use relevant laws and policies for developing the sustainable environmental development

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	0	0	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.
Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *- End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES – Not Applicable

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the* ***PrOs*** *marked* ***'*'*** *are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Total		**44**

Note

i. *More* ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some* ***sample*** *'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed* ***Practical Exercises*** *of this course required which are embedded in the COs and ultimately the competency..*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED – (Not Applicable)

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1		

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Ecosystem	1a. Explain the Structure with components of the given Ecosystem 1b. Explain Carbon, Nitrogen, Sulphur and phosphorus cycle for the given ecosystem. 1c. Justify the need to conserve the given Ecosystem on the w.r.t. following points: • carrying capacity of earth • Biomes, • Ecologically sensitive area 1d. Explain the term biodiversity with its importance. 1e. Illustrate the importance of IUCN red list in environmental engineering. 1f. Calculate global ecological overshoot and virtual water requirement of given natural and man-made materials.	1.1 Structure and components of ecosystem 1.2 Types of Ecosystem, changes in ecosystem 1.3 Various natural cycles like carbon, Nitrogen, Sulphur, Phosphorus 1.4 Ecosystem conservation, carrying capacity of earth, Biomes in India, (ESA) Ecologically sensitive areas 1.5 Bio diversity, its need and importance, International Union for Conservation of Nature (IUCN) red list 1.6 Concept of Ecological foot print, virtual water, global ecological overshoot
Unit – II Pollution and its types	2a. Explain the term, "pollution and pollutant" in the given situation. 2b. Classify the air pollution on the basis of its source 2c. Use relevant equipment to control given type of air pollution.	2.1. Definition of pollution and pollutant 2.2. Air pollution, classification and its sources 2.3. Air pollution control Equipments 2.4. Water pollution, pollution parameters like BOD,COD, pH, Total suspended solids, Turbidity, Total Solids 2.5. Waste water treatment like primary,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	2d. Explain relevant techniques of treatment to deal with given type of water pollution. 2e. Apply relevant techniques of Solid waste management based on its characteristics. 2f. Explain drawbacks of noise pollution in given situation. 2g. Describe the environmental degradation due to Plastic waste and E- waste	secondary and tertiary 2.6. Solid waste generation, sources and characteristics of Muncipal solid waste 2.7. Collection and disposal of Muncipal waste and Hazardous waste 2.8. Noise pollution- its effects, sources and measurement 2.9. Plastic waste and its hazard 2.10. E waste and its hazard
Unit– III Renewable sources of energy	3a. Justify the need of renewable energy adopting relevant energy policy in given situation. 3b. Explain the working of the solar thermal and PV systems with sketch in given situation. 3c. Justify the need of Advanced collector, Solar Pond, Solar water heater, Solar dryer in the given system. 3d. Emphasize the importance of wind power in India 3e. Select the relevant type of wind turbines in the given situation. 3f. Identify the relevant types of Sources of biomass energy. 3g. Draw the neat labelled diagram of simple biogas plant to explain its working. 3h. Identify the sources of the energy generation for the given situation.	3.1 Need of Renewable energy and energy policy 3.2 Solar energy: National solar mission 3.3 Features of solar thermal and PV systems Advanced collector, Solar Pond, Solar water heater, Solar dryer, polycrystalline, monocrystalline and thin film PV systems 3.4 Wind Energy: Growth of wind power in India 3.5 Types of wind turbines – Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT) 3.6 Types of HAWTs – drag and lift types 3.7 Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel 3.8 Anaerobic digestion, Biogas production mechanism, utilization and storage. 3.9 New energy sources: Geothermal energy, Ocean energy sources, Tidal energy conversion, Hydrogen energy
Unit– IV Climate Change	4a. Explain the term, “climate change” in context of environment. 4b. Describe the ill effects of Global warming due to various causes arising in the given situation. 4c. Explain the term, “greenhouse effect” with its causes. 4d. Relate the impact of Ozone depletion in climate change due to its causes.	4.2 Definition of climate change 4.3 Global warming-causes, effect, process 4.4 Greenhouse effect 4.5 Ozone depletion 4.6 Factors affecting climate change 4.7 Impact and mitigation 4.8 Climate change management

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	4.1 Identify Factors affecting climate change in given locality. 4e. Justify the need of relevant Climate change management system to reduce the impact of climate change in the given context.	
Unit– V Environmental legislation and sustainable practices	5.a Use relevant policy or law in relation with environment in given situation 5.b Relate the relevant provision of given act in given situation. 5.c Explain the necessity of the Environmental management system in given situation. 5.d Use the principle of Rain water harvesting in the given situation. 5.e Justify the necessity of Green building in India. 5.f. Adopt the relevant rating system for energy calculation for the given building. 5.f Explain the terms, "Cradle to cradle concept" and "Life cycle analysis" 5.g Emphasize the importance of Carbon credit system in India. 5.h Explain the importance of 5R concept.	5.1 Environmental policies in India 5.2 Air act, water act, Environment protection act, wild life protection act, Forest conservation act, Biodiversity act 5.3 Environmental management system: ISO 14000, definition and benefits 5.4 Rain water harvesting 5.5 Green building and rating system in India 5.6 Cradle to cradle concept and Life cycle analysis 5.7 Green label 5.8 Carbon credit system its advantages and disadvantages 5.9 Concept of 5R(Refuse, Reduce, Reuse, Repurpose, Recycle) 5.10 Eco tourism: advantages and disadvantages

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Ecosystem	08	6	6	2	14
II	Pollution and its types	10	4	6	6	16
III	Renewable sources of energy	10	4	6	6	16
IV	Climate Change	08	4	6	4	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
V	Environmental legislation and sustainable practices	06	5	3	2	10
Total		**42**	**12**	**28**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare specification of some renewable sources of energy.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Undertake a market survey of different green materials.
e) Prepare showcase portfolios.
f) Prepare report on various issues related to environment and sustainable development
g) Publish a research paper on themes related to environment and sustainable development.
h) Compare the pollution (water, air and noise) data of various cities with standard values as laid by pollution control board.
i) Undertake some small mini projects on various issues related to environment and sustainable development.
j) Submit a report on visit to an energy park
k) Prepare power point on clean and green technologies
l) Submit a report on visit to garbage disposal system in your city/town.
m) Submit a report on analysis of the life cycle of any one or two eco-friendly product/s.
n) Calculate ecological footprint using various calculator available on web with a report recommending ways and means to reduce ecological footprint.
o) Give seminar on relevant topic.
p) Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability
g) Guide students for using data manuals.
h) Guide students for using data manuals.
i) Arrange visit to nearby industries and workshops for understanding various sources of pollution.
j) Use video/animation films to explain various processes related to environment and sustainable development
k) Use different instructional strategies in classroom teaching.
l) Write the report on properties of various eco-friendly construction materials like Stone, aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
m) Display various technical brochures of recent projects/themes related to environment and sustainable development
n) Visit the Pollution control board office and its various projects to demonstrate the various practices adopted for control of Pollution

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Natural cycles**: Build a Chart showing different natural cycles like Carbon, Nitrogen,Sulphur and phosphorus cycle.)
b) **Solar Energy:** Build a model of Solar water heater/Solar cooker
c) **Wind energy:** Build a model of wind mill
d) **Best out of waste**: Build useful items from waste materials like used plastic bottles, discarded pens etc.

e) Compare the pollution (water, air and noise) data of various cities with standard values as laid by pollution control board.
f) Surf different websites related environment and sustainable development, Pollution control.
g) Prepare energy audit report of any residential building.
h) Collect relevant information about the software used in pollution control.
o) Visit to ongoing project and study various aspects related to environment and sustainable development

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Renewable Energy Technologies: A Practical Guide for Beginners	Solanki, Chetan Singh	PHI Learning, New Delhi, 2010 Print Book ISBN: 9788120334342 eBook ISBN: 9789354437151
2	Ecology and Control of the Natural Environment	Izrael,Y.A.	Kluwer Academic Publisher eBook ISBN: 978-94-011-3390-6 Softcover ISBN: 978-94-010-5499-7
3	Green Technologies and Environmental Sustainability	Singh, Ritu, Kumar, Sanjeev	Springer International Publishing, 2017 eBook ISBN 978-3-319-50654-8
4	Environmental Noise Pollution and Its Control	G.R. Chhatwal, M. Satake, M.C. Mehra, Mohan Katyal, T. Katyal, T. Nagahiro	Anmol Publications, New Delhi ISBN: 8170411378 ISBN: 8170411378
5	Wind Power Plants and Project Development	Earnest, Joshua & Wizelius, Tore	PHI Learning, New Delhi, 2011 ISBN-10: 8120351274 ISBN-13: 978-8120351271
6	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009 ISBN-13 - 978-8120344709
7	Environmental Studies	Anandita Basak	Pearson Publications ISBN 8131785688, 9788131785683 ISBN: 9788131721186, 8131721183
8	Environmental Science and Engineering	Aloka Debi	University Press ISBN: 9788173718113 ISBN-10: 8173716080 ISBN-13: 978-8173716089
9	Coping With Natural Hazards: Indian Context	K. S. Valadia	Orient Longman ISBN-10: 8125027351 ISBN-13: 978-8125027355
10	Introduction to Engineering and Environment	Edward S. Rubin	Mc Graw Hill Publications ISBN-10 : 0071181857 ISBN-13 : 978-0071181853

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) www.khanacademy
c) http://www1.eere.energy.gov/wind/wind_animation.html
d) http://www.nrel.gov/learning/re_solar.html
e) http://www.nrel.gov/learning/re_biomass.html
f) http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/
g) http://www.epa.gov/climatestudents/
h) http://www.climatecentral.org
i) http://www.envis.nic.in/
j) https://www.overshootday.org/
k) http://www.footprintcalculator.org/
l) https://www.carbonfootprint.com/calculator.aspx

15. PO-COMPETENCY-CO MAPPING

Semester II	Environment and Sustainability (Course Code: .....)								
	POs and PSOs								
Competency & Course Outcomes	**PO 1** Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design/ development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning	**PSO 1** Environmental planning & deisgn	**PSO 2** Execution & Maintenance
Competency - Adopt the sustainable practices to resolve the environment related issues									
a. Adopt relevant ecofriendly product in the given situation to protect ecosystem	2	1	1	-	2	1	1	2	2
b. use relevant method of pollution reduction in the given situation	2	2	1	1	2	-	2	2	2
c. Use of renewable resources of energy for sustainable development	2	2	2	1	2	2	1	2	2
d. Use the relevant techniques in given context to reduce impact due to climate change	2	2	2	1	2	1	2	2	2
e. Use relevant laws and policies for developing the sustainable environmental development	2	2	2	1	1	1	1	2	2

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. Jayesh Shah	Ass. Dean GTU, Pacific School of Engineering, Surat	9825436342	jayesh.shah.23021971 @gmail.com
2	Mrs. Jini Sunil	Shri K.J. Polytechnic, Bharuch	9601880636	jinivt@rediffmail.com

NITTTR Resource Persons

S. No	Name and Designation	Dept.	Contact No.	Email
1	Dr. V.D.Patil, Associate Professor, DCEEE	DCEEE	9422346736	vdpatil@nitttrbpl.ac.in
2	Prof. M.C.Paliwal, Associate Professor, DCEEE	DCEEE	9407271980	mcpaliwal@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester-II

Course Title: Engineering Mechanics

(Course Code: 4300008)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering, Civil Engineering, Environment Engineering, Fabrication Technology, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering.	Second Semester

1. RATIONALE

The primary purpose of the study of Engineering Mechanics is to develop the capacity to predict the effects of force while carrying out the creative design functions of engineering. This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. The course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving. It bridges the gap between physical theory and its application to technology.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use the principle of Engineering Mechanics to solve broad-based engineering related problems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Identify the force systems for given conditions by applying the basics of mechanics.
b) Determine unknown force(s) of different engineering systems.
c) Find the centroid and centre of gravity of various components in engineering Systems.
d) Apply the principles of friction in various conditions for useful purposes.
e) Select the eco-friendly relevant simple lifting machine(s) for given purposes.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Verify and calculate resultant force through Law of Parallelogram using analytical and graphical methods.	II	02*
2	Verify Law of Triangle using analytical and graphical methods.	II	02*
3	Verify and calculate resultant force through Polygon Law of Forces using analytical and graphical methods.	II	04*
4	Verify and calculate the value of unknown force through Lami's Theorem.	II	02*
5	Verify and calculate support reactions of a simply supported beam using analytical and graphical methods.	III	02*
6	Calculate centroid of a lamina having regular and irregular shapes.	IV	04*
7	Calculate angle of repose for different surfaces – Wood , Glass, Steel, plastic, wrought iron etc.	V	02*
8	Calculate coefficient of sliding Friction for different surfaces – Wood , Glass, Steel, plastic, wrought iron etc.	V	02*
9	Verify and calculate theoretical and practical velocity ratios of any four simple lifting machines. (Simple wheel and axle, Differential axle and wheel, simple screw jack, worm and worm wheel. Single purchase crab, Double purchase crab.)	VI	04*
10	Derive and draw a graph of law of machine for any two simple lifting machines and verify the effort required to lift a particular load. (Simple wheel and axle, Differential axle and wheel, simple screw jack, worm and worm wheel. Single purchase crab, Double purchase crab.)	VI	04*
	Total hours		**28 Hrs.**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify components	10
2	Prepare experimental setup.	20
3	Operate the equipment setup.	20
4	Follow safe practices .	10
5	Record observations correctly.	20
6	Interpret the result and conclude.	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Apparatus for Law of Parallelogram.	1,2 & 4
2	Universal Force table with all accessories.	3
3	Beam reaction apparatus with two circular dial types supports having 10 kg capacity each.	5
4	Stand, Regular Lamina, Irregular Lamina, Inextensible string, weight	6
5	Friction apparatus with scale on it, with wood, glass, steel, plastic surfaces, dish, string, weights	7,8
6	Simple wheel and axle, Differential axle and wheel Single and double purchase crab, simple screw jack, worm and worm wheel. Vernier caliper, weights, dish, string	9,10

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices while using equipment.
c) Realize importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If

required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Basics of Mechanics	1a. Define scope of Engineering Mechanics. 1b. Use the relevant units of various quantities in the given situation. 1c. Explain effect of force on given object. 1d. Identify the force system in given situation.	1.1 Significance and relevance of Mechanics, Applied mechanics, Statics, Dynamics. Space, time, mass, particle, flexible body and rigid body. 1.2 Scalar and vector quantity, Units of measurement (SI units) - Fundamental units and derived units. 1.3 Force – unit, representation as a vector and by Bow's notation, characteristics and effects of a Force. 1.4 Principle of transmissibility of force, Principle of Superposition 1.5 Force system and its classification.
Unit – II Coplanar Concurrent Forces	2a. Resolve the given single force. 2b. Draw the free body diagram for the given condition. 2c. Use laws and principles of coplanar concurrent forces. 2d. Calculate the resultant of given force system analytically. 2e. Determine graphically the resultant of given force system. 2f. Determine unknown force in given situation using Lami's theorem.	2.1. Resolution of a force - Orthogonal components of a force 2.2. Equilibrium and Equilibrant, Free body and Free body diagram, conditions of equilibrium, 2.3. Resultant of forces using analytical and graphical methods for the forces acting at a point: 1. Law of Parallelogram 2. Law of triangle 3. Law of Polygon 2.4. Lami's Theorem – statement and explanation, Application for various engineering problems.
Unit– III Moment of Force and Parallel Forces	3a. Differentiate Coplanar non - concurrent and parallel forces. 3b. Compute resultant & Equilibrium forces for given coplanar non-concurrent force system. 3c. Identify the types of beam for given situation. 3d. Determine reactions for given types of beam analytically and graphically.	3.1 Moment of a force, Varignon's Theorem, Couple, application, properties of couple, conditions of equilibrium. 3.2 Resultant of force, Equilibrium forces and its position using analytical methods for the coplanar non - concurrent force system. 3.3 Types of beam, supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, uniformly distributed load, couple).

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		3.4 Beam reaction for cantilever, simply supported beam with or without overhang – subjected to combination of Point load and uniformly distributed load. 3.5 Beam reaction graphically for simply supported beam subjected to vertical point loads only.
Unit– IV Centroid & Centre of Gravity	4a. Differentiate between Centroid and Centre of Gravity. 4b. Calculate Centroid of different geometrical plane and composite figures using first moment of area. 4c. Calculate Centre of Gravity of Simple and Composite Solids using first moment of mass.	4.1 Concept of Centroid, Centre of Gravity. 4.2 Axis of reference and Axis of Symmetry. 4.3 Centroid of One Dimensional geometrical figures using principle of moment. 4.4 Centroid of Two Dimensional geometrical Plane figures (Square, Rectangle, Triangle, Circle, Semi-circle, Quarter-circle) & Composite figures (not more than three figures) using first moment of area. 4.5 Centre of Gravity of Simple solids (Cube, Cuboid, Cone, Cylinder, Sphere, Hemisphere) & Composite solids (not more than two solids) using first moment of mass..
Unit– V Friction	5a. Identify Friction and its engineering application. 5b. Calculate coefficient of friction for different surfaces. 5c. Calculate frictional forces in engineering problems. 5d. Analyse various problems on block friction.	5.1 Friction, Types of Friction and laws of friction, limiting equilibrium, limiting friction. 5.2 Coefficient of friction, angle of friction, angle of repose, relation between coefficient of friction and angle of friction. 5.3 Equilibrium of bodies on level surface subjected to force parallel and inclined to plane. 5.4 Equilibrium of bodies on inclined plane subjected to force parallel to the plane only.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit– VI Simple Lifting Machines	6a. Describe the components of the given lifting machine. 6b. Determine mechanical advantage, velocity ratio, efficiency and law of the given simple lifting machines. 6c. Compare reversible & irreversible machines. 6d. Select the relevant eco-friendly lifting machine required for the given purpose with justification.	6.1 Simple lifting machine, load, effort, mechanical advantage, applications and advantages. Velocity ratio, efficiency of machines. 6.2 Application of law of machine. Ideal machine, friction in machine, maximum Mechanical advantage and efficiency. 6.3 Reversible and non-reversible machines, conditions for reversibility. 6.4 Velocity ratios of Simple wheel and axle, Differential axle and Wheel and, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack. Relevant problems on simple lifting machines.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Basics of Mechanics**	**04**	**4**	**2**	**0**	**06**
II	**Coplanar concurrent Forces**	**08**	**2**	**4**	**8**	**14**
III	**Moment of Force and Parallel forces**	**08**	**2**	**4**	**8**	**14**
IV	**Centroid and Centre of gravity**	**06**	**2**	**2**	**6**	**10**
V	**Friction**	**06**	**2**	**2**	**8**	**12**
VI	**Simple Lifting Machines**	**10**	**2**	**4**	**8**	**14**
Total		**42**	**14**	**18**	**38**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and

prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Collect five different situations with photographs indicating concurrent, parallel, general force system in equilibrium.
b) Collect five different situations with photographs where law of moment plays an important role.
c) Prepare charts showing various types of supports.(hinged, roller and fixed)
d) Prepare models in the form of geometrical figures and solids and locate centroid and centre of gravity of them.
e) Prepare a chart for friction examples which you are facing in day to day life and also interpret whether it is useful and harmful.
f) Prepare a list with photographs of simple lifting machines used in your daily life in your branch.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.
g) Guide students for using data manuals.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare spreadsheet or computer program to calculate the resultant force by the law of parallelogram and the law of polygon.
b) Using Drafting software calculate graphically the resultant force by the law of parallelogram and the law of polygon for at least five different conditions.
c) Prepare a spreadsheet or computer program to find out reactions for at least five different loading conditions on a simply supported beam.
d) Prepare spreadsheet or computer program to calculate centroid and centre of gravity for different geometrical sections.
e) Compare coefficient of sliding Friction for different surfaces (Wood , Glass, Steel, plastic, wrought iron etc.) with & without lubricant
f) Compare a suitable simple lifting machine used in your daily life in your branch.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Mechanics	R. S. Khurmi	S. Chand , New Delhi. (2019) ISBN: 978-93-5283-396-2
2	Engineering Mechanics	D. S. Kumar	S. K. Kataria & Sons, New Delhi (2021 reprint) ISBN: 978-93-5014-311-7
3	Engineering Mechanics 7th edition	Bear & Johnston	New media-McGraw Hill (India), Noida (1999) ISBN: 978-00-7239-513-6
4	Applied Mechanics	Dr. H. J. Shah & S.B. Junnarkar	CHAROTAR Publication, Anand (2013) ISBN: 978-93-803-5861-1
5	Engineering Mechanics	D.S. Bedi	Khanna Publications, New Delhi (2019) ISBN: 978-93-861-7326-3

14. SOFTWARE/LEARNING WEBSITES

a) https://youtube.com/playlist?list=PLD85An3RPybx5psW5HwPtUGH7AXtBjhLm (Bisag Video Lectures by DTE, Gujarat)
b) https://youtube.com/playlist?list=PLyqSpQzTE6M_MEUdn1izTMB2yZgP1NLfs (NPTEL Video Lectures by IIT, Kanpur)
c) https://nptel.ac.in/courses/122/104/122104015/ (NPTEL Video Lectures by IIT, Madras)
d) www.vlab.co.in (Virtual Lab by Ministry of Education, Government of India)

15. PO-COMPETENCY-CO MAPPING

Semester II	Engineering Mechanics (Course Code: 4300008)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Use the principles of Engineering Mechanics to solve broad-based engineering related problems.						
Course Outcomes COa) Identify the force systems for given conditions by applying the basics of mechanics.	3	2	-	3	2	2	2
COb) Determine unknown force(s) of different engineering systems.	2	3	-	3	2	2	2
COc) Find the centroid and centre of gravity of various components in engineering systems.	2	3	-	3	2	2	2
COd) Apply the principles of friction in various conditions for useful purposes.	2	3	-	3	2	2	2
COe) Select the eco-friendly relevant simple lifting machine(s) for given purposes.	2	3	-	3	3	2	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I/II – Semester

Course Title: Basics of Electrical and Electronic Engineering
(Course Code: 4300014)

Diploma programme in which this course is offered	Semester in which offered
Civil Engineering, Environment, Mining, Chemical, Plastics Engineering	First
Mechanical Engineering, Automobile , Metallurgy , Marine Engineering, Fabrication , Ceramics	Second

1. RATIONALE

Electrical engineering is one of the core engineering, which every common man uses in day to day life. This course is offered in all branches of engineering. Need of knowledge about fundamental electrical concepts for every branch is considered for this course.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply the basic principles of electrical and electronics engineering in relevant engineering discipline applications.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Apply fundamentals of DC circuits and batteries in relevant engineering discipline.
b) Apply fundamental of AC circuits in relevant engineering discipline.
c) Use electrical and electronics instruments for measuring various parameters.
d) Distinguish various electrical machines based on their working and applications.
e) Classify green energy sources with emphasis on working of solar and wind power plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
--	2	2	3	--	--	25*	25	50

(*): *For this practical only course, 25 marks under the practical CA has two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify resistors, inductors and capacitors.	I	02*
2	Verify Ohm's law in the given electric circuit.	I	02
3	Verify Kirchhoff's current law in the given electric circuit.	I	02
4	Verify Kirchhoff's voltage law in the given electric circuit.	I	02
5	Find equivalent resistance for series connection.	I	02
6	Find equivalent resistance for parallel connection.	I	02
7	Find equivalent voltage for series and parallel connection of batteries.	I	02
8	Measure voltage, current and power in the given DC circuit.	I	02
9	Measure voltage, current and power and power factor in single phase AC circuit.	II	02*
10	Measure various parameters for generated wave using function generator and CRO.	II	02
11	Carry out following wiring: (1) Staircase (2) Godown.	II	02
12	Calculate unit consumption for given electrical load.	II	02
13	Test the operation of protective devices like Fuse, MCB and ELCB.	II	02
14	Identify electronic components like types of diodes, transistors, SCR.	III	02*
15	Use digital meters like multi-meter, clip-on meter for measuring various parameters	III	02*
16	Identify various transducers available in the laboratory.	III	02
17	Measure output voltage of half wave and full wave rectifier.	III	02
18	Identify various parts of DC machines stating its function	IV	02
19	Identify various parts of AC machines stating its function	IV	02
20	Measure output voltage of the given single-phase transformer.	IV	02*
21	Identify components of solar power system stating its function.	V	02*
22	Identify components of wind power system stating its function.	V	02*
	Minimum 14 Practical Exercises		**28 Hrs.**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course)that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

S.No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare experimental setup.	20
2	Operate the equipment setup or circuit.	20
3	Follow safe practices while working in the lab.	10
4	Record observations correctly.	20
5	Interpret the result and conclude.	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Variable DC power supply: 0- 30V, 2A, Short Circuit protection, display for voltage and current	8
2	Discrete Component Trainer/ Analog Component Trainer: Fixed and variable D.C. Supplies, AC Supplies, Actual Components like transistors, SCR, LDR, photo diode, resistors, capacitors, inductors, diodes, LED's, transformers, 2 mm patch cords for interconnecting components	1 to 7, 13, 15,16
3	Auto-transformer: Single phase, 0- 230 V ,0-260 V, 8A	9,14,19
4	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max), Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	2 to 9, 12,14,16,19
5	Demonstration model for staircase and godown wiring.	10
6	Demonstration model for operation of fuse, MCB, ELCB and RCCB.	11
7	Clamp on meter: AC/DC current up to 40 A, 600 V	2 to 9, 12,14,16,19
8	Cut section of AC and DC rotating machines	17,18
9	Solar Energy demonstration Kit (Meters, Chargeable Batteries, with sample load)	21
10	Wind Energy demonstration kit or Wind turbine working Model (Small capacity)	22

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this course competency.

a) Work as a leader/a team member.

b) Follow safety practices while using electrical equipment.
c) Realize the importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I DC Circuits	1a. Distinguish basic electrical components. 1b. Explain effect of temperature on resistance. 1c. Determine voltage, current and resistance in electrical circuit using Ohm's law. 1d. Apply Kirchhoff's voltage and current law for given electrical circuit. 1e. Calculate equivalent resistance for given connection. 1f. Select relevant battery for given application.	1.1 Concept of Electric Potential, EMF, Current, Power and Energy 1.2 Resistor, Inductor and Capacitor 1.3 Effect of temperature on resistance of conductor 1.4 Ohm's law: Applications and limitations 1.5 Kirchhoff's voltage law and Kirchhoff's current law 1.6 Types of connections: series and parallel connections of resistors 1.7 Battery: Concept of cell and battery, Rating of battery, Series and parallel connection of batteries, Applications
Unit – II AC Circuits and Wiring	2a. Interpret parameters related to alternating waveform. 2b. Describe behavior of pure resistor, inductor and capacitor with AC supply. 2c. Explain concept of power triangle and power factor. 2d. Interpret given wiring diagram. 2e. Justify the need of electrical safety and protective device.	2.1. Basic Terminology: Cycle. Time-period, Amplitude, Frequency, RMS value. Average value, Form factor, Peak factor 2.2. Pure resistor, inductor and capacitor with AC supply 2.3. Power triangle and power factor 2.4. Domestic wiring: Types of AC supply, Concealed and conduit wiring, Power rating of domestic appliances, fitting and fixtures, Sample example of one room electrification, Staircase wiring and godown wiring, electrical unit consumption and billing, Basic

		concept of energy audit 2.5. Electrical Safety: Fuse, MCB, ELCB, RCCB, Need of Earthing, First aid against electrical shock
Unit– III Electronics and Instrumentation	3a. Explain working of diode, transistor and SCR. 3b. Interpret block diagram of battery charger, inverter and UPS. 3c. Explain working principle of different types of electrical transducers. 3d. Describe the procedure of measuring electrical parameters using given digital instruments/CRO.	3.1 Basic construction, characteristics: Diode, NPN and PNP Transistor, SCR 3.2 Applications of transistor: Common base amplifier 3.3 Basic block diagram of battery charger, inverter and UPS (ON line/OFF line) 3.4 Block diagram of instrumentation system , Transducers: Basic understanding of transducer, LDR, Thermistor, Thermocouple, LVDT and strain gauge 3.5 Meters: Multi meter, Clamp-on meter, Digital energy meter 3.6 Use of Cathode Ray Oscilloscope (CRO)
Unit– IV Electrical Machines	4a. Classify electrical machines. 4b. Describe the construction of DC motor and generator. 4c. Explain working principle of transformer. 4d. Enlist applications of various electrical machines. 4e. Explain the use of DG set as emergency supply.	4.1 Types of electrical machines: Static and Rotating, AC and DC. 4.2 Basic construction and applications of DC machines: DC motor and generator. 4.3 Basic construction and principle of working: Transformer ,Auto transformer 4.4 Basic construction and applications of AC machines: , Single phase and three phase induction motor, Alternator 4.5 Construction and applications of BLDC motor 4.6 Use of DG set as emergency supply
Unit– V Green Electrical Energy	5a. Justify the need of green energy. 5b. Classify sources of green energy. 5c. Interpret block diagram of solar power plant. 5d. Interpret block diagram of wind power plant.	5.1 Need of green energy 5.2 Classification of green energy 5.3 Solar energy: PV cell, Panel and Arrays, Block diagram of solar power system 5.4 Wind energy: Block diagram of wind power system

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Tutorial Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	DC circuits	04	Not Applicable			
II	AC circuits and wiring	06				
III	Electronics and Instrumentation	06				
IV	Electrical Machines	08				
V	Green Electrical Energy	04				
Total		**28**				

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare specification of some electrical and electronic components.
b) Calculate total installed electrical load of any premises.
c) Undertake a market survey of different semiconductor components.
d) Prepare a chart for different types of electrical machines and their applications.
e) Give seminar on innovation in renewable energy sources.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.
g) Guide students for using data manuals.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Half wave and Full wave rectifier:** Design and assemble half wave and full wave rectifier using diodes.
b) **Extension board:** Prepare Extension board few sockets and switches.
c) **Electricity bill:** Calculate power consumption of your home and check your energy bill.
d) **Market Survey**: Prepare budget for making a trainer kit for demonstrating characteristics of electronics components.
e) **Working Model making for wind /solar power plant**: Search on internet video/animation preferably dynamic animation which demonstrates the parts and working of a solar and wind power system and prepare a report.
f) **Solar/Wind power generation in India:** Prepare a report on current installed capacity of RES with emphasis on solar
g) **Electronic waste**: Compile a report of handling electronic waste with figures, tables and comparative charts and strategies used/suggested.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Basic Electronics and Linear Circuits	Bhargava N.N., Kulshreshtha D.C. and Gupta S.C.	McGraw Hill Education, New Delhi, ISBN: 9780074519653
2	A text book of Electrical Technology-Vol.1	Theraja B. L. Theraja A.K.	S. Chand Publication ISBN: 9788121924375
3	A text book of Electrical Technology-Vol.2	Theraja B. L. Theraja A.K.	S.Chand Publication
4	A text book of Electrical Technology -Vol.4	Theraja B. L. Theraja A.K.	S.Chand Publication
5	A Course in Electrical and Electronic Measurements	Sawhney A. K.	Dhanpat Rai & Co.

S. No.	Title of Book	Author	Publication with place, year and ISBN
	and Instrumentation		
6	Non-Conventional Energy Sources	Rai G. D.	Khanna Publications ISBN:978-8174090737

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) https://ndl.iitkgp.ac.in
c) www.electronicsforu.com
d) www.electrical4u.com
e) www.vlab.co.in

15. PO-COMPETENCY-CO MAPPING

Semester I & II	Basics of Electrical and Electronic Engineering (Course Code: 4300014)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustain-ability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Apply the basic principles of electrical and electronics engineering in relevant engineering discipline applications.						
Course Outcomes CO a) Apply fundamentals of DC circuits and batteries in relevant engineering discipline.	3	1	1	3	-	-	2
CO b) Apply basic fundamental of AC circuits in relevant engineering discipline.	3	2	2	3	-	-	2
CO c) Use electrical and electronics instruments for measuring various parameters.	3	2	2	3	-	-	2
CO d) Distinguish electrical machines with relevant application.	3	1	1	2	-	-	2
CO e) Classify green energy sources with emphasis on working of solar and wind power plant.	3	-	-	2	3	-	2

Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -II

Course Title: Indian Constitution
(Course Code: 4300016)

Diploma programmes in which this course is offered	Semester in which offered
Auto Mobile, Bio Medical, Power Electronics, Plastic, Computer, IT, Chemical, Civil, Electrical, Electronics and Communication. Environmental, Information Technology, Instrumentation and Control,Marine,Mechanical,Mechatronics,Mettalurgy,Mining,Textile Processing Technology, Textile Manufacturing Technology, Architectural Assistantship, CADCAM, Ceramic, Fabrication Technology, Printing Technology, Textile Designing	Second

1. RATIONALE

This course will survey the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. It will also socio-political equations. The various challenges faced by the constitution and the corresponding coping mechanisms would also be discussed. Broadly, the students would be exposed to the working of various institutions, offices and political debates ensuing from the operation of the Indian constitution in the last five decades.

2. COMPETENCY

Thepurpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Follow policies, processes, duties, rights and federal structure of Indian constitution as responsible citizens and engineer of the country.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) List salient features and characteristics of the constitution of India.
b) Follow fundamental responsibilities, privileges, rights and duties as responsible citizen and engineer of the country.
c) Differentiate between state and central administrative setup of the country.
d) Explain major constitutional amendment procedures and emergency provisions in the country
e) Explain judicial setup and electoral process of the country.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	-	-	0	-	-	50*	-	50

(*): the marks distribution total internal assessment 50 marks

5. SUGGESTED PRACTICAL EXERCISES -Not applicable

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED-Not applicable

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs andPrOs.More could be added to fulfil the development of this course t competency.

a) Work as a leader/a team member.
b) Follow constitutional duties and responsibilities
c) Follow ethical practices.
d) Practice environmental friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Constitution and Preamble	1a. Explain the meaningof preamble of the constitution. 1b. List the salient features of constitution. 1c. List the characteristics of constitution.	1.1 Meaning of the constitution of India 1.2 Historical perspective of the Constitution of India 1.3 Salient features and characteristics of the Constitution of India 1.4 Preamble to the Constitution of India

Unit – II Fundamental Rights and Directive Principles	2a. Enlist the fundamental rights. 2b. Identify fundamental duties. 2c. Follow fundamental responsibilities as an engineer. 2d. Differentiate between fundamental rights and directive principles. 2e. Identify fundamental duties and responsibilities applicable to a practicing engineer.	2.1 Fundamental Rights under Part-III (Details of exercise of rights and Limitations) 2.2 Fundamental duties and their significance 2.3 Relevance of Directive Principles of State Policy under part-IV.
Unit– III Federal Structure	3a. Draw the structure of governance in India. 3b. Differentiate between state and central administrative setup of the country.	3.1 Federal structure and distribution of legislative and financial powers between the Union and the States 3.2 Union Executive-President, Prime minister, Parliament and the Supreme Court of India, 3.3 State Executive - Governor, Chief Minister, State Legislator, and high Court 3.4 Local Administration - District Administration, Municipal Corporation, Zila Panchayat
Unit– IV Governance and Amendments	4a. Enlist the constitutional amendments 4b. Infer the purposes of various amendments.	4.1 Amendment of the Constitutional Powers and Procedure 4.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st. 4.3Emergency provisions
Unit– V Judicial System and Election Commission&National Green Tribunal	5a. Perform judicial review for societal welfare 5b. Abide by the judicial provisions. 5c. Adopt the electoral procedures with respect to citizenship. 5d. Abide by greening laws 5e. Identify the topics/subtopics in a given engineering corse where greening laws are affecting significantly.	5.1 The Indian Judicial System 5.2 Judicial Review 5.3 Election Commission 5.4 National Green Tribunal

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit	Unit Title	Teachin	Distribution of Theory Marks

No.		g Hours	R Level	U Level	A Level	Total Marks
I	Constitution and Preamble	04	04	04	0	08
II	Fundamental Rights and Directive Principles	08	03	02	10	15
III	Federal Structure	07	02	03	06	11
IV	Governance and Amendments	05	02	02	04	08
V	Judicial System and Election Commission	04	02	02	04	08
Total		**28**	**13**	**13**	**24**	**50**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of theUOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may varyslightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct following activities in group and prepare reports of about 5 pages for each activity. They also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare a report on Mock court hearing
b) Visit to courts
c) Arrange Mock Parliament.
d) Visit to Local Bodies
e) Visit to Courts.
f) Visit to Legal Service Authority
g) Design games and simulation
h) Group discussions on current print articles
i) Prepare college/posters on current constitutional issues.
j) Learning through cases

- **A.K. Gopalan Case (1950):weblink** *https://indiankanoon.org/doc/1857950/*
- **Shankari Prasad Case (1951):weblink***https://indiankanoon.org/doc/1706770/*
- Berubari Union case (1960) :weblinkhttps://indiankanoon.org/doc/1120103/
- Golaknath case (1967) :weblinkhttps://indiankanoon.org/doc/120358/
- Kesavananda Bharati case(1973):weblinkhttps://indiankanoon.org/doc/257876/
- Indira Nehru Gandhi v. Raj Narain case (1975):weblinkhttps://indiankanoon.org/doc/936707/
- Maneka Gandhi case (1978):weblink https://indiankanoon.org/doc/1766147/
- Minerva Mills case (1980): weblink https://indiankanoon.org/doc/1939993/
- Indra Sawhney and Union of India (1992):weblinkhttps://indiankanoon.org/doc/1969682/
- Samatha and State of Andhra Pradesh (1997): weblink https://indiankanoon.org/doc/1969682/

- Aruna Shanbaug Case (2011) : weblinkhttps://indiankanoon.org/doc/235821/
- Justice K.S.Puttaswamy(Retd) ... vs Union Of India And Ors.: Right To Privacy (2017)weblinkhttps://indiankanoon.org/doc/1857950/
- L Chandra Kumar Case (1997):weblink https://indiankanoon.org/doc/1152518/
- Habeas Corpus Case (1976): weblink https://indiankanoon.org/doc/1735815/
- Romesh Thapar Case (1950): weblink https://indiankanoon.org/doc/456839/
- M.C. Mehta And Anr vs Union of India &Ors on 20 December, 1986 Bhpal Gas Tragedy:weblinkhttps://indiankanoon.org/doc/1486949/
- M.C. Mehta vs Union Of India &Ors on 30 December, 1996 Taj Mahal:weblink https://indiankanoon.org/doc/1964392/
- M.C. Mehta vs Union Of India on 15 November, 2019 Delhi Pollution: weblink ttps://indiankanoon.org/doc/174204561/
- Samit Mehta v. Union of India &Ors.;National Green weblink:https://www.casemine.com/judgement/in/5b17d5604a932678010063da

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessedusing different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

- Not Applicable

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	The Constitution of India	P.M. Bakshi	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105
2	Introduction to Indian Constitution	D.D. Basu	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3	Introduction to Constitution of India	B. K. Sharma	PHI, New Delhi, 6th edition, 2011, ISBN:8120344197
4	The Constitution of India	B.L. Fadia	Sahitya Bhawan, Agra, 2017, ISBN:8193413768

S. No.	Title of Book	Author	Publication with place, year and ISBN
5	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008, ISBN:0198063555
6	The Constitutional Law of India	Durga Das Basu	LexisNexis Butterworths Wadhwa, Nagpur 978-81-8038-426-4
7	Indian Constitution	Avtar Singh	Central Law Publication, Prayagraj. Uttar Pradesh 2019. 978-9386456861
8	The Constitution of India	NaushirwanJhabwala	C. Jamnadas&Company. Ahmedabad. 2016.978-9789364572

14. SOFTWARE/LEARNING WEBSITES

a) http://www.legislative.gov.in/constitution-of-india
b) https://en.wikipedia.org/wiki/Constitution_of_India
c) https://www.india.gov.in/my-government/constitution-india
d) https://eci.gov.in/about/about-eci/the-setup-r1/
e) https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india
f) https://main.sci.gov.in/constitution
g) https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf
h) https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf
i) https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india--e.htm
j) https://constitutionnet.org/vl/item/basic-structure-indian-constitution

15. PO-COMPETENCY-CO MAPPING

1	Indian Constitution (Course Code: 4300016)						
	POs and PSOs						
Competency and Course Outcomes	**PO 1 Basic and Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation andTesting**	**PO 5 Engineering practices for society, sustainability and environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency ***Follow policies, processes, duties, rights and federal structure of Indian constitution as responsible citizens***							

and engineer of the country.							
Course Outcomes CO a) List salient features and characteristics of the constitution of India.	-	1	1	-	2	1	2
CO b) Follow fundamental responsibilities, privileges, rights and duties as responsible citizen and engineer of the country.	-	1	1	-	2	1	2
CO c) Differentiate between state and central administrative setup of the country.	-	1	1	-	2	1	2
CO d) Explain major constitutional amendment procedures and emergency provisions in the country.	-	1	1	-	2	1	2
CO e) Explain judicial setup and electoral process of the country.	-	1	1	-	2	1	2

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr PeenaThanky Lecturer [English] BOS Member	RCTechnical Institute, Ahmedabad	94094 11256	drpeena@gmail.com

2	Dr. Yatharth Vaidya Lecturer [English] BOS Member	Government Polytechnic, Rajkot	8980291650	yatharthvaidya@gmail.com
3	Dr J U Nanavaty Expert	Formal principal Sheth M N Law college Patan.	9898115448	junanavaty@gmail.com

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr. Roli Pradhan, Assistant Professor	Department of Management Education	09893205011	rpradhan@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester- I/II/III

Course Title: Computer Applications and Graphics
(Course Code: 4300019)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical (CAD/CAM)	First
Mechanical Engineering, Automobile Engineering, Fabrication Technology, Renewable Energy, Marine Engineering	Second
Mechatronics Engineering	Third

1. RATIONALE

The objective of this subject is to make the students understand and applythe functioning of office application software, basic engineering drafting software. It will provide the student hands-on experience on different application software used for office automation and improve day-today problem-solving skills using online resources for creating business documents, data analysis, graphical representations and creating, editing and printing technical drawings. It will also enable the student to use Internet services for different communication. Development of sketching ability strengthens effective engineering communication & presentation. This course helps to develop the skills in student to generate various digital production drawings as required in industry using various CAD software.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Develop basic skills using various IT software tools for creating professional documents, analyzing data, preparing multimedia presentation and use internet services.**
- **Prepare production drawings using computer and relevant software following standards codes and norms.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for theachievement of the following COs:

a) Utilize various computer hardware, peripheral devices and software tools.
b) Create professional documents, analyzing data and presentation using various IT

software tools.

c) Interpret cyber security in use of internet services for various applications.

d) Draw simple Mechanical components/assembly in 2D using CAD software.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are thesub-components of the Course Outcomes (Cos).All PrOs are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify and prepare report document including sample specifications that contains brief information regarding various components of computer systems and peripheral devices available in the institute's computer labs.	I	02
2	Demonstrate the installation procedure of computer peripheral devices/software in Desktop/Laptop from the following list: - Computer Mouse & Keyboard (Wired/Wireless) - Webcam - Microphone - Scanner - Printer - Projector - Data Storage Devices (USB/Portable Hard Disk drive) - Operating systems/software tools	I	02
3	Install preferable web browser in the computer system and perform various use of web browser for accessing the internet facility.	I	02
4	Demonstrate participation in any three Digital India Platforms from the following list. Digital India Platforms: BHIM, Dig-Locker, mParivahan,The Unique Identification Authority of India (UIDAI), Digital Gujarat.	I	02
5	Create a text document incorporating various page setup feature, font, language and character feature, pictures-shape-icons-smart-	II	06

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	art feature, header-footer with page number feature, using an equation and symbols, plot data table and chart/graph with referring published technical paper or any technical survey/Project report. Submit the completed report in PDF format.		
6	Create spreadsheet document with use of sort & filter features, conditional formatting features, font & alignment setting, cell property and formatting features, analyze data using formulas and functions and present it through charts with referring student's results data sheet. Submit the completed spreadsheet in PDF format.	II	06
7	Create slide presentation of relevant topic using basic formatting features, insert and design slide, drawing tools, shape and picture style, object fill and effects, data table or 2D-3D charts, animation and transition effects, short media clip and hyperlink. Submit the completed presentation in PDF format.	II	06
8	Study of the features of firewall in providing network/cyber security and to set Firewall Security in computer operating system and visit site https://cert-in.org.in/	III	02
9	Draw and edit 4 simple problems of different geometrical shapesin AutoCAD software using Drawing Tools, Modifying tools, Dimensioning tools, etc. Submit the completed drawings in PDF format.Write steps to prepare each drawing. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.	IV	4
10	Prepare orthographic production drawings of minimum four mechanical components with all necessary views, dimensions, tolerances, notes, title block, etc. using CAD software (Real industrial component may be selected by student as student activity and approved / assigned by teacher.) Submit the completed drawings in PDF format.Write steps to prepare each drawing/component. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.	IV	12
11	Prepare 2D drawings of minimum one mechanical assemblyand its components with all necessary views, dimensions, tolerances, notes, title block, etc. using CAD software. (Following are some samplesfor reference, teacher may assign any other branch specific assembly). Take print out of the same using printer/plotter. 1. Drawing of cotter joint assembly 2. Drawing of knuckle joint assembly 3. Drawing of Flanged coupling assembly	V,VI	12

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	4. Drawing of Machine vice assembly Write steps to prepare each drawing/component/assembly. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.		
			56

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1.	Lab Records and regularity	20
2.	Question answer / Writing steps of exercise	20
3.	Execution of exercise	20
4.	Printout/Result	10
5.	Viva voice	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specificationsfor the PrOsis a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Computer system with latest configuration.	All
2.	Laser printer-scanner, plotter.	All
3.	Related software. (OS, open office, CAD software, MS office, Auto CAD, Anti-Virus software, Gujrati-Hindi language input tool software etc.).	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs andPrOs.More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical and electronics equipment.
c) Maintain tools and equipment.
d) Realize importance of E-waste management. (Environment related).

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I **Basics of Computer Systems & Internet and applications**	1a Describe computer system and its components. 2a Explain functions of CPU, ALU and memory unit of a computer system. 3a Describe basic terminologies of Internet. 4a Utilize the internet for various applications.	1.1 Computer system block diagram, concept of hardware and software. 1.2 CPU, control unit, Arithmetic Logic Unit(ALU), memory unit, power unit and interfacing ports. 1.3 Input Output unit: monitor, keyboard, external hard disk, mouse, printers, plotters, scanner, projectors, webcam, Mic, etc. 1.4 Introduction to internet and basic internet terminologies: browser, webpage, website, URL. 1.5 Google search engine introduction and search query. 1.6 Applications of Internet Digital Platforms. (BHIM, Digi-Locker, mParivahan, NSDL, Digital Gujarat, Passport seva, UIDAI.)

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-II Documenta-tions, Spreadsheet & Presentation using Software.	2a. Write steps for text formatting, page Setup features, checking spelling and grammar, with header and footer for a text document. 2b. Write steps for inserting graphics/clipart, shapes and table in a text document. 2c. Write steps to mail merge documents for inviting students. 2d. Write steps for creating spreadsheet and representing in the form of chart. 2e. Write steps to setup page as per given layout and print a spreadsheet sheet. 2f. Write steps for creating presentation and apply basic formatting features using spreadsheet. 2g. Write steps to insert objects,	**Using Text Processing** 2.1. Basics of font type, size, color, effects and other text formatting features. 2.2. Page settings and margins including header and footer in word document. 2.3. Spelling and grammatical checks. 2.4. Table and its options, inserting rows or columns, merging and splitting cells, arithmetic calculations in a table. 2.5. Working with pictures, drawings and word-art, Mail merge. **Using Spreadsheet** 2.6. Introduction to data, cell address, data types, formatting, number, text and date concept of hyperlink in spreadsheet. 2.7. Understanding formulas, operators and common spreadsheet functions. 2.8. Types of graphics: art, auto shapes, Images, charts. 2.9. Concept of print area, margins, header, footer and other page setup options. **Using Professional Presentation** 2.10. Creating new slides, working with text boxes, fonts, tables, Layouts, themes, effects, background and colors. 2.11. Selecting, deleting, moving, copying, resizing and arranging objects. 2.12. Working with drawing tools, applying shape or picture styles, applying object borders, object fill, object effects, clip art collection and modifying clip art. 2.13. Embed a video, link to a video, size a video, video playback options. 2.14. Configuring a sound playback, assigning sound to an object, adding a digital music sound track, transition effects and timings. **Using Gujarati/Hindi IME** 2.15. Installation of Guajarati/Hindi IME software. 2.16. How to change language English to Gujarati/Hindi.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	clips, video, audio, with special effects and hyperlink in a multimedia presentation. 2h. Write steps for installing Indic IME Gujarati for creating a document.	2.17. Introduction about the Gujarati/Hindi keyboards. 2.18. Introduction about the Gujarati IME and create Documents in Gujarati/Hindi.
Unit-III Information Security.	3.a. Explain concepts of Information Security for Data Protection. 3.b. Write various methods tosecure your personal computer Describe cyber laws for data protection and IPR.	3.1. Need for Information Security. 3.2. Definition of various terms of Information Security. - Cryptography - Vulnerability - Threat - Attack - Encryption - Decryption 3.3. Security services. 3.4. Cyberattacks: Introduction of common types of attacks. 3.5. Preventing Tools: Antivirus, Firewall. 3.6. Cyber Law: IT Amendment Act 2008 (Section 66 & 67).
Unit–IV Creatingdigitaldrawingsusing aComputerAided Drafting(CAD)Software.	4.a. Start Computeraideddraftingsoftware(AutoCAD). 4.b. Invokecommandsin AutoCAD. 4.c. Setlimits&Coordinatesystems. 4.d. Useobjectselection. 4.e. Create basic & advance 2D entitiesClose & save work	IntroductiontoBasicDraw CommandsinanyComputerAidedDraftingsoftwarelikeAutoCADPowerdraft,Microstation: 4.1. Systemrequirements &Understandingtheinterface. 4.2. Explain Drawing standards.(IS-696 /SP 46) (Drawing/ printing/ storage). 4.3. Componentsof aCADsoftwarewindow:SuchasQuick Access Toolbar, Ribbon, Command Bar, Orientation tools, Status bar, Different Menu / Tools / commands, etc. 4.4. Filefeatures:Newfile,savingthefile,Openinganexistingdrawingfile,CreatingTemplates,Quit. 4.5. Settingupnewdrawing:Units,Limits,Grid, Snap,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		4.6. MethodsofSpecifyingpoints-AbsolutecoordinatesandRelativeCartesian&Polarcoordinates. 4.7. Use of objectSnap 4.8. Conceptofmodel spaceandpaperspace. 4.9. Standardsizesofsheet.Selectingvariousplottingparameterssuchas Papersize,paperunits,Drawingorientation,plotscale,plotoffset,plotarea, printpreview. 4.10. Creatingviewportsinmodel spaceandcreatingfloatingviewportinpaperspace.Shiftingfrommodel spacetopaperspaceandviceversa. 4.11. Take print outs from a CAD Software.
Unit–V EditingDrawingusingaCADsoftware.	5a. Modifyexisting2Dentities. 5b. Usedifferentarraysinexisting2Ddrawing. 5c. Viewgivendrawingentitiesproperly. 5d. Enquireaboutvariousattributes ofexisting2Dentities.	IntroductiontoBasicEdit,InquiryanddisplayCommands. 5.1. Copy,Rotate,Move,Erase,Mirror,Array,Trim,Break,Extend,Chamfer,Fillet. 5.2. Zoom window,Zoom in-out,PAN. 5.3. List,Dblist,Area,Massprop.
Unit–VI Advanceeditingofadrawingusing aCADSoftware.	6a. Uselayersforpropermanagement ofdrawings. 6b. Setpropertiesofexistingdrawingentitiesasperrequirement. 6c. Abletodimensiongiven2Dentities withperfection. 6d. UseBlockseffectivelytocreateperfectdrawings.	IntroductiontoAdvancedModify&otherutility CommandsinanyComputerAidedDraftingsoftwarelikeAutoCADPowerdraft,Microstation: 6.1. Properties,Linetype,color,lineweight 6.2. ConceptofLayers. 6.3. ConceptofBlocks. 6.4. ConceptofHatch. 6.5. Dimensioning:Typesofdimensioning:Linear-Horizontal,Vertical,Aligned,Rotated,Baseline,Continuous,Diameter,Radius,AngularDimensions. 6.6. Dimscale variable. 6.7. Editingdimensions. 6.8. TextStyles: Selectingfont,size,alignmentetc.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Not applicable						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Undertake micro-projects in team/individually.
b) Encourage Students for creating and designing forms related to Departmental work.
c) Prepare a portfolio for the Digital India platform and identify digital services for Indian citizens.
d) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc. to further enhance their learning.
e) Select at least four simple mechanical components each made up of minimum 5-6 manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex.No10).
f) Select at least one simple mechanical assembly in group of 5-6 students, each made up of minimum 5-6 components. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex.No.11).
g) Bring Actual assembly from workshop/industry, measure dimensions, sketch it and make 2D production drawing for the same.(For Ex.No.11)
h) Prepare the Charts that classify recycling process for electronic waste and plastics.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.

   About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature may be given to the students for ***self-learning***, but to be assessedusing different assessment methods.

   Guide students on addressing the issues on environment and sustainability using the knowledge of this course.
c) Introduce IS Codes of drawing for self-study.
d) Guide studentsfor keeping the drawings in digital form and reduce use of paper.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs.Similar micro-projects could be added by the concerned course teacher:

a) Word documents: Prepare Subject teacher shall assign document/Reports to be prepared by each student covering all the major features of word processing software.
b) Slide Presentations: Prepare slides show with all Presentation features such as: classroom presentation, presentation about department, presentation about institute, presentation of report. (Subject teacher shall assign a presentation to be prepared by each student).
c) Spreadsheets: Prepare Pay bills/salary statements, tax statement, student's assessment record, Students fees system, earning and expenditure statement of a company to ascertain profit-loss etc. using spreadsheet. (Teacher shall assign a spreadsheet to be prepared by each student).
d) Bring an industrial production drawing/component from workshop. Learn to interpret and List the commands to be used to draw it.
e) Sorting of e-waste: Compile a reportfor sorting different types of electronic and plastic waste.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Fundamentals of Computers, Sixth Edition	Rajaraman V, Adabala N	Prentice Hall India Learning Private Limited. ISBN: 8120350677
2.	Computer Course	R Taxali	Tata McGraw Hills. New Delhi. ISBN: 9780070700376

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
3.	INFORMATION TECHNOLOGY	Dennis P. Curtin, Kim Foley, Kunal Sen, Cathy Morin	Tata McGraw Hills Publication. ISBN: 978-0074635582
4.	MS-Office for Dummies	Wallace Wang	Wiley India, New Delhi. ISBN: 9788126578559
5.	Sams Teach Yourself Internet and Web Basics All in One	Ned Snell, Bob Temple, Michael Clark	Sams Publishing, Indiana, USA, ISBN:0672-32533-0
6.	Computer Fundamentals	R.S. Salaria	Khanna Book Publishing Company ISBN: 978-9381068533
7.	MachineDrawingincludingAutoCAD	Ajeet Singh	McGrawhill
8.	ProductionDrawing	KLNarayan	NewAgePublication
9.	FundamentalofGeometricToleranceanddimensioning	AlexKrulikowski	Cengage Learning
10.	EngineeringGraphicswithAutoCAD	Sarkar.A.K	PHIindia
11.	EssentialsofEngineeringDrawingandGraphicsusing AutoCAD	Jeyapoovan	Vikaspublication
12.	AutoCADUser Guide	Autodesk	AutodeskPress.

14. SOFTWARE/LEARNING WEBSITES

a. https://www.tutorialspoint.com
b. https://edu.google.com/intl/ALL_in/teacher-enter/products/forms/?modal_active=none
c. www.w3schools com
d. https://support.microsoft.com/en-us/training
e. https://edu.gcfglobal.org/en/topics/googleapps/
f. https://www.udemy.com
g. https://www.coursera.org/
h. https://www.digitalindiaportal.co.in/
i. https://getintopc.com/

j. https://nptel.ac.in/
k. https://magazine.opensourceforu.com/
l. https://www.electronicsforu.com/
m. https://www.redhat.com/en
n. https://www.netacad.com/
o. https://www.cert-in.org.in/
p. https://www.youtube.com/results?search_query=engineering+drawing
q. https://www.youtube.com/c/MechanicalEnggSubjectsGTU/playlists
r. https://youtu.be/MT1T31GtGpg
s. https://youtu.be/WEwkepkv6mg
t. https://youtu.be/trJQIvatIpI
u. https://nptel.ac.in/courses/112/103/112103019
v. https://nptel.ac.in/courses/112/105/112105294
w. https://en.wikipedia.org/wiki/Engineering_drawing
x. https://www.slideshare.net/search/slideshow?searchfrom=header&q=engineering+drawing
y. https://www.scribd.com/search?content_type=tops&page=1&query=engineering%20drawing&content_types=tops,books,audiobooks,summaries,articles,documents,sheet_music,podcasts
z. http://www.cognifront.com/tools.php
aa. https://www.youtube.com/watch?v=bmAlJAMndwM
bb. https://www.youtube.com/watch?v=904_RPjGJg4
cc. https://www.youtube.com/watch?v=jzlDouas0Wc
dd. https://www.youtube.com/watch?v=VuHdV38fyjc
ee. https://www.youtube.com/watch?v=iOzlIJge_G0
ff. https://www.youtube.com/watch?v=-l0iRdH3MbA
gg. https://www.youtube.com/watch?v=vI5xhCD5mXQ
hh. https://www.youtube.com/watch?v=GDrD9nEZ9LY

15. PO-COMPETENCY-CO MAPPING

Semester I	Instrumentation Workshop (Course Code: 4311702)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation&Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency 1. Develop basic skills using various IT software tools for	3		2	2	2		2

creating professional documents, analyzing data, preparing multimedia presentation and use internet services.							
2. Prepare production drawings using computer and relevant software following standards codes and norms.	3		2	2	2	1	2
CO 1) Utilize various computer hardware, peripheral devices and software tools.	3			2			2
CO 2) Create professional documents, analyzing data and presentation using various IT software tools	3	1	2	2	2		2
CO 3) Use internet services for various applications.	2			2	2		2
CO 4) Draw simple Mechanical assembly in 2D using CAD software.	3		2	2	2	1	2

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
5.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmedabad	9227200147	gpasiraj@gmail.com
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Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr.J.B.Patel,Lecturer in Mechanical Engineering	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9998816294	jaybpti241120@gmail.com
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3.	Prof. H.V.Patel, Lecturer in Automobile Engineering.	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9978872090	hvpautodept@gmail.com
4.	Prof. R.B.Zapadiya, Lecturer in Fabrication Techmology	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9033219351	rohan.zapadiya@gmail.com

BOS Resource Persons

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -II

Course Title: Applied Mathematics
(Course Code: 4320001)

Diploma programmes in which this course is offered	Semester in which offered
Chemical Engineering, Civil Engineering, Marine Engineering, Mechanical Engineering, Mining Engineering	Second

1. RATIONALE

This course is an extension of the course based on Mathematics of first semester namely Applied Mathematics. The course is designed to inculcate its applications in relevant branch of engineering and technology using the techniques of Differentiation, Integration, Differential equations, Matrix theory and Statistics. Calculus is a branch of Mathematics that calculates how matter, particles and heavenly bodies actually move. With calculus, we can find how the changing conditions of a system affect us, we can control a system. Derivatives are useful to find maxima and minima of the function, velocity and acceleration and also useful for many engineering optimization problems. Definite integrals are a powerful tool to help us realize and model the world around us. Differential equations are widely applied to model natural phenomena, engineering systems and many other situations. Matrix analysis is a valuable tool used in nearly all the engineering sciences. Statistics can be defined as a type of mathematical analysis which involves the method of collecting and analyzing data and then summing up the data into a numerical form for a given set of factual data or real-world observations. This course further develops the skills and understanding of mathematical concepts which underpin the investigative tools used for modeling and analysis in a wide range of applications in engineering.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Solve broad-based technology problems using the principles of Applied mathematics.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Demonstrate the ability to Crack engineering related problems based on Matrices.
b) Demonstrate the ability to solve engineering related problems based on applications of differentiation.
c) Demonstrate the ability to solve engineering related problems based on applications of integration.
d) Develop the ability to apply differential equations to significant applied problems.
e) Solve applied problems using the concept of mean.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	1	-	4	30*	70	-	-	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL/TUTORIALS EXERCISES (During Tutorial Hours)

The following practical outcomes (PrOs)/Tutorials are the sub-components of the COs. *Some of the **PrOs/Tutorials** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)/Tutorials	Unit No.	Approx. Hrs. required
1	Solve simple problems using the concept of algebraic operations of matrices.	I	1
2	Use the concept of adjoint of a matrix to find the inverse of a matrix.	I	1
3	Solve system of linear equations using matrices. Use suitable software to demonstrate the geometric meaning of solution of system of linear equations.	I	1
4	Solve examples related to 1^{st} rule of derivative, working rules.	II	1
5	Solve examples of derivative related to Chain Rule, Implicit functions.	II	1
6	Solve the examples derivative of Parametric functions and second order derivative of simple functions.	II	1
7	Use concept of derivative to solve the problems related to velocity, acceleration and Maxima-Minima of given simple functions. Use suitable graphical software to visualize the concept of maxima-minima of function.	II	1
8	Solve examples of integration using working rules, standard forms of integration and method of substitution.	III	1
9	Use the concept of integration by parts to solve related problems. Solve problems related to definite integral using properties.	III	1
10	Apply the concept of definite integration to find area and volume.	III	1

S. No.	Practical Outcomes (PrOs)/Tutorials	Unit No.	Approx. Hrs. required
11	Solve problems of the order, degree of differential equations and Variable Separable method.	IV	1
12	Apply the concept of linear differential equations to solve given differential equation. Explain the various applications of differential equations in engineering and real life.	IV	1
13	Solve examples Mean for the given data.	V	1
14	Solve examples of Mean deviation and Standard deviation for the given data.	V	1
			14 Hrs.

Note

*i. More **Practical Exercises/Tutorials** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises/Tutorials** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs/Tutorials	Weightage in %
	Geometric Thinking: Comprehend geometric concepts to interpret solutions by applying apt results to solve well defined Engineering problems.	
1	Solve problems based on derivative/integration and interpret geometrically the obtained solution.	40
2	Solve problems involving area and volume through integrals and interpret geometrically.	30
3	Frequency curves its interpretation.	20
4	Interpret the result and conclude.	10
Total		**100**
S. No.	**Sample Performance Indicators for the PrOs/Tutorials**	**Weightage in %**
	Algebraic Thinking: Create, interpret, use, and analyze expressions, equations, and inequalities in a variety of contexts.	
1	Represent, interpret, and solve variable expressions, equations, and inequalities.	40
2	Write expressions in equivalent forms to solve problems.	40
3	Interpret the result and conclude.	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer System &LCD Projector	3,5,6,10,12,13, 14
2	Scientific Calculator (Display type: Natural Display Algebraic input logic: Natural V.P.A.M. Significant function: 10+2.	5,9,11

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Realize importance of green Mathematics.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher
to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Matrices**	1a. Solve simple problems using the concept of algebraic operations of matrices. 1b. Apply the concept of adjoint of a matrix to find the inverse of a matrix. 1c. Investigate the solution of system of linear equations using matrices.	1.1 Concept of Matrix 1.2 Types of Matrices 1.3 Addition, Subtraction and multiplication by scalar of matrices 1.4 Product of two matrices 1.5 Adjoint and Inverse of a matrix of order 2X2 and 3X3. 1.6 Solution of Simultaneous linear equations of two variables.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Matrices	09	4	6	6	16

Unit – II **Differentiation and its Applications**	2a. Apply the working rules and standard forms of differentiation to find the derivative of simple functions. 2b. Invoke the concept of Chain Rule to find the derivative of simple functions. 2c. Find the derivative of given Implicit and Parametric functions. 2d. Apply the standard forms and rules of derivative to find the second order derivative of simple functions. 2e. Apply the concept and rules of derivative to solve the problems related to velocity, acceleration and Maxima-Minima of given simple functions.	2.1. Concept and Definition of Differentiation 2.2. Working rules : Sum, Product, Division 2.3. Chain Rule 2.4. Derivative of Implicit functions 2.5. Derivative of Parametric functions 2.6. Logarithmic Differentiation 2.7. Successive Differentiation up to second order 2.8. Applications: Velocity, Acceleration, Maxima & Minima of given simple functions.
Unit– III **Integration and its Applications**	3a. Apply the working rules and standard forms of integration to find the integral of simple functions. 3b. Find the integral of simple functions using the method of substitution and integration by parts. 3c. Solve given problems related to definite integral using properties. 3d. Apply the rules and standard forms of integration to solve the problems related to area and volume.	3.1 Concept and Definition of Integration. 3.2 Working rules and Integral of standard functions. 3.3 Method of substitution. 3.4 Integration by parts. 3.5 Definite Integral and its properties. 3.6 Applications: Area and volume. (Simple problems)
Unit– IV **Differential Equations**	4a. Find the order and degree of given differential equations. 4b. Solve Differential Equations related to Variable Separable method. 4c. Solve given linear differential equations.	4.1 Concept and Definition, Order and Degree of differential equation. 4.2 Solution of DE of first degree and first order by Variable Separable method. 4.3 Solution of linear Differential equation.
Unit– V **Statistics**	5a. Find Mean for the given data. 5b. Calculate Mean deviation for the given data. 5c. Calculate Standard deviation for the given data.	5.1 Mean for ungrouped and grouped data. 5.2 Mean deviation and Standard deviation about Mean for ungrouped and grouped data.

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Differentiation and its Applications	10	4	6	6	16
III	Integration and its Applications	10	4	4	6	14
IV	Differential Equations	06	2	4	6	12
V	Statistics	07	2	4	6	12
Total		**42**	**16**	**24**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Identify engineering problems based on real world problems relevant to content of the unit and solve these problems in the light of free tutorials available on the internet.
b) Explore the opportunity to visit Science city, ISRO or nearby Science centers.
c) Explore the opportunity to visit Mathematics Lab Virtually.
d) Prepare charts showing formulas of differentiation.
e) Prepare charts showing formulas of integrations.
f) Use Graphing calculator to plot the graph of solutions explaining Engineering applications.
g) Communicate mathematical thinking coherently and clearly to other students, peers, and others.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Explore the possibility for understanding the Biosphere through Mathematics.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Charts:** Prepare the Charts of formulae for Matrix, Differentiation, Integration.
b) **Charts:** Compare last weather conditions with current weather to predict future weather through chart.
c) **Models:** Prepare the cardboard models based on real world applications of derivatives.
d) **Presentation/Seminar:** Prepare a presentation/seminar on any relevant topic of interdisciplinary nature.
e) **History of Mathematics**: Prepare a write up on the Historical path of Calculus.
f) **Solution of system of linear equations:** Form the system of linear equations up to three variables for the given electrical circuit using matrices solve it.
g) **Maxima and Minima:** Find a real-world problem related to finding area/volume, form the corresponding function and find maxima/minima. For example, maximize the volume of a box made of a rectangle tin sheet by cutting off squares of same size from each corner and folding up.
h) Slope of tangent: Find the slope of tangent for the given curves at a given point using derivative and visualize the location using suitable software.
i) Area/Volume: Find the area of a given closed region or volume of revolution for a given function using integration and visualize using suitable software.
j) Solution of Differential equation: Form differential equations for real-world problems and plot the graph using suitable software with geometrical interpretation.
k) Statistics: Collect the data of world of work and find mean, mean deviation and standard deviation for that data.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Elementary Engineering Mathematics	B. S. Grewal	Khanna Publishers,15th Edition. ISBN: 978-81-7409-257-1
2	Engineering Mathematics	Croft, Anthony	Pearson Education, New Delhi, 2014.

S. No.	Title of Book	Author	Publication with place, year and ISBN
	(Third edition).		ISBN 978-81-317-2605-1
3	Calculus and Its Applications	Marvin L. Bittinger David J. Ellenbogen Scott A. Surgent	Addison-Wesley 10th Edition ISBN-13: 978-0-321-69433-1
4	Calculus and Analytic Geometry	G. B. Thomas, R. L. Finney	Addison Wesley, 9th Edition, 1995. ISBN 978-8174906168
5	Understanding Engineering Mathematics	John Bird	Routledge; 1st edition ISBN 978-0415662840
6	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5
7	Elementary Mathematical Statistics	S. C. Gupta and V. K. Gupta	Sultan Chand and Sons, Educational Publisher, New Delhi ISBN: 978-8180547003

14. SOFTWARE/LEARNING WEBSITES

a) https://www.youtube.com/channel/UCLJVrQyPYsseCf78QWCDsvA/featured (YouTube Channel of DTEGUJ)
b) https://www.geogebra.org/?lang=en
c) https://nios.ac.in/online-course-material/sr-secondary-courses/mathematics-(311).aspx
d) www.dplot.com/ - DPlot
e) www.wolfram.com/mathematica/
f) www.easycalculation.com
g) www.scilab.org/ - SCI Lab
h) https://ncert.nic.in/textbook.php (NCERT Textbooks of Mathematics 11th and 12th Science)
i) https://www.desmos.com/

15. PO-COMPETENCY-CO MAPPING

Semester II	Applied Mathematics (Course Code:4320001)

	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency .	Solve broad-based technology problems using the principles of Applied mathematics.						
Course Outcomes CO a) Demonstrate the ability to Crack engineering related problems based on Matrices	3	1	-	-	-	-	1
CO b) Demonstrate the ability to solve engineering related problems based on applications of differentiation	3	1	1	-	-	-	1
CO c) Demonstrate the ability to solve engineering related problems based on applications of integration	3	1	1	-	-	-	-
CO d)Develop the ability to apply differential equations to significant applied problems	3	1	1	-	-	-	1
CO e) Solve applied problems using the concept of mean	3	1	-	-	-	-	-

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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3	Mr. P. N. Joshi Sr. Lecturer	A.V.P.T.I, Rajkot	9924844699	pnj2004@rediffmail.com
4	Dr. J. S. Prajapati Sr. Lecturer	R.C.T.I, Ahmedabad	9426469752	jsprajapati26@gmail.com
5	Dr. Sachin J. Gajjar Lecturer	Government Polytechnic, Gandhinagar	9925362754	gjr.sachin@gmail.com
6	Dr. Nirav H. Shah Lecturer	Government Polytechnic, Jamnagar	9327632570	Nirav.hs@gmail.com

NITTTR Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-II

Course Title: Mechanical Drafting
(Course Code: 4321902)

Diploma programme in which this course is offered	Semester in which offered
Mechanical, Marine, Mechatronics	Second

1. RATIONALE

The students of mechanical engineering programme are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) at industries. For all such activities, reference document is the drawing of components/assemblies to be manufactured. In this context, it is of utmost priority to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. Development of sketching ability also strengthens effective engineering communication & presentation.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Draw various mechanical component drawings using codes, norms and standards.**
- **Interpret basic engineering drawings for various planning, manufacturing activitiesand inspection.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for theachievement of the following COs:

a) Prepare sectional orthographic views of complex mechanical parts as per**ASME Y14.3-2003** standard.
b) Draw lines/curves of intersection of pipe lines and ducts like solid.
c) Develop the lateral surface of given combination of solid.
d) Apply Geometric Dimensioning and Tolerancing (GD&T)to machine parts in a manner that complies with the **ASME Y14.5-2009** standard.
e) Prepare assembly and detail drawing of various mechanical components.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	4	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; T– Tutorial/Teacher Guided Theory Practice; P-Practical; C– Credit, **CA** -Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. These PrOs need to be attained to achieve COs.

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Multiviews with Sectional Views:** 1a. Given the pictorial view, draw multi views. -Two problems. 1b. Faculty has to assign objects and multi views have to be drawn. (From mutliviews i.e., FV, TV, RV, BV, RHSV&LHSV, one view of each problem must be *sectional view*)	I	10
2	**Missing Views:** Given adequate number of minimum views, draw additional view/s asasked. -Three problems.	I	04
3	**Penetration and Intersection:** Draw the intersection curves-4 problems. (1. Prism into Prism, 2. Cylinder into Cylinder, 3. Cylinder into Prism& 4. Cone into Cylinder.)	II	08
4	**Surface Development:** Draw development of surface - 4 problems (*3 problems* fromPrism, Pyramid, Cylinder and Cone – independent and sectioned&*1 problem* from combination of any two as suggested in Topics & Sub-Topics 3.5)	III	06
5	**Details:** Draw the details of all parts for the assembly assigned and sketched asstudent activity.	VI	12
6	**Assembly:** Draw the assembly of all parts assigned by faculty. This includesminimum one sectional view and also prepare BOM.	VI	10
7	**Production Drawing:** Draw the production drawing of simple machine components	V	06

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	assigned by faculty. This includes Geometric & Dimensional Tolerances (GD&T), Surface Roughness Symbols, Open Dimensional Tolerances, Notes, etc.,		
8	**Mechanical DraftingSymbols& Fasteners:** *Draw following symbols & its interpretation:* Drafting Symbols (Machining, threading,dowels, pins, ribs, bearings, heat treatmentconditions, surface conditions, assemblynotes), Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementarysymbols), Piping Symbols (Pipe line symbol as per passing fluid, air, gas, water etc. and Piping fitting symbols.) *Draw sketches of following fasteners & its interpretation:* Sketches of threads (square, acme,knuckle, Internal – external threads,left hand – right hand threads, Single &multi start threads). Sketches of studs (cap screws, machinescrews, set screws). Sketches of bolts & nut (hexagonal,square). Sketches of rivets (snap, pan,countersunk, conical). Sketches of keys.	IV& VII	-
	Minimum8PracticalExercises		**56**

Note

i. *The sketchbook should contain data related to all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.*
ii. *Draw freehand sketch of Sheet No.8 data in sketchbook only.*
iii. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
iv. *The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed Practical Exercises of this course required which are embedded in the COs and ultimately the competency.*
v. *Faculty should encourage students for optimum use of drawing sheet space. Further, instruct them to use both sides of a drawing sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.*
vi. *First angle orthographic projection and codes* (SP 46:2003, ASME Y14.3-2003 & ASME Y14.5-2009) *should be followed wherever applicable.*
vii. *The dimensions of line, axes, distances, angle, side of polygon, diameter, etc. must be varied for each student in batch so that each student will have same problems, but with different dimensions.*
viii. *A softcopy containing applicable standards from* IS codes, ASME Y14.3-2003 & ASME Y14.5-2009 *should be accessible to students.*

ix. For 25 marks Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to prepare drawings.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr.	Sample Performance Indicators for the PrOs	Weightage %
1	Drawing planning layout and scale (for optimum use of drawing sheet)	20
2	Use of appropriate instruments, lines, dimensioning & annotations	30
3	Accuracy and Neatness of drawing	15
4	Timely submission of completed drawing sheet	15
5	Answering viva voce questions	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specificationsfor the PrOsis a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Drawing instruments for class room teaching (Large Size).	1 to 7
2.	Models of various objects	1, 3, 5, 6, 7
3.	Drawing Board (B2) & Mini Drafter.	1 to 7
4.	Other Instruments: T-Square,Set square (45˚ and 30˚-60˚), Roller Scale, Protector, Drawing Compass, Dividers, Drawing Pencils(Clutch Pencil with H & 2H Lead), Lead Box (H & 2H – 0.5 or 0.7 mm) Circle Master, French Curves, Stencils (8-6-4 mm, All in One), Eraser, Drawing sheets, Drawing Pins/Clips, Sheet Container and Drawing instrument box.	1 to 7
5.	Set of various drawings being used by industries/developed by experienced teachers.	4, 5, 6, 7
6.	Interactive board with LCD overhead projector	1 to 7

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs andPrOs.More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices
c) Follow ethical practices.
d) Maintain cleanliness
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I **Multiviews with sectional orthographic representation**	1a. Draw multi views of an object. 1b. Interpretation of multi views drawings. 1c. Draw sectional orthographic views of an object. 1d. Interpretation of sectional orthographic views.	1.1 First & third angle projection methods & and positions of six views.Importance of it in engineering drawing field. 1.2 Multi view drawings (all six views) from given isometric drawing / pictorial view. 1.3 Need of sections, section lines &cutting plane, rules forsectioning and section lines. 1.4 Types and application of sections- full, half, revolved, removed, partial, off-set, aligned, etc. 1.5 Sectional view drawings from given isometrics drawing / physical object and cutting plane conditions. 1.6 Missing view drawings from given adequate orthographic views. (**Faculty**should**demonstrate**the physical model/dirty model/3D CAD model for better conceptualization and in depth understanding of topic.)
Unit– II **Intersection and Penetration of Solids and Surfaces**	2a. Draw intersection/ penetration views of an object.	2.1 Types and dimensional specifications ofsolids (prism, pyramid, cylinder, cone). 2.2 Importance and field use/industrial applications with examples of intersection/penetration. 2.3 Intersection curve for Intersection/ penetration of: - Prism into prism. - Cylinder into cylinder. - Cylinder into prism. - Cone into cylinder. 2.4 Discussion / demonstration of moderate

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		industry objects related to topic.
	3a. Develop the surfacerequirement of given application.	3.1 Importance and field use / industrial applications of development ofsurfaces. Introduction to cutting planes / section planes, positions of the cutting plane (HCP, VCP, PCP, AVP &AIP) w.r.t solids. 3.2 Drawing of development of surfaces of various solid - surface development of combination of different solids and of sectioned solids of: - Prism - Cylinder & Cone - Pyramid 3.3 Surface development of combination of any two solid (example: pipe joints, litre can, funnel, etc.)
Unit-IV **Mechanical DraftingSymbols**	4a. Use & interpretmechanical drafting symbols.	4.1 Drafting Symbols (Machining, threading, dowels, pins, ribs, bearings, heat treatment conditions, surface conditions, assembly notes.) 4.2 Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementary symbols.) 4.3 Piping Symbols (Pipe line symbol as per passing fluid,air, gas, water etc. and Piping fitting symbols.) 4.4 Demonstration of above symbol in production drawing.
Unit-V **System of Geometric Dimensioning and Tolerancing (GD&T)**	5a. Use & interpret Geometric & Dimensioning Tolerances (GD&T) in production drawing.	5.1 Difference between dimensional tolerance & geometric tolerance. Limits & Fits–Introduction, need & applications. 5.2 Abbreviations & designations for shaft, holes and grades, determinations of deviation, limit, tolerance and fits, shaft basis and hole basis system & selection of shaft & hole pair as per standard tolerance of grades. 5.3 Selection of appropriate shaft / hole for a given condition, calculation of tolerances & deviations for a fit according to application of mating parts. 5.4 Geometric Tolerances – Introduction, symbols, representation, meaning of each element of tolerance frame and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		application in industrial drawing. (**Faculty** should **demonstrate**&**discuss** moderate production drawing for better understanding of topic)
Unit-VI **Details & Assembly**	6a. Prepare andinterpret detail andassembly drawing. 6b. Workout bill of material (BOM) from a given drawing.	6.1 Importance and difference of these drawings. 6.2 Detail drawing from given assembly. 6.3 Assembly drawings from given details and prepare BOM.
Unit-VII **Fasteners**	7a. Use appropriatefastener s for givensituations. 7b. Draw sketches fordifferent types offasteners.	7.1 Detachable & permanent fasteners. 7.2 Sketches of threads (square, acme,knuckle, Internal – external threads,left hand – right hand threads, Single & multi start threads). 7.3 Sketches of studs (cap screws, machinescrews, set screws). 7.4 Sketches of bolts & nut (hexagonal,square). 7.5 Sketches of rivets (snap, pan,countersunk, conical). 7.6 Sketches of keys.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Multi views with Sectional Orthographic Representation	06	00	00	14	14
II	Intersection &Penetration of Solids &Surfaces	06	00	04	06	10
III	Development of Surfaces	05	00	02	06	08
IV	Mechanical Symbols	04	06	04	00	10
V	System of Geometric Dimensioning and Tolerancing (GD&T)	04	02	04	04	10
VI	Details &Assembly	03	02	00	10	12
VII	Fasteners	-	04	00	02	06
	Total	**28**	**14**	**14**	**42**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Solve all problems for all sheets number 1 to 7 in sketch book (with complete data and dimensions).
b) Prepare list of products nearby you which is made by development of surface.
c) Take a visit of manufacturing industry and prepare production drawing of simple part manufactured by that industry.
d) List out different weld joints carried out in fabrication industry.
e) Download soft copy of technical drawing of any engineering products. Read and interpret this drawing (e.g., connecting rod, piston, pulley etc.).
f) Explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each batch student.
g) Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessedusing different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students for using ASME Y14.3-2003 & ASME Y14.5-2009 standard.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs

which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs.Similar micro-projects could be added by the concerned course teacher:

a) Creating Digital Portfolio:Students should Observe and collect photographs and images of industrial/domestic components/items which utilize intersection of solid.
b) Make a poster presentation on exploded view of assembly of mechanical components.
c) Take a simple assembly of 3 to 4 parts and prepare its assembly and detail drawing.
d) Model Making: Students should build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap.
e) World of work connect: Students should collect Production drawings from nearby workshops/industries and try to:
   - Redraw types of lines used.
   - Redraw lettering styles used.
   - List ASME/BIS code referred.
   - List the symbols/annotations/dimensioning used.
   - List the type of scales used. Compare the size of component on drawing sheet with actual component.
   - Redraw the 2D entities.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014 ISBN-13: 9789380358963
2	Machine Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014 ISBN-13: 9789385039232
3	Machine Drawing	P.J. Shah	S.Chand; New Delhi, 2013 ISBN-13: 9788121929660
4	Machine Drawing	K. L. Narayana, P. Kannaiah, K. Venkata Reddy	New Age International Pvt Ltd; New Delhi, 2016 ISBN-13: 9788122440546
5	Engineering Graphics	M.B.Shah, B.C.Rana	PearsonEducation; Ahmedabad,2009 ISBN-13: 9788131710562
6	Engineering Drawing Vol 1 & 2	K. R.	Subhash Publications;

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
	Combined	Gopalakrishna	Bengaluru, 2017 ISBN-13: 9789383214235
7	The Fundamentals of Engineering Drawing: With An Introduction To Interactive Computer Graphics For Design And Production	Warren J. Luzadder, Jon M. Duff	Pearson India; Bengaluru, 2015 ISBN-13: 9789332549982
8	Technical Drawing	W. Abbott, Revised by T. H. Hewitt	English Language Book Society and Blackie & Son Ltd.; London, 1978 ISBN-10: 021690210X
9	Geometric Dimensioning and Tolerancing for Mechanical Design	Gene R. Cogorno	McGraw Hill; Noida,2011 ISBN-13: 9780071772129
10	Westermann Tables for the Metal Trade	Jutz Hermann	New Age International Pvt. Ltd.; Hyderabad, 2018 ISBN-13: 9788122417302
11	SP 46-2003	-	Bureau of Indian Standards; Old Delhi, 2003 ISBN-10: 8170610192
12	BIS 696 - 1972	-	-
13	BIS 919 (Part 1): 1993& BIS 919 (Part 2): 1993	-	-

14. SOFTWARE/LEARNING WEBSITES

Mechanical Drafting Subject

- https://youtube.com/playlist?list=PL5Rqb_WO7qVxzROfyk2EusQDokGkLXVax
- https://nptel.ac.in/courses/112/103/112103019/
- https://nptel.ac.in/courses/112/105/112105294/

Multiviews with sectional orthographic representation

- https://youtu.be/55mR97uzjys
- https://youtu.be/5bkG-LTb6-s
- https://youtu.be/uiZ8Xl0QTkU
- https://youtu.be/o2s7A658rag

Missing views

- https://youtu.be/NQU_ml5xpo8

Intersection and Penetration of Solids and Surfaces

- https://youtu.be/5bkG-LTb6-s
- https://youtu.be/vhYe-E99bog
- https://youtu.be/fudq7JQiwjs
- https://youtu.be/l0PVFFaQAf4
- https://youtu.be/V5p8DGL63Ho
- https://youtu.be/0h56yj3AHNc
- https://youtu.be/A1CKh4zewd4
- https://youtu.be/Ume3AD38-Vk

Development of Surfaces

- https://youtu.be/EVTrZ-ApC7g

- https://youtu.be/a5C_VPEkUtI
- https://www.youtube.com/playlist?list=PLUqOKW86QrMblA4NuoaCgGVKXrjZtOb5i
- https://www.youtube.com/playlist?list=PLIhUrsYr8yHwdB96ft6c0Uwc4SDCLuG1v
- https://www.youtube.com/watch?v=mEIYKa1x2Y4&list=PLSJ0s_ue4lgjMr7sFOuyQQVTihpR_fBrU
- https://www.youtube.com/watch?v=P5oPrynRsTI

Mechanical Symbols

- https://youtu.be/KdeeZeKO7ko
- https://youtu.be/euySmmCnzpA
- https://www.youtube.com/watch?v=A-J-tQEuACA
- https://www.youtube.com/watch?v=gAyceJb5OWc
- https://www.youtube.com/watch?v=4p3FzrMxRtA
- https://www.youtube.com/watch?v=PIjLvwe_uMY

System of Geometric & Dimensioning Tolerances (GD&T)

- https://youtu.be/IQHcIi8X360
- https://www.youtube.com/watch?v=joBy4BoJszo
- https://www.youtube.com/watch?v=RYQUXGSEsV0
- https://www.youtube.com/watch?v=-3tN7KvDUjQ
- https://www.youtube.com/watch?v=NZ_zAqvNcFo
- https://engineeringandindustry.medium.com/reading-a-production-drawing-1d0fc94f45eb

Details & Assembly

- https://www.youtube.com/playlist?list=PLSJ0s_ue4lgiBn3PWHLN5TtiuFHLByEsN

Fasteners

- https://www.youtube.com/watch?v=y6DnJ0HEmCI
- https://www.youtube.com/watch?v=hlGcb72II5Q

15. PO-COMPETENCY-CO MAPPING

Semester I	Instrumentation Workshop (Course Code: 4311702)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation&Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	✓ Draw various mechanical component drawings using codes, norms and standards. ✓ Interpret basic engineering drawings for various planning, inspection and manufacturing activities.						
Course Outcomes CO 1) Prepare sectional orthographic views of complex mechanical parts as per ASME Y14.3-2003 standard.	2	2	-	2	-	-	-

CO 2) Draw lines/curves of intersection of pipe lines and ducts like solid.	2	2	2	-	-	-	2
CO 3) Develop the lateral surface of given combination of solid.	2	2	2	-	-	-	2
CO 4) Apply Geometric Dimensioning and Tolerancing techniques to machine parts in a manner that complies with the ASME Y14.5-2009 standard.	2	3	2	3	2	2	3
CO 5) Prepare assembly and detail drawing of various mechanical components.	2	2	2	2	2	-	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Sunil S. Sonigra, Lecturer in Mech. Engg.	Government Polytechnic, Rajkot	9427322129	sssonigra@gmail.com
2.	Prof.Altaf H. Nalbandh, Lecturer in Mech. Engg.	Government Polytechnic, Porbandar	9904230786	altaf.nalbandh85@gmail.com
3.	Prof.Dipak A. Solanki, Lecturer in Mech. Engg.	Government Polytechnic, Porbandar	9016221933	dipak.solanki.gp@gmail.com

BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmedabad	9227200147	gpasiraj@gmail.com
2	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B&B Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
3	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	Asshah97@yahoo.in

3rd Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-II/III

Course Title: Engineering Material
(Course Code: 4300020)

Diploma Programs in which this course is offered	Offered in
Automobile Engineering, Mechatronics (Load taken by Mechanical/Metallurgy dept.)	Sem 2nd
Mechanical Engineering, Fabrication Technology (Load taken by parent department)	Sem 3rd

1. RATIONALE

Due to globalization manufacturing sector experiencing a vital change over, where the emphasis is on reducing weight, fuel economy, ergonomically design and cost. It is essential to understand various material their composition, properties and applications.

Engineering Materials play an important role as the vital tool for solving the problems of material selection and application in the production and manufacturing of equipment/machines, devices, tools, etc. Therefore, an engineering diploma student must be conversant with the properties, composition and behavior of materials from the point of view of reliability and performance of the product.

Subject is concerned with the changes in structure and properties of matter. Many of the processes which are involved to bring out these changes, forms the basis of engineering activities. The study of basic concepts of material science and metallurgy will help the students understanding engineering subjects where the emphasis is laid on the application of these materials.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

i. Compare Engineering materials based on properties, behavior and environmental effect for given engineering application.
ii. Examine microstructure and alloying elements of given engineering materials

3. COURSE OUTCOMES (Cos)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following Cos:

a) Compare appropriate material for manufacturing various components.

b) Explain appropriate heat treatment process for various components.
c) Describe various metal and its alloys based on composition and properties.
d) Understand classification and properties of non-metallic materials and composites,
e) Explain electrolysis, paints and powder material to improve surface properties.
f) Identify green material as an alternative of existing materials.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P – Practical; C – Credit, CA – Continuous Assessment; ESE – End Semester Examination.

5. SUGGESTED PRACTICAL/EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the Cos. These PrOs need to be attained to achieve the Cos.

Sr. No.	Unit No.	Practical/Exercises	Approx. Hours.
1		Prepare report on- a) 1. Types of bonds, construction and characteristics of electrovalent, covalent, coordinate, hydrogen and metallic bond. b) Structure of solids 1.Concept of crystalline structure. 2. Structure of metal-unit cell, BCC, FCC and HCP with Examples of each.	4
1 OR 2			
2	I	1. State the criteria to identify any five (3metallic and 2 nonmetallic) materials from the selected set of material 2. List properties of each above identified materials. Also identify main alloy in elements and reasons to add them.	4

3	II	Analyze content of ferrous/nonferrous material using photo-spectrometer. (This may be covered during industrial visit).	4
3 OR 4			
4	II	1. Demonstrate/Study various heat treatment furnaces. 2. Study various Heat treatment processes Annealing, normalizing, carburizing, casehardening, hardening, tempering, spherodising, nitriding, tempering, stabilizing, etc. Methods, parameters and changes in properties 3.Types of quenching mediums, their properties and applications	4
5	II	Perform hardening process on ferrous material. Measure the hardness before and after hardening.	4
5 OR 6			
6	--	1. Prepare a report on metallurgical examination, its need and importance of microstructure. 2. Write steps for preparation of specimen for microscopic examination. 3. Examine the given specimen by use of metallurgical microscope.	4
7	III	Prepare ferrous micro specimens and examine them. Also prepare report on this. – Four specimens. (One of plain carbon steel, second of alloy steel, third of heat-treated steel and fourth of cast iron.)	4
8	III	Prepare non-ferrous micro specimens and examine them. Also prepare report on this. –Three specimens. (One of copper, second of brass and third of aluminum.)	4
9	IV	Prepare a report on various non-metallic material its classification, properties and application. At least four non-metallic materials.	4
10.	V	Prepare a report on different types of Electrolytes and Non-electrolytes and Industrial applications of electrolysis.	2

10 or 11			
11.	V	Prepare a report on different types of corrosion, identify reasons and suggest remedies for each type of corrosion.	2
12.	VI	Prepare a report on process equipment's and set up used for any two-powder coating process, its working principle and merits.	2

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

1. Metallurgical Microscope.
2. Standard specimens.
3. Furnaces to perform heat treatment process.
4. Sorted/required quenching mediums.
5. Hardness tester-to check Rockwell hardness-scales A, B and C.
6. Other hardness testers like sceleroscope, etc.
7. Polishing machine to prepare specimens with necessary consumables.
8. Hand grinder – specifically to prepare specimens and for spark testing.
9. Other consumables.

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfil the development of this course competency.

a) Work as a leader/a team member.

b) Follow ethical practices.

c) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year

ii. 'Organization Level' in 2nd year.

iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Engineering Materials**	1a. Explain different types of bonds material, its construction and characteristics	1.1 Types of bonds, construction and characteristics of electrovalent, covalent, coordinate, hydrogen and metallic
	1b. Draw molecular arrangement in solids, liquid and gases	1.2 Intermolecular force of attraction 1.3 Molecular arrangement in solids, liquid and gases 1.4 Structure of solids i. Concept of crystalline structure. ii. Structure of metal-unit cell, BCC, FCC and HCP. iii. Examples and properties of metallic structures
	1c. Describe various properties of material	1.5 Physical, mechanical chemical, electrical, electromagnetic and thermal properties of Material.
Unit– II **Phase Diagrams**	2a. Explain the concept of equilibrium diagram. 2b. Plot cooling curves for pure metals and alloys. 2c. Explain effects of Cooling rate, grain size on materials properties.	2.1 Equilibrium diagrams. i. Concept, definition and need. ii. Alloys-major elements, reasons to add and important effect on material properties. iii. Cooling curve-concept and method to plot. 2.2 Solidification of metals i. Concept. ii. Crystal, grain, grain boundaries and dendritic solidification. iii. Effect of cooling rate on material properties.

	2c. Draw and Interpret TTT curves and Iron carbon diagram	2.3 Time Temperature Transformation curve-(TTT curve). i. Need and application. ii. Steps to construct TTT curve 2.4 Iron carbon equilibrium diagram. i. Concept, need & characteristics. ii. Definition of the terms used.
	2d. Improvement of Metal Properties using Different Heat Treatment Process	2.5 Heat treatment processes. i. Heat treatment processes. (Annealing, normalizing, carburizing, case hardening, hardening, tempering, spherodising, nitriding, tempering, stabilizing, etc.). Methods, parameters and changes in properties. ii. Types of quenching mediums, their properties and applications.
Unit– III **Metals And Its Alloys**	3a. Identify various ferrous metals and alloys based on composition and properties for prescribed application 3b. Test material for alloying elements content	3.1 Classification of metals. 3.2 Ferrous metals i. Classification. ii. Steels-types, composition, properties, applications. (For Plain carbon steel, alloy steel including stainless steel and cast iron.)
	3c. Compare various non-ferrous metals and alloys based on composition and properties for given application	3.3 Nonferrous metals i. Classification. ii. Types, composition, properties and applications. (For Copper, copper alloys, Aluminum and Aluminum alloys.)
Unit– IV **Non-Metallic Materials**	4a. Identify non-metallic material by judgment and lay-man tests 4b. Compare the non metallic material for given simple machine elements	4.1 Introduction and classification of non-metallic materials. 4.2 Classification of Polymers on basis of Thermal behavior (Thermoplastics & Thermosetting). 4.3 Properties and applications of polymers (like Polyethylene, Polypropylene, Polyvinyl chloride, Teflon, Polystyrene, Phenol formaldehyde, Acrylonitrile, Epoxy resin.) 4.4 Composites. i. Introduction of composite. ii. Characteristics of composites. iii. Constituents of composite. iv. Types and applications of composites.

		4.5 Other nonmetallic materials-types, properties and applications, (like rubber, ceramics, refectories, abrasives, adhesives, conductor, electronic circuits/components, insulators etc.).
Unit– V Electrolytes, oils, paints/ varnish and powder material	5a. Describe proper surface engineering process for specified application. 5b. Explain basic concept of powder metallurgy and corrosion.	5.1 Surface engineering processes: Coatings and surface treatments; Cleaning and mechanical finishing of surfaces; Organic coatings; Electroplating and Special metallic plating; Electro polishing and photo-etching; Conversion coatings: Oxide, phosphate and chromate coatings; Thin film coatings: PVD and CVD 5.2 Oils. i. Types and properties. ii. Designation methods as per BIS. iii. Applications in Mechanical engineering. 5.3 Paints and varnishes. i. Definition and classifications. ii. Surface preparation and coating methods using paints and varnishes. 5.4 Powder metallurgy. i. Basic concept of powder metallurgy and its applications, merits and demerits. 5.5 Corrosion-types and reasons.
Unit- VI Green material	6.a Understand importance of green material. 6.b Identify the parts which can be replaced by green material	6.1 Concept of green material 6.2 Sustainable and renewable material in mechanical and allied industries. 6.3 Need of advanced material in mechanical and automotive sector. (Electric vehicle, solar panels, battery etc)

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hrs.	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I.	Engineering Materials.	06	4	2	2	8
II.	Phase diagrams.	10	6	4	6	16
III.	Metals and alloys.	08	6	4	4	14
IV.	Non-metallic materials.	07	2	4	6	12
V.	Electrolytes, oils, paints/ varnish and powder material	07	4	2	8	14
VI.	Green material	04	2	2	2	6
	Total	**42**	**24**	**18**	**28**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of each activity. They should also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Charts can be prepared.

b) Small report on any topic given by concern faculty.

c) Small groups of students can be formed for assigned work. Assigned work should be such that it covers market survey, team work, presentation, time management, quality development.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.

b) Guide student(s) in undertaking micro-projects.

c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.

e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

f) Guide students on how to address issues on environment and sustainability

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably being ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should be about **14 -** ***16 (fourteen to sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

Identify at least five metals used in laboratory and list the material of selected objects
Identify at least five nonmetals used in laboratory and list the material of selected objects
Identify at least three oils, greases used with their application
List different types of paints available in market for the metals with their specialty.

List the material used for manufacturing of the selected components.
Identify various heat treatment processes used for the manufacturing industries, which and why?
Study report on green material used in manufacturing industry
List different types of material for generation and storage of electricity from solar energy (Electric vehicle, solar panels and battery)
List different types of materials for manufacturing of conductor, electronic circuits/components, insulators

12. SUGGESTED LEARNING RESOURCES

S.No.	Author	Title of Books	Publication with place, year and ISBN
1.	GBS Narang	Materials science	Khanna Publishers, New Delhi, (2021),8195028721.
2.	R.K.Rajpoot	Materials science	S.K. Katariya and sons, Dariyaganj, New Delhi. (2013),8185749108
3.	R.S.Khurmi R.S.Sedha	Materials science	S. Chand, Ahmedabad, (2004), 8121901464
4	U.C. Jindal	Materials science and metallurgy	Pearson Education India, Ahmedabad, (2011) 9788131759110
5.	V. Raghavan	Materials science and Engineering	EEE Edition, Prentice Hill, New Delhi, (2015) 9788120350922
6.	R.B.Gupta	Material science and Engineering	Tech India publication, New Delhi, (2018),9351921077
7.	O.P.Khanna	Material science	Dhanpatrai publication, New Delhi, (2010), 8189928317
8.	Sidney Avner	Physical Metallurgy	Tata McGraw-Hill Education, Noida, (2017).0074630067

14. List of Software/Learning Websites

1. http://vimeo.com/32224002
2. http://www.substech.com/dokuwiki/doku.php?id=iron carbon_phase_diagram
3. http://www-g.eng.cam.ac.uk/mmg/teaching/typd/
4. http://www.ironcarbondiagram.com/

5. http://uk.ask.com/web?q=Who+Discovered+Carbon%3F&qsrc=14097&o=41647924&l=dir
6. http://www.youtube.com/watch?v=fHt0bOfj3T0&feature=related
7. http://www.youtube.com/watch?v=cN5YH0iEvTo
8. http://www.youtube.com/watch?v=m9l1tVXyFp8
9. http://www.youtube.com/watch?v=98lh5Q0M0cg
10. http://www.youtube.com/watch?v=KIyGr-1snMY
11. http://en.wikipedia.org/wiki/Materials_science
12. http://www.studyvilla.com/electrochem.asp

15. PO-COMPETENCY-CO MAPPING

Semester II/III	**Engineering Materials Course Code: 4300020**						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Compare Engineering materials based on properties, behavior and environmental effect for given engineering application.	3	1	1	2	1	1	3
Examine microstructure and alloying elements of given engineering materials	2	1	1	2		1	2
CO a) Compare appropriate material for manufacturing various components.	3	1	1	2		1	2
CO b) Explain appropriate heat treatment process for various components	2	1	1	2		1	2
CO c) Describe various metal and its alloys based on composition and properties.	2			1		1	3
CO d) Understand classification and properties of non-metallic materials and composites	3			1		1	3
CO e) Explain electrolysis, paints and powder material to improve surface properties	2					1	2

CO f) Identify green material as an alternative of existing materials	2				3	2	3

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No	Name and Designation	Institute	Contact No.	Email
1	Prof. D. A. Dave (Retd. HOD Automobile)	Sir BPTI, Bhavnagar	9427182407	deven_a_dave@yahoo.co.in
2	Prof. N. P. Oza (Lect. in Mech)	Government Polytechnic, Rajkot.	9328746470	nityamoza@gmail.com
3	Prof. G. R. Khunt (Lect. in Mech)	C. U. Shah Polytechnic Surendranagar	8128291616	grkhunt@gmail.com
4	Prof. Hitarthi Chhaya (Lect. in Mech)	C. U. Shah Polytechnic Surendranagar	9925222469	hitarthibuch@gmail.com
5	Prof. Bijal Pandya (Lect. Mechatronics)	B & B Institute of Technology, V.V. Nagar	9106030805	bijalpandya99@gmail.com

BOS Resource Persons

S. No	Name and Designation	Institute	Contact No.	Email
1	Dr. S. H. Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic, Ahmedabad	9227200147	gpasiraj@gmail.com
2	Dr. Rakesh D. Patel BOS Member HOD Mechanical Engg.	B&B Institute of Technology, V V Nagar	9825523982	rakeshgtu@gmail.com
3	Dr. Atul S. Shah BOS Member Principal	B.V.Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in
4	Prof. Shyam Varghese BOS Member HOD Automobile Engg	Government Polytechnic Ahmedabad	9426396640	shyamvarghese@gmail.com
5	Prof. A. K. Nanavati BOS Member HOD Automobile Engg	C U Shah Polytechnic Surendranagar	9426674409	aknanavati@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Summer Internship-I
(Course Code: 4330001)

Diploma programme in which this course is offered	Semester in which offered
All Branches of Diploma Engineering(Except Automobile, Bio Medical, ICT, Power)	Third

1. RATIONALE

Idea of Embedded Internships- AICTE has made 7-10 weeks summer internships mandatory in the new curriculum which will equip the students with practical understanding and training about industry practices in a suitable industry or organization. To make education holistic, sports, physical activities, values and ethics have been embedded in the curriculum.

We must agree that all Branches of Diploma Engineering are changing rapidly. New technologies are adding fast which effects can be seen in our society. Summer internship is a good option by which students to get flavor of such emerging technology and familiar with industry environment to identify scope and focus of their career development opportunities. Main objective of summer internship is hand-on practice to expose students for thinking about professional career by observing, understanding working mechanism of ongoing work of industry and to obtain various types of skills throughout internship program.

This two week mandatory internship is to equip the students with practical knowledge and provide them exposure to real time industrial environments. Further, in these internships, the option is provided to do internship in Government Agencies/ skill centers/ social sector/ Govt. initiated social schemes/ NGOs etc. The duration of internship will be two weeks. It will be after completion of 2nd Semester and before the commencement of Semester 3rd. Any options from following can be chosen by the students:

1. **Offline internship in industry** - Student is supposed to produce joining letter for starting and relieving letter once the internship is over in case of Offline internship in any industry.
2. **Online internships –** Student can select from any of approved /supported / recommended by the All India Council of Technical education for Internship (like Internshala/ NEAT/ Gujarat Knowledge Society Initiative etc.) or Approved by the state government or University approved
3. **A Mini Project** - On some suitable topic related to respective branch. It can be small fabrication / experimental results/ simulations/ Application development / Design and / or Analysis of System(s) etc. depending on the branch of the student. Preferably a single student should carry out a mini-project.

2. COMPETENCY

The purpose of this course is to help the student to attain flavor of the following industry identified competency through summer internship experiences:

- **Develop multiple types of skills such as planning, communication, collaboration, decision making / Problem solving and management skills along with selected technical knowledge.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Learn and adopt the engineer's role and responsibilities with ethics.
b) Get exposure to the industrial environment for professional activities.
c) Get possible opportunities to learn, understand and sharpen the technical skills required for technical advancement.
d) Develop managerial skills required for professional career.
e) Attain skill for writing technical report and prepare poster for presentation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	0	1	0	0	25	25	50

1. **Offline internship in industry:** CA will be carried out based on submitted progress card by Industry resource person and ESE / Assessment will be carried out by institute resources person.
2. **Online internships:** CA will be carried out based on submitted certificate and ESE/ Assessment will be carried out by institute resources person.
3. **A Mini Project:** CA will be carried out based on project work by institute resources person.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

List of Documents to be prepared for Submission:

- Detail report duly signed and approved by the internal/external mentor
- Presentation softcopy approved by the internal/external mentor
- Poster of summer internship activities approved by the internal/external mentor.

Sample forms for Registration and Evaluation of Summer Internship-I –SI-I are given below:

1) Both forms are mandatory to be filled at the commencement and completion of SI respectively.
2) It is mandatory to file and map SI-I Registration and Evaluation with respective forms of SI-II (Later in Semester 5) so that students get enough exposure of industry / technology. (Mapping doesn't mean same industry/ company/ project-it can be independent/ different also.)
3) Mapping will be done to ease CA and ESE Evaluations.
4) A Seminar / Webinar can be arranged so that students coming from different industry / institute / project background can share experiences and learnings to their peers / all students of the same department.
5) Attached formats for Registration, Completion and Evaluation are suggestive. But, adhering to these formats is anticipated.

Summer Internship-I Registration Form

Note: Students needs to submit this registration form after finalizing mode of internship.

Student Details												
Enrollment Number												
Student Name												
Student Details	Mobile Number :											
	Email Address:											
Branch												
Code of the Institute	Name of the Institute											
Mentor Details (Institute)	Name:											
	Designation:											
	Mobile No:											
	Email Address:											
Industry Details	Name:											
	Address:											
	Email:											
	Phone:											
	Website:											
Mentor Details (Industry)	Name:											
	Designation:											
	Mobile No:											
	Email Address											
Mode of Internship Carried Out	Online / Offline/ Mini Project											
Title of the Project/ Internship carried out												
Nature of Work Carried Out	Web Design / Application development (Web / Mobile), Experimental results/ simulations/ Analysis of System(s) etc… Other please Specify_____											

Student Signature Faculty Signature

Summer Internship-I -Suggested Letter for Completion

[Company or Institute letter head]

No: Date

TO WHOM SO EVER IT MAY CONCERN

This is to certify that, Mr. /Mrs._____

Enrollment No._____ Student of_____

Has successfully completed a two week Internship in the field of_____

From the date:_____ to date:_____.

[90% Attendance is mandatory for completion of Internship]

During the period of his/her summer internship program with us, He / She were exposed to following different processes and were found sincere and hardworking.

1. _____

2. _____

3. _____

4._____

Mentor Signature **Head of Department**

Stamp Stamp

Summer Internship-I -Evaluation Rubrics for Institute

Evaluation Rubrics (Institute)

Enrollment No: _____ Branch: _____

Name of the Students: _____

Date of Evaluation: _____

Internal Evaluation – 25 Marks PA(I) **(To be carried out by the mentor in consultation with Industry) Minimum Passing Marks: 13**					
Parameter	**Excellent**	**Good**	**Average**	**Not up the level of Satisfaction**	**Obtained Marks**
Mark range	**4-5**	**3-4**	**2-3**	**Below 2**	
Knowledge acquisition in specific domain. **5 marks**					
Skill and attitude attainment in specific domain. **5 marks**					
Feedback and suggestions given are incorporated? **5 marks**					
Quality of the prepared report and poster. **5 marks**					
Quality of the presentation. **5 marks**					
Total Marks Obtained Out of 25 PA(I)					

Signature: _____ Institute Resource Examiner Name: _____

Suggested Evaluation Rubrics for Industry

Evaluation Rubrics (Industry)

Enrollment No: _____ Branch: _____

Name of the Students: _____

Date of Evaluation: _____

External Evaluation – 25 Marks ESE(V) **(To be carried out by the Industry Supervisor) Minimum Passing Marks: 13**					
Parameter	**Excellent**	**Good**	**Average**	**Not up the level of Satisfaction**	Obtained Marks
Mark range	**4-5**	**3-4**	**2-3**	**Below 2**	
Student regularity during the Internship period and proactive ness/responsiveness towards the given tasks (**5 Marks)**					
Work Plan, Execution and quality of work in forms of Outcome achieved (**5 Marks)**					
Engineering Tools and Techniques (**5 Marks)**					
Quality of poster design and presentation (**5 Marks)**					
Quality of the report and Skill **(5 Marks)**					
Total Marks Obtained Out of 25 ESE(V)					

Signature: _____ Industry resource/ Examiner Name: _____

Common Note:

1) For Summer Internship / Projects / Seminar etc. Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc. The internal / external assessment is based on the student's performance in viva-voce /work record respectively.
2) In case Industry Supervisor is not available / Institute Mentor/ Faculty can fill up both.

5. AFFECTIVE DOMAIN OUTCOMES

The following affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member as role of Engineer.
b) Practice environmentally friendly methods and processes.
Follow safety precautions and ethical practices.

6. SUGGESTED STUDENT ACTIVITIES

Following are the suggested student-related curricular, **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities and prepare reports and give presentation in front of students and faculty members. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Perform various tasks given by industry resources person during offline internship.
b) Perform various tasks given during online internship.
c) Perform various task required to complete mini project work under guidance of faculty member.
d) Summer Internship program Interns are required to give a presentation before review committee consisting of a group of academic staff members.
e) The review committee gives feedback and suggests possible improvements in the work.
f) At the end of the program all the Summer Internship program Interns make a poster presentation of the work carried out. The poster presentation is open to the public. It is also evaluated by faculty members.
g) A completion certificate will be issued to all Summer Internship program Interns only after the completion of internship tenure.

7. SOFTWARE / LEARNING WEBSITES

An internship is a short term work program usually offered to students by companies and institutes who require staff for assistance at junior levels. Thus for the students undergoing internship a professional learning experience is provided to benefit them in their skills as well as career. It will brush existing skills and provide exposure to new skills. Generally it is provided ay entry level in the industry.

Here is a suggestive list for reference only.

- https://www.internshala.com
- https://swayam.gov.in
- https://nptel.ac.in/
- https://neat.aicte-india.org/
- https://www.edx.org/
- https://www.coursera.org/
- https://www.udemy.com/
- https://www.linkedIn.com
- https://www.stumags.com
- https://www.letsintern.com
- https://www.internship.com
- https://www.glassdoor.com

8. PO-COMPETENCY-CO MAPPING

Semester III	Summer Internship (Course Code:4330001)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	**Use principles of basic electronics to maintain various electronics circuits And equipment**						
CO1) Learn and adopt the engineer's role and responsibilities with ethics.	2	1	1	1	1	1	1
CO2) Get exposure to the industrial environment for professional activities.	1	1	1	1	1	1	1
CO3) Get possible opportunities to learn understand and sharpen the technical skills required for technical advancement.	2	1	2	2	1	1	1
CO4) Develop managerial skills required for professional career.	1	1	2	1	1	1	1
CO5) Attain skill for writing technical report and prepare poster for presentation.	1	1	-	1	1	1	1

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Jiger P. Acharya	GP, Ahmedabad	9429462026	jigeracharya@gmail.com
2	Alpeshkumar R. Thaker	GP, Ahmedabad	9879709675	alpeshrthaker@gmail.com
3	Umang D. Shah	GP, Ahmedabad	9427686364	umang.shah111gp@gmail

BoS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Shri U. V. Buch- BoS Member and Subject in-charge (EC)	G P Ahmedabad	9825346992	uvbuch@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Theory of Machines and Mechanisms
(Course Code: 4331901)

Diploma Programs in which this course is offered	Offered in
Mechanical Engineering, Mechatronics Engineering	Third

1. RATIONALE

No matter how computerized, remote, online, bluetoothicized, internet-based and virtualized the world becomes, Mechanisms will always be important! Modern machines (e.g. Cars, boats, aircraft, space crafts, appliances, air and water handling, machine tools, robots, etc.) are a complicated combination of structures, mechanisms and controls.

In industries, the mechanical engineers/technicians are supposed to manage functioning of equipment with proper planning, operation and maintenance of machines and equipment. Students need to know about the combination of force and movement defines power and a mechanism that **manages power to achieve the desired set of forces and movement**. A mechanism is usually a piece of a larger process, known as a mechanical system or machine. This course includes such necessary knowledge and skill and ultimately becomes key course for mechanical engineering students.

2. EXPECTED COMPETENCY

The importance of this course is closely related to the ability of the student to understand and analyze to find problem solutions for machines and automation processes.

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire the following competency: "Use principle of kinematics and dynamics in operation and maintenance of various mechanisms, machines, and equipment"

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Understand Kinematics and Dynamics of different machines and mechanisms.

b) Understand different types of Cams and their motions along with the drawing ability of Cam profiles for various motions.

c) Justify the role of Flywheel, Governor, Brakes, Bearings and Clutchesalong with selection of suitable drives in Mechanical applications.

d) Appreciate concept of balancing and vibrations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	4	70	30	25	25	150

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit,PA - Progressive Assessment; ESE - End Semester Examination.

5. SUGGESTED LIST OF EXERCISES/PRACTICALS

Sr. No.	Concerned Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. Required
1	ALL	**Preparatory Activity:** a. Interpret and write various course-relatedQuantities, SI units, and their conversions. b. Recall and write scalar and vector quantities. c. Demonstrate various mechanisms.	02
2	II	**Cam Profile:** a. Demonstrate working of any type of cam and followers. b. Prepare one sheet on construction of cam profile for given data (without offset). This should include one problem of knife-edge follower, and roller follower. c. Prepare one sheet on the construction of cam profile for given data (with offset). This should include one problem for knife-edge and another for roller follower.	04
3	III	**Demonstration of Clutches:** To demonstrate the working of plate/cone/centrifugal/diaphragm clutch.	02
4	III	**Demonstration of Brakes:** To demonstrate the working block/band/block & band/ Disc	02
5	III	**Study of Dynamometers:** To demonstrate the working of Rope Brake/Hydraulic/Eddy current dynamometer.	02
6	IV	**Demonstration of Power Transmission Systems:** a. Identify various power transmission systems by observing different machines and equipment used in the Mechanical engineering laboratory/workshop. Examples- IC Engine test rigs, Compressors, Machine tools, Elevators, etc. Sketch at least four mechanisms with labeling on each. b. Demonstrate the working of each.	02
7	V	**Demonstration of Governors:** To demonstrate the working Watt/Porter/Proell governor.	02

8	VI	**Balancing:** Prepare one sheet on balancing using graphical and analytical methods for a given data. This should include a minimum of two problems.	04
9	III, IV and V	**Tutorials:** a. Calculate at least one problem of power loss due to friction in bearings and clutches from given problems/experimental data. b. Solve at least two problems of power transmission systems by a belt drive and gear drive from given problems/ experimental data. c. Calculate and prepare at least one turning moment diagram from given problems/experimental data. d. Calculate the mass of the flywheel from given problems/ experimental data. Note: Teachers will provide the data for tutorial problems well in advance to the students. (Within two weeks of the commencement of the semester) So that the students can complete the numerical problems timely and submit the solutions simultaneously. Teachers will solve the given problem/data in the lab if needed in this duration.	02
10	ALL	**Mini Project and Presentation:** a. Compile information from the internet related to various mechanisms/elements like piston, crank, connecting rod, cam, clutch, brake, flywheel, governor, or animation of mechanism, etc. along with functions of each. b. Select any one mechanism (preferably that which is NOT part of the syllabus) from mechanical laboratory/workshop/real life. Sketch the same. Take a photograph of the same. Also, record the movie of its working. c. Prepare any simple model of a subject-related mechanism. This has to be proposed by the student/sand has to be approved by the teacher. d. Present that detail of selected simple model in abovepoint C with a PowerPoint presentation. This has to include: i. Compile and synchronize the information. ii. Explain the mechanism selected at b above. Use photographs and movie recordings. iii. Explain the working of the model prepared at cabove. iv. Photographs/movies of students working on aproject. e. Present student activities also	06

11	ALL	**Student Activities & Report presentation** a. Select any machine tool's mechanism available in the institute's workshop and perform the following activity: • Measuring dimensions of different links of a given shaper machine/any machine • Sketching • Labelling the sketch b. List the mechanisms which you are using in your day-to-day life. Sketch any three from these and explain in brief. c. Identify the type of clutches used in different automobiles and explain how it works. d. Identify the type of brakes used in different automobiles and bicycles. Explain how it works. e. Write the names of the five mechanical power transmissions you have seen in your daily life. f. Choose any vehicle and tell what kind of brakes it has and give a brief description of how it works. g. Make a note of that 'Is there "friction" in your routine?' and Justify your viewpoint.	-
		Total Hours	28

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Theory of Machine practicals need following Lab Equipment

- Cam Analysis Apparatus.
- Journal Bearing Apparatus.
- Setups to show different modes of transmissions
- Universal Governor apparatus
- Rope Brake and Dynamometer.
- Epicyclic Gear Train Apparatus.
- Working / Wooden / Thermocol Models & Mechanisms of:
    1. Kinematic links and pairs.
    2. Single slider-crank.
    3. Four bar chain.
    4. Types of cams, followers, and cam/follower arrangements.
    5. Friction bearing- all types.
    6. Dynamometers - all types.
    7. Friction clutches - all types.
    8. Friction brakes - all types.
    9. Rope/belt – All types of flat and Vs (ve).
    10. Gear trains - all types. (Simple, compound, reverted, epicyclical).
    11. Balancing machines -Revolving masses.
    12. Steam engine, Internal combustion engine.

13. Governors - all types.
14. Vibration -spring and mass model.
15. Any machine having a flywheel.

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
C) Vision of finding faults in defective machines and different modes of maintenance for shop floor.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level of Revised Bloom's taxonomy that is formulated for development of the COs and competency. If required, more such higher level could be included by the course teacher to focus on attainment of COs and competency.

Unit Nos.	Major Learning Outcomes /Unit Outcomes	Topics and Sub-topics
Unit I **Motions & Mechanisms**	1a. Define various terms related to mechanisms. 1b. Explain different Inversions of Mechanism. 1c. Explain the construction and working of various mechanisms. 1d. Understand various terms and methods related to velocity and acceleration diagrams.	1.1 Theory of machines: Introduction, need, scope and importance in design and analysis, basic terminology that has already been studied in Engineering Mechanics. 1.2 Kinematics of Machines: Definition of Kinematics, Dynamics, Statics, Kinetics, Kinematic link, Kinematic pair, and its types, constrained motion and its types, Kinematic chain and its types, Mechanism, inversion, machine, and structure. 1.3 Inversions of four-bar chain, Single Slider Crank chain and Double Slider Crank Chain. 1.4 Concept of velocity and acceleration of a point on link by relative velocity method in four-bar chain and single slider crank mechanism (without numerical).

Unit– II **Cams and Followers**	2a. Define the terms related to Cam and followers. 2b. Classify Cams and Followers. 2c. Draw cam profile as per the given problems.	2.1 Concept, definition and application of Cams and Followers. 2.2 Classification of Cams and Followers. 2.3 Different follower motions and their displacement diagrams like Uniform velocity, Simple harmonic motion (SHM), Uniform acceleration and retardation. 2.4 Drawing of a profile of radial cam with a knife-edge, roller & flat-faced follower with and without offset with reciprocating motion (Graphical method).
Unit– III **Bearings, Clutches, Brake & Dynamometer**	3a. Differentiate between uniform pressure and uniform wear theories. 3b. Explain construction and working of various thrust bearing 3c. Explain construction and working of various clutches. 3d. Calculate torque and power lost in friction in bearing & clutch. 3e. Differentiate between brake sand dynamometers. 3f. Construction and working of various brakes and dynamometers.	3.1 Concept, definition, basic terminology of friction, types and application of friction. 3.2 Uniform pressure and Uniform wear theories. 3.3 Types of thrust bearing, Torque and Power lost in i) Flat pivot, ii) Conical pivot, v) single collar v) muti-collar bearing and it's numerical. 3.4 Function of Clutch and its application, Construction and working of i) Single plate clutch, ii) multi-plate clutch, iii) Centrifugal Clutch iv) Cone clutch v) Diaphragm clutch. (Simple numerical on single and multi-plate clutch) 3.5 Function of brake and its application, Construction and working of i) block brake ii) band brake iii) Band & block brake iv) internal expanding shoe brake v) disc brake (without numerical). 3.6 Dynamometer- Function, Construction and working of i) Rope Brake, ii) Hydraulic iii) Eddy current.

Unit– IV Power Transmission	4a. Explain the need and modes of power transmission. 4b. Calculate velocity ratio, belt tensions, slip, angle of lap, and power transmitted in belt drives. 4c. Calculate the train ratio for the given gear drives. 4d. Select suitable drives for the given application withjustification.	4.1 Concept need and types of power transmission. 4.2 Types of Drives-Belt, Chain, Rope, Gear and their comparison with applications, advantages & limitations. 4.3 Flat belt, V-belt & its applications, material, angle of lap, belt length. Slip and Creep. Determination of velocity ratio, the ratio of tight side and slack side tension, centrifugal tension and initial tension, condition for maximum power transmission (Numerical on belt drives) 4.4 Rope Drives- types; application; Advantages & limitations of steel ropes 4.5 Chain Drives- Advantages & disadvantages; Selection of chain & sprocket wheels 4.6 Gear Drives- Classification of Gears - Nomenclature of a gear - explanation and applications of spur, helical and bevel gears, worm and worm wheel, rack and pinion; types of gear trains; their selection for different applications. 4.7 Train value & Speed ratio for Simple, Compound, and Riveted gear trains using spur gears (Numerical of gear drive for finding Speed ratio or Train ratio excluding epicyclic gear train).
Unit- V Flywheel and Governors	5a. Construct a Turning moment diagram. 5b. Calculate the energy fluctuation and variation in speed of the Flywheel. 5c. Demonstrate the working of different types of Governors. Differentiate the working of Flywheel and Governor.	5.1 Flywheel- Concept, function and application of flywheel with the help of turning moment diagram for Single cylinder double acting steam engine, Single cylinder 4 -Stroke I.C. Engine, Co-efficient of fluctuation of energy, Co-efficient of fluctuation of speed, Energy stored in a Flywheel and its significance. Simple numerical. 5.2 Governor- Concept, function and application & terminology of Governors. Types, Explanation of Watt, Porter, Proell. 5.3 Comparison between Flywheel and Governor.

Unit- VI Balancing and Vibrations	6a. Calculate balancing mass and its position for masses revolvingin the same plane. 6b. Identify different types of vibration, its causes and remedies.	6.1 Concepts and types of balancing. 6.2 Effects of unbalanced masses. 6.3 Balancing of single rotating mass. Analytical and graphical method for balancing of several masses revolving in the same plane. 6.4 Concept, types and terminology used in vibration, causes of vibrations in machines, their harmful effects and remedies.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hrs.	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I.	Motions & Mechanisms	9	6	8	0	14
II.	Cams and Followers	5	2	0	7	9
III.	Bearings, Clutches, Brake & Dynamometer	11	2	6	8	16
IV.	Power transmission	9	2	5	8	15
V.	Flywheel and Governors	5	2	2	4	8
VI.	Balancing and Vibrations	3	2	2	4	8
	Total	42	16	23	31	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: Above table provides general guidelines to assist students in their learning. For teachers to teach and for question paper designers/setters to formulate test items/questions to assess the attainments. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from the above table.

Recommendation / General Notes:

- If only one mid-sem test is the part of continuous evaluation system, Examiner is free to decide the topics for the exam. But it is recommended to cover atleast 65 % of the CO's / Topics in the mid test exam.
- Ask the questions from each topic as per Bloom's taxonomy weightage marks. Numerical questions are to be asked as per the instructions of the syllabus only. Optional questions must be asked from the same topic / unit with consideration of same Bloom's taxonomy's level (RUA). Each question must be mapped with their UOs (Unit Outcomes) COs (Course outcomes), and Bloom taxonomy in Mid sem exam. A sample is provided here for the convenience of the teacher.

Question No.	Questions	Marks	UOs	COs	BTL
Q-1					

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, the following are the suggested student-related ***co-curricular*** activities that can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct the following activities in a group and prepare reports of each activity. They should also collect/record physical evidence for their (student's) portfolio which will be useful for their placement interviews:

a) Charts can be prepared.
b) A short report on any topic given by concerned faculty
c) Small groups of students can be formed for assigned work. Assigned work should be such that it encompasses market survey, Model making, Powerpoint presentation, time management... etc.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

Unit	Unit Name	Strategies
I	Motions & Mechanisms	Model, Education charts & videos, and Real-life examples. Demonstration of real industrial parts used in different devices, Movies/ Animations.
II	Cam and cam profile	Demonstration of cams, Movies/Animations.
III	Bearings, Clutches, Brakes,and dynamometers	Model, Education charts & videos, and Real-life examples. Demonstration of real industrial parts used in different devices, Movies/ Animations.
IV	Power transmission	Demonstration of real industrial parts, Movies/Animations, and Models of different power transmission elements
V	Flywheel and Governors	Industrial visits, Animations/movies, Models of different types of governors.
VI	Balancing and vibrations	Industrial visits, Animations/movies.

These are sample strategies, which the teacher can use to accelerate the attainment of thevarious outcomes in this course:
Massive open online courses (MOOCs) may be used to teach various topics/sub topics
Guide the student(s) in undertaking mini-projects.

12. SUGGESTED LEARNING RESOURCES

Sr. No.	Author	Title of Books	Publication
1.	Jagdish Lal	Theory of Machines	Metropolitan book New Delhi.
2.	Abdulla Shariff	Theory of Machines	Dhanpatray and Sons, New Delhi
3.	S S Ratan	Theory of Machines	Tata McGraw Hill New Delhi
4	A Ghosh & A K Malik	Theory of Machines	East-West Press (Pvt) Ltd. New Delhi
5.	Thomas Bevan	Theory of Machines	C S B Publishers and distributors
6.	Joseph Edward Shigley	Theory of Machines	McGraw Hill
7.	P L Bellaney	Theory of Machines	Khanna Publications, New Delhi
8.	Sadhu Singh	Theory of Machines	Pearson Education, India
9.	R S Khurmi & J K Gupta	Theory of Machines	S Chand, New Delhi
10.	Gordon R. Pennock & Joseph E. Shigley John J. Uicker	Theory of Machine and Mechanisms	Oxford University Press
11.	Dr. V. P. Singh	Theory of Machines	Dhanpat Rai Publishing Co Pvt Ltd

13. LIST OF SOFTWARE/LEARNING WEBSITES

- https://nptel.ac.in/courses/112106270
- https://nptel.ac.in/courses/112104121
- https://nptel.ac.in/courses/112103108
- https://youtu.be/ASIl3HWTT4U
- https://youtu.be/MAuVDB-G-HQ
- https://youtu.be/ApuBEn2zct8
- https://youtu.be/SJGFX1Nub1A
- https://youtu.be/devo3kdSPQY
- https://youtu.be/HY_PjmHRxuE
- https://youtu.be/6DL0j0eKD8Y
- https://youtu.be/lqo0_StXf4M
- https://youtu.be/m4UmBbS7mfI
- https://youtu.be/uwZGtFRtGoU
- https://youtu.be/zDRc01bD6a8
- https://youtu.be/uW1CvgfJuEg
- https://youtu.be/Ibs10c9FX0M
- https://youtu.be/j6woGQdUPFs
- https://youtu.be/u5nwkm5IbqY
- https://youtu.be/LmYhzHnMH9o

14. PO - COMPETENCY - CO MAPPING

Semester III	THEORY OF MACHINES & MECHANISMS						
	POs						
Competency & Course Outcomes -Cos (concerned Units)	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Understand Kinematics and Dynamics of different machines and mechanisms. (Unit No I)	3	1				1	2
Understand different types of Cams and their motions along with the drawing ability of Cam profiles for various motions. (Unit No II)	3	3				1	3
Justify the role of Flywheel, Governor, Brakes, Bearings and Clutches along with selection of suitable drives in Mechanical applications. (Unit No III, IV & V)	3	3		2		1	3
Appreciate concept of balancing and vibrations. (Unit No VI)	3	3	2	2		1	3

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE GTU Resource Persons:

Sr. No	Name and Designation	Institute	Contact No.	Email
1	Prof. G R Khunt Sr Lecturer in Mech Engg. Dept	R C Technical Institute SOLA, Ahmedabad.	8128291616	grkhunt@gmail.com
2	Dr. Mihir T. Patel Lect. in Mech Engg. Dept.	B & B Institute of Technology, V V Nagar	9426033823	mtpatel@bbit.ac.in

3	Prof. Ravikumar D Gujarati Lect. in Mech Engg. Dept.	Government Polytechnic, Porbandar	9925267725	ravi009.4ever@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (G.T.U.)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Engineering Thermodynamics
(Course Code: 4331902)

Diploma programs in which this course is offered	Semester in which offered
Mechanical Engineering , Mechatronics Engineering, Marine Engineering	Third

1. RATIONALE:

Thermodynamics is a branch of science that deals with energy transformations and are primarily concerned with the two forms of energy heat and work. The energy transformations are governed by the various laws of thermodynamics known as zero, first, second and third laws. These laws were deducted from experimental observations and logical reasoning. Extensive applications of thermodynamics can be found in fields ranging from refrigeration and air-conditioning to aerospace. Its principles are used to design energy converting devices, automobile engines, steam and gas turbines, power plants, compressors, HVAC, alternators, propulsion systems of aircraft and rockets, etc. Thus, every student of Diploma Mechanical Engineering should have a fundamental knowledge of thiscourse. It is a pre-requisite course for many courses of Thermal Engineering in higher semesters.

2. COMPETENCY:

The course should be taught in such a way that it can develop the necessary skills to bridge the gap between theoretical knowledge and its practical application. The students achieve the following competencies after completion of this course:

- **Apply fundamental concepts, laws and principles of thermodynamics on various thermal Devices/systems.**

3. COURSE OUTCOMES (COs)

1. Identify thermodynamic properties and systems by interpreting the basic concepts of thermodynamics.

2. Apply various thermodynamic laws and gas laws to thermal systems.
3. Calculate various parameters of different thermodynamic processes and cycles using P-V and T-s diagrams.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	0	0	100

(*) out of 30 marks under the component of theory CA, 10 marks are allotted for the assessment of the micro-project to facilitate the integration of COs. The remaining 20 marks would be the average of marks of the 2 mid-semester exams to be taken during the semester for assessing the attainment of the cognitive domain. UOs are required for the attainment of the COs.

*Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **E.S.E.** -End Semester Examination.*

5. UNDERPINNING THEORY

The primary underpinning theory is below based on the higher level UOs of the *Revised Bloom's taxonomy* formulated for developing the COs and competency. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit–I Basic Concepts of Thermodynamics	1.a Illustrate various terms related to thermodynamics. 1.b Identify thermodynamic properties with appropriate usages. 1.c Describe a zeroth law of thermodynamics.	1.1 Introduction and applications of Engineering thermodynamics. 1.2 Basic thermodynamic Concepts. - State, System, Boundary and Surroundings. - Types of Systems and boundaries with examples. - Thermodynamic properties, their units and classifications. 1.3 Energy, Heat, Work, Power and its simple numericals. 1.4 Thermodynamic equilibrium. 1.5 Thermodynamic Process and Cycle 1.6 Zeroth law of thermodynamics and its application.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit –II First Law of Thermodynamics	2.a Describe the first law of thermodynamics. 2.b Apply the first law of thermodynamics to real-life situations. 2,c Solve various numerical related to the first law of thermodynamics.	2.1 Law of conservation of energy. 2.2 Heat and work relation with Joule's Experiment. 2.3 Statement of the first law of thermodynamics. 2.4 Application of the firstlaw of thermodynamics: - Closed system (Non-flowProcesses). - Open system (Flow Processes). 2.5 Definition of the flow process, control volume and flow work. 2.6 Steady and unsteady flow processes. 2.7 Steady Flow Energy Equations (SFEE) and its applications in Nozzle, Diffuser, Boiler, Turbine, Compressor, Condenser, and throttling devices. 2.8Simple numerical examples based on the above. 2.9 Identify the applications of First law of thermodynamics for green environment.
Unit–III Second Law of Thermodynamics	3.a Describe the second law of thermodynamics. 3.b Apply the second law of thermodynamics to real-life situations. 3.c Solve various numerical related thermal efficiency &C.O.P.. 3.d Interpret the entropy, its equations with the unit.	3.1 Limitations of the first law of thermodynamics. 3.2 Concept of heat source, heat sink, heat engine, heat pump, refrigerator and simple numerical on thermal efficiency and COP (Coefficient of Performance) respectively. 3.3 Statement of the second law of thermodynamics: - Kelvin Planck Statement - Clausius Statement 3.4 Applications of the second law of thermodynamics.Also identify its applications for green environment. 3.5 Concept of reversibility and irreversibility. List of irreversibility only. 3.6 Definition of Entropy and its T-ds equation. (Without Derivations) 3.7 Statement of the third law of thermodynamics.
Unit-IV Ideal Gases and Thermodynamic Processes	4.a Describe various ideal gas laws. 4.b Derive the relationship of specific heats.	4.1 Concept of Ideal gas. 4.2 Boyle's law, Charle's law and Gay-Lussac law for ideal gases. 4.3 Characteristic gas equation and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4.c Identify various thermodynamic processes. 4.d Calculate the amount of heat transfer, work transfer & internal energy associated with the process. 4.e Plot various thermodynamic processes on P-V and T-S diagrams. 4.f Solve various numerical.	Universal gas constant, Specific heats of gas and their relationship. 4.4 Thermodynamic Processes, its representation on P-V (Pressure-Volume) and T-S (Temperature-Entropy) diagram: - Constant Volume Process - Constant Pressure Process - Constant Temperature Process - Adiabatic Process - Polytropic Process - Throttling Process 4.5 Equations of P-V-T relationship, work transfer, heat transfer and internal energy of the above processes. (Without derivations) 4.6 Simple numerical based on the above.
Unit–V Thermodynamic Cycles	5.a Identify thermodynamic processes in a cycle. 5.b Plot various cycles on P-V and T-s diagram. 5.c Solve various numerical related to power-producing cycles.	5.1 Classifications of thermodynamic cycle. 5.2 Carnot cycle and its representation on P-V and T-s diagram. 5.3 Derivation of thermal efficiency of Carnot cycle and simple numerical based on it. 5.4 Concept of air standard efficiency. 5.5 Otto, Diesel, Dual and Brayton cycle (Without derivation) 5.6 Representation on P-V & T-s diagram, Equation of air standard efficiency (Without derivations) and simple examples. 5.7 Representation of Reversed Carnot cycle and Reversed Brayton cycle on P-V and T-s diagram respectively.

6. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic Concepts of Thermodynamics	8	05	04	04	13
II	First Law of Thermodynamics	09	04	05	06	15
III	Second Law of Thermodynamics	05	02	03	03	8

IV	Ideal Gases and Thermodynamic Processes	10	04	06	07	17
V	Thermodynamic Cycles	10	04	06	07	17
	Total	**42**	**19**	**24**	**27**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note: This specification table gives general guidelines to assist studentsin their learning, and to the teachers, for question paper design and teaching methodology to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U, and A) in the question paper may slightly vary from the above table.

7. SUGGESTED STUDENT ACTIVITIES

Sr.No.	Activity.
1.	Identify and list real situations working on a:Zerothlaw of thermodynamics. b:Firstlawofthermodynamics. c:Secondlawofthermodynamics.
2.	Prepare charts of diesel, dual and gasoline cycles.Tabulate the main points of differences between them.
3.	List out the thermodynamic laws/concepts used in the Solar system. Also, Prepare technical specifications of solar rooftop at your home or nearby areas.
4.	Write the specifications of the domesticrefrigeratoravailableatyourhomeandI.C.Engineofanytwo-wheelers.Also,drawandexplainthe cycle on which domestic Refrigerator and I.C. Engine works.
5.	Presentations on "Smart Thermostat" of home appliances.
6.	Collect/ download product catalogs with the specification of various types of air compressors/ I.C.Engines /Refrigerators used in daily life.
7.	Take any thermal Device/system available in the Institute and identify it based on 1)type of system, 2) type of boundary.
8.	Prepare specification of some thermal devices/systems available in the Institute/surrounding.
9.	Give seminars on various topics learned in the course.
10.	Prepare chart on: (1) Types of system, (2) Temperature scale, (3) Types of process, (4) Types of thermodynamic cycles, and (5) Refrigeration cycle, etc.
	Interpret the relationship between different thermodynamic properties.

8. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (IF ANY)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Basic Concepts of Thermodynamics	o Real-life examples. Demonstration ofrealsystems. Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs).
II	Ideal Gases and Thermodynamic Processes	
III	First Law of Thermodynamics	
IV	Second Law of Thermodynamics	
V	Thermodynamic Cycles	

9. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to them during the semester. The teacher can assign any activity suggested in section 7 of ***"SUGGESTED STUDENT ACTIVITIES"*** according to their convenience. While designing the micro-project, it should be kept in mind that it encompasses most of the COs.It should be the application of the theoretical knowledge into some practical aspect.

10. SUGGESTED LEARNING RESOURCES

Sr. No.	TitleofBooks	Author	Publication& ISBN
1.	Engineering Thermodynamics	Yunus A. Cengel	Tata McGraw Hill 975-1-25-906256-8
2.	Thermodynamics	R.Yadav	CPH ISBN-13: 9788185444031
3.	Thermodynamics for Engineers	M.L.Mathur	Dhanpatrai & sons 81-200-0029-3
4.	Heat Engines	C.S.Shah& N.C.Pandya	Charotar Publi.House 81-85594-49-X
5.	Elements of Heat Engines Vol.I&II	R.C.Patel	AcharyaBookDepot
6.	Thermodynamics	SAAD	Prentice-Hall
7.	EngineeringThermodynamics-2nd Edition	P.K. Nag	Mc-GrawHillEducation 978-0-07-026062-7
8.	Applied Thermodynamics	R.C.Patel	AcharyaBookDepot
9.	Thermodynamics	Gupta	Pearson 9788131717950

10.	Thermodynamics	J.P. Holman	Tata Mc Graw-Hill
11.	Thermodynamics – Theory & Application	Robert Balmer	Jaico publication house
12.	Fundamentals of Thermodynamics	Sonntag, Borgnakke & Van wylen	John Wiley & sons (ASIA) PVT. LTD

11. SOFTWARE/LEARNING WEBSITES

Sr. No.	Software/Website address	Topic covered
1.	CALPHAD software	Thermodynamic modeling
2.	https://lawofthermodynamicsinfo.com/what-is-thermodynamic-system/	Basic of thermodynamics
3.	https://thermo.pressbooks.com/chapter/chapter-4/	Problems based on first law of thermodynamics
4.	https://study.com/academy/lesson/First-law-of-thermodynamics-law-of-conservation-of-energy.htm	First law of thermodynamics
5.	https://vimeo.com/94762428	First law of thermodynamics
6.	https://www.youtube.com/watch?v=OmhXb-miAhw	Thermodynamic cycles
7.	https://nptel.ac.in/courses/112/105/112105123/	All units
8.	http://www.thermofluids.net/	All units
9.	http://www.grc.nasa.gov/WWW/k-12/airplane/thermo.html	Basic concepts
10.	http://www.youtube.com/watch?v=Xb05CaG7TsQ	First law of thermodynamics

11.	http://www.youtube.com/watch?v=aAfBSJObd6Y	Ca rnot cycle
12.	http://www.youtube.com/watch?v=DHUwFuHuCdw	Secondlaw ofthermodynamics and heat engines
13.	http://www.youtube.com/watch?v=GKqG6n6nAmg	Zeroth law of thermodynamics
14.	https://www.youtube.com/watch?v=ty4F30dRdwk	Understanding entropy
15.	https://www.youtube.com/watch?v=WTtxlaeC9PY	Understanding secondlaw of thermodynamics
16.	https://www.youtube.com/watch?v=Jsnv8L7HdEk	Thermodynamic processes

12. PO-COMPETENCY-CO MAPPING

Semester II	**Engineering Thermodynamics (Course Code: 4321901)**						
	POs						
Competency & Course Outcomes	**PO1** (Basic & Discipline specific knowledge)	**PO2** (Problem Analysis)	**PO3**(Design/ development of solutions)	**PO4**(Engineering Tools, Experimentation Testing)	**PO5** (Engineering practices for society, sustainability & environment	**PO6** (Project Management)	**PO7** (Life-long learning)
Competency	Apply fundamental concepts, laws and principles of Thermodynamics on various thermal devices/systems.						
CO.1 Identify thermodynamic properties and systems by interpreting the basic concepts of thermodynamics.	3	-	-	-	-	-	2
CO.2 Apply various thermodynamic	3	2	-	-	1	-	2

laws and gas laws to thermal systems.							
CO.3 Calculate various parameters of different thermodynamic processes and cycles using P-V and T-s diagrams	3	2	1	-	-	-	-

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation ofeach CO with PO.*

13. COURSE CURRICULUM DEVELOPMENT COMMITTEE

o **GTU Resource Persons:**

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BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
Semester-III

Course Title: Manufacturing Engineering-1
(Course Code: 4331903)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mining Engineering , Mechatronics Engineering	Third Semester

1. RATIONALE

This subject of Manufacturing Engineering -1 provides knowledge and also embed skill to students to produce various products using metal forming, metal casting, metal joining and plastic moulding processes. Manufacturing Engineer is a key person in engineering industries and he/she should have knowledge and associated skill of manufacturing processes. Hence emphasis is given on skill development by adding practices in all topics in this Manufacturing Engineering-I subject. Manufacturing processes are the most important element in any engineering industry. Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

Metal-forming processes, Casting processes, Plastic moulding process and Welding processes are essential components of many industries such as the automotive industry, machines and equipment industry, construction industry, aviation industry, and more.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Produce the job as per given specification by selecting and applying appropriate manufacturing processes like Casting, Forming, Joining, using safe working procedures.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Classify various mechanical manufacturing processes.
b) Select appropriate metal working processes to produce mechanical components.
c) Select appropriate casting processes to produce mechanical components.
d) Select moulding methods suitable for non-metal components.
e) Select metal joining methods for various applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Preparatory activity a. Recall Mechanical properties of material. b. Safety Practices to be followed in metal forming, casting, non-metal moulding and joining processes.	ALL	02
2	Prepare a job using hot/cold forging/hot smithy process. This includes cutting of raw material and preparation of pre forged parts.	II	06
3	Prepare a pattern for the given components/drawings, considering pattern allowance.	III	06
4	Prepare a mould using a prepared pattern, andmoulding sand. Also pour molten metal and get the casting. (Use wax in place of molten metal for the purpose of demonstration.)	III	06
5	Prepare a job using arc welding. This includes cutting of raw material and edge preparation.	V	06
6	Prepare a job using gas welding. This includes cutting of raw material and preparation of pre-weld parts	V	04
7	Prepare a job using spot/seam resistance welding. This also includes cutting of raw material and preparation of pre-weld parts.	V	04
8	Prepare two jobs, one using soldering and another using brazing.	V	04
9	Study of Non- metal moulding processes. (Demonstration of processes shall be carried out during industrial visit)	IV	02
10	Visitnearby Rolling mill/Hot-Cold material processes, foundry, plastic processing industry, fabrication industry and prepare a two-page report comprises of types of items produced, quantities, different sections, equipments used with specification and consumables.	ALL	–

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
11	Micro Project as suggested in section no. 4	ALL	14
12	SCHOOL WITHIN SCHOOL: Each student will present and will prepare report on: a. His/her observation for the jobs made. b. His/her experience during industrial visits. Process parameters and their effects.	ALL	02
	Total hours		**56 Hrs.**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify components (Knowledge)	10
2	Prepare experimental setup. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Pattern Making: 1. Wood cutting planer machine/Wood jack plane 2. Carpentry vice 3. Flat file 4. Hammer 5. Steel rule 6. Right angle 7. Saw	3
2	Molding 1. Cope and drag Boxes 2. Molding sand with additives and binder 3. Vent wire 4. Furnace or Oven	4

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
	5. Consumable (Wax)	
3	Smith forging 1. Anvil 2. Furnace 3. Hammer 4. Tong 5. Steel rule 6. Air blower 7. Swage block	2
4	Spot/Resistance welding 1. Spot welding machine 2. Plier cutter 3. Hammer 4. Steel rule 5. Anvil	7
5	Arc welding 1. Arc welding Machine with electrode holder 2. Tong 3. Chipping hammer 4. Wire brush 5. Hand gloves 6. Hand screen 7. Safety goggles	5
6	Gas welding 1. Oxy acetylene gas cylinders with regulators 2. Welding torch 3. Tong 4. Chipping Hammer 5. Steel rule 6. Hand gloves 7. Safety goggles	6
7	Soldering/ Brazing a. Brazing torch ii. Consumables iii. Tong iv. Hammer v. Anvil vi. Wire brush vii. Soldering iron & lead wire	8

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices while using equipment.
c) Realize the importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **INTRODUCTION**	1.a Define Manufacturing processes. 1.b Classify various Manufacturing processes. 1.c Define various mechanical properties of material.	1.1 Introduction of mechanical manufacturing processes. 1.2 Classification of various Manufacturing processes. 1.3 Recall mechanical properties of material.
Unit – II **METAL FORMING PROCESS**	2.a Recall residual stresses and recrystallization temperature. 2.b Compare the principles of hot and cold working Processes. 2.c Identify various metal working processes. 2.d Select the appropriate metal working process to produce a given mechanical component.	2.1 Effect of residual stresses and recrystallization temperature on metals. 2.2 Concept and differences of hot and cold working processes. 2.3 Classification of metal forming processes. 2.4 Types, working principle, equipments used and applications of Forging, Rolling, Drawing, Extrusion. 2.5Press working operations 2.6 Safety Precautions in metal forming processes.
Unit – III **Metal casting processes**	3.a Identify various metal casting processes. 3.b Calculate pattern allowances. 3.c Interpret the standard color coding on pattern.	3.1 Basic concept, advantages, Limitations and Applications of Casting process. 3.2 Pattern: i. Definition, Types and materials of construction.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	3.d Select appropriate casting processes to produce mechanical components. 3.e Identify casting defects, their causes and suggest remedies.	ii. Allowances, their needs and normal values. iii. Drawings and color codes. iv. Making process. v. Applications. 3.3 Cores: i. Need. ii. Types 3.4 Molding sand: i. Sand properties ii. Types iii. Sand binders 3.5 Recovery of sand for control of environment pollution. 3.6 Mould making equipments, and their applications. 3.7 Moulding processes. 3.8 Furnace: Types, working and applications. i. Crucible furnace ii. Pit furnace iii. Electric furnace iv. Cupola 3.9 Casting processes: basic principle, working, and applications. i. Centrifugal. ii. Die. iii.Investment. 3.10 Casting defects -types, causes, effects and remedies. 3.11Safety precautions in Casting processes. 3.12 Pollution prevention in metal casting industry.
Unit– IV **Non-metal moulding processes**	4.a Suggest appropriate moulding method suitable for a given non-metal component. 4.b Classify plastic materials.	4.1 Construction, Working and Applications. i. Injection moulding process. ii. Blow moulding process. iii. Extrusion moulding process. 4.2 Plastic materials: Types (commonly used i.e PP, HDPE, LDPE, PS, PCE, ABS etc.), applications. 4.3 Construction of Injection mould. 4.4 Safety precautions in plastic processing.
Unit– V **Metal Joining Processes**	5.a Explain different welding processes. 5.b Identify the area of applications of a particular joining	5.1 Classification of metal joining processes. 5.2: Working principle, setup sketch, equipment and consumables, Applications, advantages, limitations of following metal joining processes.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	process. 5.c Select metal joining methods for various applications. 5.d Practice standard safety norms during any joining process.	(i) Arc welding: Metal Arc Welding, MIG (Metal Inert Gas), TIG (Tungsten Inert Gas), Submerged arc welding. (ii) Gas welding: Oxy-acetylene Gas welding, cutting, Types of flames. (iii) Resistance welding: spot, seam, Projection welding. (iv) Thermit welding 5.3 Welding defects -types, causes, effects and remedies. 5.4 Arc welding Electrodes selection. 5.5 Types of weld joints 5.6 Soldering: Procedure and Application 5.7 Brazing: Procedure and Application 5.8 Comparison of Welding, Brazing and Soldering. 5.9 Safety precautions in metal joining processes.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Introduction**	**02**	**0**	**4**	**0**	**04**
II	**Metal Forming Processes**	**12**	**4**	**12**	**4**	**20**
III	**Metal Casting Processes**	**12**	**4**	**12**	**4**	**20**
IV	**Non Metal Moulding Processes**	**04**	**0**	**3**	**3**	**06**
V	**Metal Joining Processes**	**12**	**4**	**12**	**4**	**20**
Total		**42**	**12**	**43**	**15**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.* **At Least 3 CO'S should be met to achieve in the Mid Sem Exam.**

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

Sr. No.	Activity.
1	Select four industrial components (approved by teacher) and list various methods of manufacturing used to produce these components.
2	Select at least two components which are made by casting only. Also state the type of casting method used.
3	Prepare a list of household items which are prepared by joining processes.
4	Prepare a list of plastic items which are produced using different types of molding methods. Name the process used.
5	Prepare a list of industries/workshops in the nearby area which are producing components by casting/forming/moulding/Joining.
6	Identify the types of manufacturing processes used in making the main component of a car engine.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** : Use different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contributions in the project work and give a

seminar presentation of it before submission. The duration of the micro-project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a small useful product (approved by teacher) like flower pot / stool / table / bench / laboratory equipment/set-up utilizing laboratory resources.
b) Using Drafting software, prepare a pattern drawing/forged component drawing.
c) Survey/Visit nearby vendor, prepare sample specifications of manual metal arc welding machine, injection moulding machine, forging and casting equipments.
d) Maintenance of available infrastructure related to fabrication.i.e., benches, stool, table, doors, grills, solar structure.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Workshop Technology I & II	J. A. Schley	Tata McGraw Hill Education
2	Workshop Technology I & II	Raghuvanshi	Dhanpat Rai and Sons
3	Workshop Technology I, II &	W. A. J. Chapman	Arnold
4	Manufacturing Processes	M. L. Bagman	Wiley India
5	Production Technology	R.K. Jain and S.C. Gupta	Khanna publication
6	Welding Engineering	B.E. Rossi	Jefferson Publications
7	Audles Welding Guide	F.D. Graham	Wiley India
8	Foundry Engineering	P.L. Jain	Tata McGraw Hill Education
9	Principle of Foundry	Jain & Gupta	National Book Trust, India
10	Manufacturing Processes	S.E. Rusinoft	Times of India Press
11	Production Technology	H.H. Marshall	Machinery Publishing Company
12	Production Technology	HMT	Tata McGraw Hill Education
13	Elements of Workshop Technology (Vol I & II)	Hajra Chowdhary & Bhattacharya	Media Promoters

14. SOFTWARE/LEARNING WEBSITES

a. www.youtube.com/watch?v=k6iODHla6qY
b. http://web.iitd.ac.in/~pmpandey/MEL120_html/Metal%20Forming%20Processes.pdf
c. http://thelibraryofmanufacturing.com/forming_basics.html
d. http://www3.nd.edu/~manufact/MPEM%20pdf_files/Ch07.pdf
e. www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/3_forming.pdf
f. www.youtube.com/watch?v=HkjdMdp9KVU
g. http://www-old.me.gatech.edu/jonathan.colton/me4210/casting.pdf
h. http://www.mccannsales.com/book/sandcasting.pdf
i. http://me.emu.edu.tr/me364/2.pdf
j. http://www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/8_joining.pdf
k. http://www.tech.plym.ac.uk/sme/mats116/Materialsjoiningprocesseslecturenotes_docx.pdf
l. http://www.aws.org/w/a/
m. www.youtube.com/watch?v=H3Qb9I03FCk
n. www.youtube.com/watch?v=JqFp5kCeTA0
o. www.youtube.com/watch?v=7F0ypF6IdrU
p. http://www.flamingfurnace.com/
q. http://www.sme.org
r. http://www.youtube.com/watch?v=IrcNSgLZuFs(Metal Casting)
s. http://www.youtube.com/watch?v=Yk1JOYzwRP4(Loose piece Pattern)
t. http://www.youtube.com/watch?v=khEvhjlh_SM (Foundry Pattern making)
u. http://www.youtube.com/watch?v=f7FXtnXVqzY(Aluminium Casting)
v. http://www.youtube.com/watch?v=dOw624I9FDQ(Investment Casting)
w. w: http://www.youtube.com/watch?v=bzSSfBgkWfc&NR=1&feature=endscreen(Hot Chamber Die Casting Process)
x. http://www.youtube.com/watch?v=pTTap4WiEAU(Gravity Die Casting)
y. http://www.youtube.com/watch?v=eUthHS3MTdA(Plastic Injection Moulding)
z. http://www.youtube.com/watch?v=6xnKmt_gsLs(Hot Rolling)
aa. http://www.youtube.com/watch?v=9MU0vSN_w-A(Cold roll forming)
bb. http://www.youtube.com/user/IGEJohannesen?feature=watch(Channel For welding videos)
cc. http://www.youtube.com/watch?v=SDJdiNeDXto(Introduction to Welding)
dd. http://www.youtube.com/watch?v=CJ42scaWFnw(Brazing video)

15. PO-COMPETENCY-CO MAPPING

Semester II	Manufacturing Engineering-1 (Course Code:)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Produce the job as per given specifications by selecting and applying appropriate manufacturing processes like Casting, Forming and Joining using safe working procedures.						
(a) Classify various mechanical manufacturing processes.	3						
(b) Select appropriate metal working processes to produce mechanical components.	3	2		3	2		2
(c) Select appropriate casting processes to produce mechanical components.	3	2		3	2		2
(d) Select moulding methods suitable for non metal components.	3	2			2		2
(e) Select metal joining methods for various applications.	3	2		3	2		2

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Strength of Materials
(Course Code: 4331904)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering, Marine Engineering	Third Semester

1. RATIONALE

After learning Mechanics of rigid bodies in second semester as course Engineering Mechanics, students will now learn the fundamentals of Mechanics of deformable bodies in this course as Strength of Materials. This course deals with this behavior of solid materials by studying the distribution of internal forces, the stability and deformation of the materials under the applied loads or forces. To choose proper material by keeping its strength and suitability in mind is very important stage in production and design level in the field of Mechanical Engineering. Hence the course is prerequisite for understanding principles of machine design at various levels.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use the principle of Mechanics of deformable bodies to solve broad-based engineering related problems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Analyse structural behaviour of various materials under axial loading.
b) Determine moment of inertia of a symmetrical and asymmetrical section about a given axis.
c) Draw and Interpret shear force and bending moment diagrams and determine the bending and shear stresses in beams for various types and loading conditions.
d) Determine slope and deflection in cantilever and simply supported beams.
e) Determine stresses in the shaft and springs under twisting moments.
f) Select suitable material(s) for given purposes in engineering**.**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	

3	0	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the subcomponents of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Conduct tension test on a given sample of mild steel and draw stress-strain curve.	I	04*
2	Determine Young's Modulus of wire of given material.	I	02*
3	Find out Compressive Strength of Cast Iron, Mild Steel, Wooden specimen with parallel & perpendicular to grains.	I	04*
4	Compute Polar Moment of Inertia of Fly Wheel.	II	02*
5	Conduct flexural test on wooden beam and find out ultimate bending stress.	III,IV	02*
6	Conduct shear test (Single and Double shear) on mild steel and cast iron specimen.	III,IV	02*
7	Find out deflection of cantilever beam for end point load and simply supported beam for central point load	V	02*
8	Conduct Torsion test on cast iron, mild steel specimen.	VI	02*
9	Verify stiffness of springs in series and parallel	VI	02*
10	Determine Izod impact value and Charpy impact value of given materials.	VII	04*
11	Determine Brinell and Rockwell hardness of given materials.	VII	02*
	Total hours		**28 Hrs.**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify components	10
2	Prepare experimental setup.	20
3	Operate the equipment setup.	20
4	Follow safe practices .	10

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
5	Record observations correctly.	20
6	Interpret the result and conclude.	20
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practicals in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Universal Testing Machine with beam and shear attachment.	1,5&6
2	Searl's apparatus to find Young's modulus of wire	2
3	Compression Testing Machine.	3
5	Fly Wheel for polar moment of inertia	4
6	Deflection of beam apparatus	7
7	Torsion Testing Machine	8
8	Spring stiffness testing apparatus.	9
4	Izod & Charpy Impact Test Apparatus	10
7	Brinell Hardness Testing Machine	11
8	Rockwell Hardness Testing Machine	11

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices while using equipment.
c) Realize importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Direct Stress & Strain	1a. Evaluate Material properties Under Longitudinal and Lateral Loads. 1b. Calculate stress and strain under thermal variation. 1c. Interpret stress strain curve for various material. 1d. Analyse composite & compound section for stress and strain. 1e. Compute Strain Energy under different types of loading on elements.	1.1 Direct stress, Linear strain, Elasticity, Elastic limit, Hook's law, Modulus of Elasticity or Young's modulus, Stress Strain curve for mild steel bar under tension with numerical problems. 1.2 Lateral stress and strain, Poisson's ratio, Volumetric strain, Bulk modulus, relation between three moduli and numericals. 1.3 Basics Concepts of Shear Stress , Shear Strain & Modulus of rigidity. 1.4 Concept of composite and compound section, modular ratio and numericals. 1.5 Concept of Thermal stress and strain, Thermal stresses for non-yielding and yielding condition with numericals. 1.6 Stresses due to gradual, sudden and impact load, corresponding deformation, Strain energy, Resilience, Proof resilience and Modulus of resilience with numericals.
Unit – II Moment of Inertia	2a. Locate the axis of symmetry & Centroidal axis in symmetrical & asymmetrical solid and hollow sections 2b. Apply Parallel axis theorem to determine moment of inertia, for symmetrical & asymmetrical sections about centroidal axis and any other reference axis. 2c. Apply Perpendicular axis theorem to determine Polar Moment of Inertia of a section.	2.1. Importance of Moment of Inertia. 2.2. Axis of symmetry, Centroidal axis and axis of reference. 2.3. Parallel Axis Theorem & Perpendicular Axis Theorem 2.4. Formulas to calculate Moment of Inertia of solid and hollow rectangle, square, circle, triangle shapes (without derivations). 2.5. Moment of Inertia of symmetrical and asymmetrical I-section, Channel section, T-section, Angle section, Hollow sections and Built up sections about Centroidal axis and any other reference axis using Parallel axis theorem. 2.6. Polar Moment of Inertia of solid & hollow circular sections.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit– III **S.F. & B. M. in Beam**	3a. Identify statically determinate and statically indeterminate beams. 3b. Analyse statically determinate beam for Bending Moment and Shear Force. 3c. Draw Shear Force and Bending Moment diagram for statically determinate beams. 3d. Interpret Shear Force and Bending Moment diagram of statically determinate beams.	3.1 Statically Determinate and statically indeterminate beam examples. 3.2 Concept of Bending Moment and Shear Force in beam. 3.3 Sagging and Hogging Bending Moment. Positive and Negative Shear Force. 3.4 Calculation of Bending Moment and Shear Force at various sections of beam for cantilever simply supported and overhang beam subjected to point load and/ or u.d.l. 3.5 S.F. & B.M. Diagram for above beams 3.6 Point of Contra-flexure & its importance.
Unit– IV Bending & Shear Stress in Beam	4a. Determine Bending stress at a particular section of beam using the bending equation. 4b. Draw a Bending stress distribution diagram for a particular beam section. 4c. Determine Shear stress at a particular section of beam using the shear equation. 4d. Draw a Shear stress distribution diagram for a particular beam section. 4e. Identify factors affecting Bending and Shear stress.	4.1 Concept and theory of pure bending, assumptions, Bending equation (without derivation), Section Modulus, Bending stresses and their nature, Bending stress distribution diagram. 4.2 Concept of moment of resistance and simple numerical problems using bending equation. 4.3 Shear stress equation (without derivation), relation between maximum and average, Shear stress for rectangular and circular section. 4.4 Shear stress distribution for square, rectangular, circle, hollow square, rectangular, circular, angle sections, channel section, I-section, T section. Simple numerical problems based on Shear equation.
Unit– V Slope and Deflection	5a. Differentiate between strength and stiffness of structural member. 5b. Calculate maximum slope and deflection in cantilever and simply supported beams under symmetrical loads. 5c. Identify factors affecting slope and deflection.	5.1 Concept of Slope & Deflection of beams. 5.2 Flexural rigidity and its significance. 5.3 Formulas (without derivation) of maximum slope & deflection for cantilever beams subjected to point load at free end and u.d.l. over the entire span. 5.4 Formulas (without derivation) of maximum slope & deflection for simply supported beams subjected to point load at center and u.d.l. over the entire span.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit– VI Torsion & Springs	6a. Calculate torque and power transmitted by a shaft in the given situation. 6b. Compute shear stress and angle of twist in a shaft for the given power to be transmitted. 6c. Determine the diameter of shaft for the given shear stress and angle of twist for maximum transmission of power. 6d. Analyse the Closed Coiled Helical spring spring for stresses.	6.1 Torque or turning moment or twisting moment, Angle of twist, Shear stress in shaft, strength of shafts, Polar moment of inertia, Torsional rigidity, assumptions in the theory of torsion. 6.2 Equation of Torsion (without derivation) and related numericals. 6.3 Relationship of H.P. , Torsion and RPM and related numericals 6.4 Springs: Stiffness of a spring(s)- Individual, in series and in parallel, Uses of springs, Types of springs. 6.5 Calculation of main dimensions of Closed Coiled Helical spring.
Unit– VII Mechanical Properties of Material	7a. Identify various materials used in Mechanical Engineering 7b. Evaluate different mechanical properties of materials used. 7c. Compare and select the material for their utility point of view.	7.1. Classification of engineering materials. 7.2. Physical properties of material:- Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness etc. 7.3. Testing of materials for impact value (Izod impact and charpy impact test) and hardness (Brinell and Rockwell hardness test) 7.4. Factors affecting selection of materials.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Direct Stress & Strain**	**10**	**2**	**4**	**8**	**14**
II	**Moment of Inertia**	**04**	**2**	**2**	**4**	**08**
III	**S.F. & B. M. in Beam**	**08**	**2**	**4**	**8**	**14**
IV	**Bending & Shear Stress in Beam**	**06**	**2**	**2**	**6**	**10**
V	**Slope and Deflection**	**04**	**2**	**2**	**4**	**08**
VI	**Torsion & Springs**	**06**	**2**	**2**	**6**	**10**
VII	**Mechanical Properties of Material**	**04**	**2**	**2**	**2**	**06**
Total		**42**	**14**	**18**	**38**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test*

items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Collect different situations with photographs of machine components where axial force is predominant.
b) Collect the photographs of machine component made of I-section, angle section, channel section and built-up section.
c) Collect different situations with photographs of machine components where bending moment and shear force are predominant.
d) Collect the information with photographs of machine component where check for deflection is important.
e) Collect different situations with photographs of machine components where torsion is predominant.
f) Collect different situations with photographs of machine components where impact force is predominant.
g) Collect the information of machine components where hardness and important and also collect required hardness for that.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.
g) Guide students for using data manuals.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare spreadsheet or computer program to calculate the stresses in the composite section.
b) Compare tensile strength and cost of three locally available steel bars.
c) Compare modulus of elasticity of wires of three different materials using Searle's apparatus.
d) Prepare spreadsheet or computer program to calculate the support reactions of statically determinate beams.
e) Prepare spreadsheet or computer program to calculate the bending stress and shear stress in a beam having a rectangular or circular section.
f) Prepare spreadsheet or computer program to calculate slope and deflection of simply supported beam and cantilever beam for various load cases.
g) Calculate modulus of elasticity of a material by measuring deflection of beam.
h) Prepare spreadsheet or computer program to calculate dia. of shaft for given data.
i) Measure dia. of shaft in at least three power transmitting machines and justify it.
j) Compare chart for any 5 material regarding their Mechanical properties.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Strength of Materials (Mechanics of Solids)	R.S.Khurmi N. Khurmi	S Chand Publishing (2019) ISBN: 97-893-528-339-79
2	Strength of Materials	Dr. R.K.Bansal	Laxmi Publications (P) Ltd. New Delhi (2005) ISBN: 97-881-700-814-70
3	Strength of Materials	S. Ramamrutham & R.Narayanan	Dhanpat Rai Publishing Company (2011) ISBN:97-881-874-335-45
4	Strength of Materials (Mechanics of Materials)	R.S. Laheri A.S. Laheri	S.K. Karatia & Sons, Delhi. (2010) ISBN: 97-881-857-494-40

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
5	Strength of Materials	Dr. Sadhu Singh	Khanna Publishers , New Delhi.(2018) ISBN: 97-893-810-686-18

14. SOFTWARE/LEARNING WEBSITES

a) https://nptel.ac.in/courses/105104160 (NPTEL Course :- Mechanics of Solids by IIT, Kanpur)

b) https://www.youtube.com/watch?v=GkFgysZC4Vc&list=PL27C4A6AEA552F9E6 (NPTEL Video Lectures by IIT, Kharagpur)

c) www.vlab.co.in (Virtual Lab by Ministry of Education, Government of India)

15. PO-COMPETENCY-CO MAPPING

Semester III	Strength of Materials (Course Code: 4331905)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Use the principle of Mechanics of deformable bodies to solve broad-based engineering related problems.						
Course Outcomes COa) Analyse structural behaviour of various materials under axial loading.	2	3	-	3	2	2	2
COb) Determine moment of inertia of a symmetrical and asymmetrical section about a given axis.	2	3	-	2	2	2	2
COc) Draw and Interpret shear force and bending moment	2	3	-	-	2	2	2

diagrams and determine the bending and shear stresses in beams for various types and loading conditions.							
COd) Determine slope and deflection in cantilever and simply supported beams.	2	3	-	3	2	2	2
COe) Determine stresses in the shaft and springs under twisting moments.	2	3	-	3	2	2	2
COf) Select suitable material(s) for given purposes in engineering.	2	3	-	2	2	2	2

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Shri P.V. Rayjada, HOD Applied Mechanics	G.P.Rajkot	9824281646	satwikpr@gmail.com
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4.	Shri S.M.Kondhiya, Sr. Lecturer Applied Mechanics	G.P. Rajkot	9825764005	sharadkondhiya@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Computer Aided Machine Drawing Practice
(Course Code: 4331905)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering & Mechatronics Engineering	Third

1. RATIONALE

The students of the mechanical engineering programme are mainly involved in drafting, manufacturing, inspection, and planning activities (such as preparing process sheets preparing the bill of materials (BOM), etc.) in industries. For all such activities, a reference document is the drawing of the component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for the production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms, and standards generally used in industries.

The development of sketching ability also strengthens effective engineering communication& presentation. Nowadays the market-driven economy demands frequent changes in product design to suit customer needs. With the introduction of computers, the task of incorporating frequent changes as per requirement is becoming simpler. This course has been introduced at the Diploma level in order to develop the skills in the student so that they can generate various digital production drawings as required in the industry using various CAD software.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Prepare production drawings using computer and relevant software and following standards codes and norms.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Interpret and Draw, edit and modify 2D Production drawing/Machine Drawing of mechanical Components
CO-2	Create detailed drawings of various machine parts with sectional or plain elevations, plans, side views and dimensioning with bill of materials using (BOM) using CAD software like AutoCAD.
CO-3	Prepare a report of mechanical components with Sketch of components at each step with dimensions and sequence of commands with name, options and values.
C0-4	Create various parametric drawings of mechanical components with company logo, tolerances and level of surface finish by using latest parametric CAD software.
CO-5	Create given project drawings with orthographic projection, bill of material and report using CAD software.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate the attainment of COs holistically, as there is no theory ESE.

***Legends: L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	A. Prepare orthographic production drawings of 3-4 mechanical components (Minimum two should be based on real industrial components selected by student as student activity and approved by teacher) each made up of minimum 5-6 manufacturing operations using AutoCAD. B. Prepare report on following. i. Select at least two physical-mechanical components (approved by teacher). Sketch them with dimensions. ii. Write steps to prepare each drawing using AutoCAD Steps must include followings. i. Sketch of components at each step with dimensions. ii. Sequence of commands with name, options and values.	1	06
2	A. Machine drawing practice using Auto CAD: Detailed drawings of following machine parts are to be given to the students to assemble and draw the sectional or plain elevations, plans and side views with dimensioning and bill of materials using cad software (any 10 of the following). 1) Sleeve & Cotter Joint, 2) Spigot & Cotter Joint, 3) Knuckle Joint, 4) Stuffing Box, 5) Screw Jack, 6) Foot Step Bearing, 7) Universal Coupling, 8) Plummer Block, 9) Simple Eccentric,10) Machine Vice, 11) Connecting Rod, 12) Protected Type Flanged Coupling. B. Write steps to prepare each drawing using AutoCAD or AutoCAD Mechanical Steps must include followings. i. Sketch of components at each step with dimensions. ii. Sequence of commands with name, options and values.	1	30
3	Prepare 2D parametric drawings of 3-4 mechanical components (like fasteners & company's logo) using AutoCAD, ProE (Creo)/Solid works/SolidEdge/Inventor professional. A. Prepare a report on the following. Write steps to prepare each	1	06

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Drawing using AutoCAD. Steps must include the followings. i. Sketch of components at each step with dimensions. ii. Sequence of commands with name, options and values.		
4	Prepare given project in the group of 4-5 students using AutoCAD or Inventor Professional/Creo/Solid Works/Solid Edge assembly drawing of minimum6 different parts. Prepare orthographic drawings and bill of material.	1	14
		Total	**56**

Note

- ***i.*** *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
- ***ii.*** *Care must be taken in assigning and assessing study report as it is a Second-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Quality of Drawing	30
2	AutoCAD/ Inventor professional/ Creo settings	10
3	Participation	20
4	Punctuality	20
5	Knowledge	20
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Criteria	4	3	2	1
Quality of Drawing	1. Individual part is duplicated with 100% accuracy. 2. Dimensions are provided as assigned. 3. Correct Template used. 4. Parametric relations used as assigned.	1. Individual part is duplicated up to 70 to 80% accuracy. 2. Minor Mistake found in dimension style. 3. Minor mistake in Template 4. Minor mistake in Parametric Relation.	1. Individual part is duplicated up to 50 to 60% accuracy. 2. One or two mistakes found in dimension style. 3. One or two mistakes in template. 4. One or two mistakes in Parametric Relation.	1. Individual part is duplicated less than 50%. 2. More than two mistakes found in dimension style. 3. Major drawing errors are present in template. 4. More than 02 mistake in Parametric Relation.
AutoCAD/ Inventor Professional/Creo Settings	AutoCAD settings*. Are accurate as assigned.	One or Two mistakes in AutoCAD settings*.	Three or Four mistake in AutoCAD settings*.	More than four mistake in AutoCAD settings*..
Participation	Used time well in lab focused attention in exercise	Used time mostly in lab focused attention in exercise	Used time moderate in lab focused attention in exercise	Participation is minimum
Punctuality	Timely Submission	Submission late by 1 laboratory	Submission late by 2 laboratories	Submission late by more than 2 laboratories
Knowledge	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%

- ***Units, Limits, UCS Icon, Layering, Planes, References etc.**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	CAD Workstation with 8 GB RAM and 1 TB hard disk drive with Windows -10 OS	1 to 4
2.	24" color or mono plotter	1 to 4
3.	Autodesk AutoCAD (Educational stand alone or network licensed the latest Version).	1 to 4

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
4.	Creo or Solid Edge or Inventor Professional (Educational stand alone or network licensed latest Version).	1 to 4

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Introduction	1a. Interpret drafting, tolerance and geometrical symbols in given production drawings. 1b. Appreciate AutoCAD environment in context to production drawings.	1.1 Concept and need of machine drawings. 1.2 Drafting, tolerance and geometrical symbols used in machine drawing 1.3 AutoCAD screen, library, symbols, templates in context of machine drawing.
Unit – II 2D production drawings	2a. Prepare and plot 2D production machine drawings using AutoCAD.	2.1 Simple 2D production drawings of Mechanical components made up of various manufacturing operations using Auto CAD. 2.2 Draw assembly productions drawing of simple mechanical assembly having minimum 5-6 components each made up of Various manufacturing operations using AutoCAD.
Unit-III	3a. Prepare 2D parametric	3.1 Concept and examples of

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
2D parametric drawings	Drawings of simple machine components using AutoCAD, Pro/E (Creo)/Solid Works/Solid Edge or Inventor Professional.	Parametric and non-parametric models. 3.2 Concept, examples and applications of constraints and relations 3.3 Simple 2D parametric drawings of 6-7 machine components.
Unit – IV Project work	4a. Prepare assembly drawing of mechanical components with codes, standards and symbols using AutoCAD. (Inventor professional or Creo Software can be also used.)	4.1 Prepare one assembly drawing having 4-5 mechanical parts, draw orthographic projections of each component with Institute template and take print out of it. (Group of 5-7 students).

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Not Applicable						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Select at least four simple mechanical components each made up of minimum 5-6manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions.
b) Select at least one simple mechanical assembly in group of 5-6 students, each made up of minimum 5-6 manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions.
c) Bring Actual assembly from workshop/industry, measure dimensions, sketch it and make 2D production drawing for the same.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.

e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

f) Guide students for data sheets.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16 *(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:
Assembly drawing of following mechanical part

a) Bench vise
b) Motor pulley block
c) Motor blower
d) Pipe wise
e) Radial engine
f) Shaper tool head

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Machine Drawing including AutoCAD	Ajeet Singh	McGraw hill
2	Production Drawing	K L Narayan	New Age publication
3	Fundamental of Geometric Tolerance and dimensioning	Alex Krulikowski	Cengage Learning
4	Engineering Graphics with AutoCAD	Sarkar .A.K	PHI india
5	Essentials of Engineering Drawing and Graphics using AutoCAD	Jeyapoovan	Vikas publication
6	Pro Engineer Wildfire 5.0 For Engineers and Designers	Sham Tickoo	Dream Tech press
7	AutoCAD User Guide	Autodesk	Autodesk Press.
8	AutoCAD: A Problem-Solving Approach	Sham Tickoo	Thomson Learning EMEA, Limited

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
9	Machine Drawing	N.D.Bhatt	Charotar Publication
10	Autodesk Inventor Professional 2022 for Designers	Sham Tickoo	CADCIM Technologies, USA Prof. ShamTickoo, Purdue University Northwest, USA

14. SOFTWARE/LEARNING WEBSITES

i. Autodesk AutoCAD (Educational network or stand-alone licensed latest Version)
ii. Autodesk Inventor Professional or Creo (Pro-Engineer)or Solid edge (Educational network or stand-alone licensed latest Version).

Learning Websites

(a) https://www.cadcim.com
(b) http://www.we-r-here.com/cad/tutorials/index.htm
(c)http://www.cadtutor.net/tutorials/autocad/
(d) http://www.caddprimer.com/AutoCAD_training_tutorial/AutoCAD_training_lessons.htm
(e) http://www.autocadmark.com/
(f) http://www.autocadtutorials.net/
(g)https://www.autodesk.com/education/edu-software/autocad
(h)https://www.autodesk.in/campaigns/autocad-tutorials
(i)https://www.autodesk.com/education/support

15. PO-COMPETENCY-CO MAPPING

Semester III	Computer Aided Machine Drawing Practice(Course Code: 4311702)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation& Testing	PO 5 Engi tices for society, & ..	PO 6 Project Management	PO 7 Life-long Learning
Competency	**Prepare production drawings using the computer and relevant software and following standards codes and norms**						
Course Outcomes CO 1) Interpret and Draw, editand modify 2D Production drawing/Machine Drawing of mechanical Components	**3**	**-**	**2**	**-**	**-**	**-**	**2**
CO 2) Create detailed drawings of various machine parts are with sectional or plain elevations, plans , side views and dimensioning with bill of materials using (BOM) using CAD software like AutoCAD.	**3**	**3**	**3**	**-**	**2**	**-**	**2**
CO 3) Prepare report of Technical components with Sketch of components at each step with dimensions and sequence of commands with name, options and values.	**2**	**-**	**2**	**-**	**2**	**-**	**2**
CO 4) Create various parametric drawing of mechanical components with company logo, tolerances and level of surface finish by using latest parametric CAD software.	**3**	**2**	**3**	**-**	**2**	**-**	**2**
CO 5) Create given projects drawings with orthographic projection, bill of material, and report using CAD software.	**2**	**3**	**3**	**-**	**-**	**3**	**3**

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Muhammad Azharuddin U Badi, Lecturer in Mechanical Engg.	Government Polytechnic, Porbandar	9558800951	muhammadabdi92 @gmail.com
2.	Vinitkumar K. Modi, Lecturer in Mechanical Engg	B.&B. Institute of Technology V. V. Nagar	9428661810	modi_vinit@yahoo. com
3.	Amit M. Patel, Lecturer in Mechanical Engg.	Government Polytechnic, Ahmedabad	9426355443	hiamit24@gmail.com

BOS Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B.&B. Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	Asshah97@yahoo.in

4th Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Semester – IV

Course Title: Essence of Indian knowledge and Tradition
(Course Code: 4340001)

Diploma programme in which this course is offered	Semester in which offered
All branches of Diploma Engineering	4th Semester

1. RATIONALE:

National education Policy 2020, has given ample emphasis on Indian Knowledge system. The significance of teaching of Indian knowledge and Tradition is very much required as for centuries this great tradition had been trampled under the feet of invaders. Even after Independence, Indian Knowledge System had been neglected and only Western parameters have been considered as standard.

The essence of Indian culture has been carried through centuries only because of its scientific and humanitarian approach. It is the need of the hour that young students learn the significance of the contribution made by Indian Knowledge Systems and contribute to the world with pride and confidence even in the field of Science and technology which had been mastered centuries ago but was perished by invaders. This course will provide an opportunity to the students the hidden secrets of the great heritage of knowledge that existed thousands of years ago in Indian Tradition.

2. COMPETENCY:

1) Study of IKS will enable students to respect and relish the greatness of our tradition. The awareness of IKS will make them feel proud about their own culture.
2) The knowledge of Indian knowledge will enable and empower them with the first hand knowledge of India's great heritage, culture and traditions.
3) This will create a scope and awareness amongst the foreigners regarding India and its contribution to the world.

3. COURSE OUTCOMES

1. Students will attain awareness regarding the significance of IKS
2. The syllabus will enhance their confidence in Indian traditional knowledge system and enable them to perceive at the problems with Indian perspective
3. This will also enable them to analyze the issues on their own and enable them for critical thinking.
4. The knowledge about the ancient Indian Scientific traditions will generate more confidence in themselves.
5. This will lead them to make research and innovative thinking which can result in global contribution at later stage.

4.TEACHING AND EXAMINATION SCHEMES

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	25	25	150

5.PRACTICAL / PROJECT :

The student can visit any historical / monumental sights like Adalaj step well or Rani Ki Vav – Patan and study about architectural skills of Indians in past.

Topics:-

1. **Ancient Indian Astronomy :**

- **Development of Astronomy**:
  A) Consideration of Purnima and Amavasya
  B) Beginning of The New Year- Vasant Ritu- (Vernal Equinox)
  C) Ancient Indian Calender
  D) Science Behind "Adhikmaas"
  E) Uttarayan and Dakshinayan

- **Knowledge about Constellations / planets / distance between planets etc.**

A) Saptarushi – seven Seers- Significant Knowledge of star and constellations
B) Knowledge of Speed of Light – Rigveda(1.50.04)
C) Distance between Earth and Sun (Hanuman Chalisa)

- **Advances in Mathematics and Geometry in Ancient India**

A) Sulbha- Sutra (Kalpa Sutra) composed by Baudhayana, Manava, Apastamba and Katyayana

B) Contribution of Ancient Rushis to Mathematics

A)Bodhayana's value of pie
B) Lilavati
C) Bhaskaracharya
D) Arya Bhatt.

2. **Town Planning in Ancient India**

A)Roads in Ancient India – Uttarpath by Chandra Gupta
B)Ancient Indian Trade Routs/ Waterways
C)Ship- Building In Ancient India
D)Temple Architecture
-Nagar Style/ Dravida style/ Vesara style

3. **Atomic Theory of by Kanada**

A) Concept of Seven Padartha and Nine Dravyas
B) Theory of Gurutva
C) Characteristics of Atom

4. **Metallurgical Discoveries in Ancient India**

- Lime a Mortar
- Bronze
- Gold & Silver /\
- Glass / Iron
- Nagarjuna's Contribution in making Alloys

5. **Vimanshastra - Airbourne Vehicles.**

A) References of Vimana- Flying Machines in Rigveda, Mahabharat and Ramayana
B) BhardwajSutra- Chapter-1 Rasyagnoadhikari

6.REFERENCE BOOKS:

1)History of Science, Arts & Technology By Dr. Shripad Dattatrya Kulkarni, Bhishma Prakashan, Mumbai -1998.

2)Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana, PHI Learning Pvt. Ltd., Delhi
3)Town Planning in Ancient India by Binode Bihari Dutt, Thacker, Spink & Co.
4) ભારતનો વૈજ્ઞાનિક વારસો લેખક-જે . જે . રાવલ યુનિવર્સિટી ગ્રંથ નિર્માણ બોર્ડ, ગુજરાત રાજ્ય

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)
Semester – IV

Course Title: Contributor Personality Development
(Course Code: 4340002)

Diploma programme in which this course is offered	Semester in which offered
All branches of Diploma Engineering	4th Semester

Type of course: Work-Personality Development

For Year: Pre-final year for all Diploma programs

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their I-Can attitude and self-confidence for their career.
- Improve their ability to engage positively to handle the challenges in career and workplaces.
- Build long-term and sustainable view of success and career that will help them make sustainable choices in a volatile and changing world of work.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Awaken their aspiration to develop as Contributors in their organizations and society.

The program is focused on building foundational career values and the self-esteem of students to contribute in today's world of work.

The Contributor Program syllabus has been evolved and fine-tuned over several years, to –

a) address the changing needs and contemporary challenges being faced by industry and what employers today are looking for in the people they hire.
b) working extensively with universities and students and an appreciation of their challenges and concerns.
c) guided by the higher ideas and principles of Practical Vedanta in work.

OVERALL TEACHING AND EXAMINATION SCHEME
FOR ALL DIPLOMA COURSES

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	25	25	150

L- Lecture; T- Tutorial/ Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
-	**30**	**30**	**10**	-	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note:
It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

Note:
1. This subject is compulsory.
2. It will carry 2 credits.

COURSE FORMAT

Class Sessions:

- Students will have to attend 3 hours of discovery-based sessions, to build new models of thinking & capacities for every module. [i.e., total 18 hours of classroom sessions in the semester]
- They will work closely with their peers to discuss and understand these new models of thinking.
- Their learning will be facilitated by trained college faculty.
- They also go through standard end-of-module, live assessments in class via a Student App, for continuous assessment of learning, which will be used for the progressive assessment component.

Project work:

- Students will have to complete projects as part of Practical work. They have one project corresponding to each module. These projects help them apply contributor thinking into their careers and life. These also help them build their confidence to communicate, ability to do systematic research and present their thinking effectively.
- For the successful completion of projects:
    - Students will be given orientation to the project and systematic guidelines on how to conduct the project by their trained college faculty in a project orientation session.
    - The projects will be done in teams and will require research. It may also need field work.
    - Student teams present their projects in the classroom in project presentation sessions.

COURSE CONTENT:

MODULE		WHAT IS COVERED	Total Hrs.
1	Part 1: Developing self-efficacy and basic inner strength	**Who is a Contributor?** Students build a vision of who they can become as a 'Contributor' in their career. They gain clarity on expectations from the future workforce, and importance of being a contributor. This enables students to transform their expectation of themselves in their career and future work.	3 hrs Lab Sessions (discovery-based facilitator led)

2		**The 'creator approach' to life & challenges** In a "caged approach", we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator approach" to challenges and situations. This helps them take ownership & responsibility to shape destiny, build a new future, find answers to challenges; and stop being complainers.	Same as above
3		**Develop yourself to succeed: The I CAN Approach** Students learn to develop an "I CAN" attitude to everything. This is the base that helps them develop a Growth Identity & builds their self-esteem step by step; making them ready to deal with the dynamic demands of the future workplace.	Same as above
4	Part 2: Building ability to make more effective career choices	**Achieving Sustainable Success in their career** Students discover how to achieve sustainable or lasting success, by making themselves success worthy. Where their focus shifts to building one's "engine of success" rather than being focused on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. This helps them make better choices in life, that leads to steady success & long-term career fulfillment in an uncertain world.	Same as above
5		**Career Development Pathways open to us** In this topic, students explore a range of diverse "career development models" and the possibilities for contribution that each opens up for them. This helps them open up hidden opportunities that such an environment offers. And free themselves from a herd mentality when making career	Same as above

		choices.	
6		**Unleashing our Power to Contribute** In this topic, students learn how to expand the contribution possible in any role they play. This helps them take charge of their own career growth & discover their power to contribute in any role or job.	Same as above
Project work		Project Assignments are given corresponding to each of the six topics. These projects require research and field work beyond the classroom that students are expected to do.	Beyond classroom, with student presentations in the class

Reference resources:

A. Basic reference for both students and teachers –

1. Student Resources for study comprising of key ideas learnt in the classroom in each topic and additional references to videos, articles etc. from the internet for continued exploration. These resources are made available via the Student App.
2. In-class Assessment Quizzes for each of the 6 modules that students do via the Student App.
3. Structured classroom presentations that teachers use to conduct classes systematically. This is provided via a digital delivery platform (only for teachers).
4. Guides and preparation material to help teachers prepare for the classroom sessions. This is also provided via the digital delivery platform.
5. Project Guides and support materials provided via the digital delivery platform and the Student App.

These will be made available by Illumine (www.illumine.in), Knowledge Partner for the Contributor Program.

B. Advanced reference for teachers –

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Awaken the Contributor Within (Contributor Ethic), Srinivas V.; Illumine Ideas, 2019
3. Becoming a Contributor Teacher (Contributor Ethic), Srinivas V.; Illumine Ideas, 2018
4. Reclaiming our intentionality: from “victims” to “creators of our destiny” (Design of Life), Srinivas V.; Illumine Ideas, 2016.
5. Examining our motives of work: can we ask more out of ourselves? (Design of Life), Srinivas V.; Illumine Ideas, 2016.
6. Building a Contributor Ethic in Organizations, Srinivas V.; Illumine Ideas, 2019.
7. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
8. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan

9. Karma Yoga, Swami Vivekananda; Advaita Ashrama
10. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
11. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
12. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
13. Why not? how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
14. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
15. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
16. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of class sessions		
CO-1	Students are able to recognize the work ideal of a Contributor in terms of their motives for working and approach to work. They appreciate the value and importance of becoming Contributors in today's context.	10-12%
CO-2	Students are able to recognize & appreciate a "caged" approach as distinct from a "creator" approach in the way people deal with challenges and situations; and learn ways to develop a creator approach.	10-12%
CO-3	Students are able to recognize an "I Can" approach or way of thinking in situations. They learn how to apply this thinking to systematically develop themselves and their self-confidence in any area they choose.	10-12%
CO-4	Students are able to widen their understanding of success, that will help them make more sustainable career choices.	10-12%
CO-5	Students are able to recognize & appreciate different career development pathways and their value; to open up different career possibilities for themselves.	10-12%
CO-6	Students are able to recognize that any role has the potential for contribution. And they learn how to systematically expand the contributions and impact they can make in any role.	10-12%
Outcome of practical /project sessions		
	Students learn to apply the new thinking in the real world context	30%

EXAMINATION PATTERN:

End Semester Examination Pattern:

1.0 The final examination will cover all six modules included in the course content.

2.0 The examination is largely understanding and application oriented. Thus, a thorough appreciation of the key concepts of the course to recognize contributor thinking and application of the concepts in everyday life & work context, will help students to do well in the examination.

3.0 The examination paper will have ~30 questions and is to be completed in 1 ½ hours.

4.0 All questions are compulsory.

5.0 Pattern of questions –

- There are four sections in the question paper.
- All questions are in multiple-choice format (MCQ).
- The questions are in the form of scenarios / situations giving options. The student is expected to choose one option out of the given options.

6.0 The total number of marks is **70 marks**. The No. of questions and maximum marks per section is given below:

Section	Type of questions & No. of questions	Marking scheme
Section A	Case with 4 MCQs (with 2 or 3 options each). Student has to choose only one option.	2 questions x 3 marks each 2 questions x 2 marks each Max. marks = 10 marks Min. marks = zero
Section B	10 MCQs (with two valid options each). Student has to choose only one option.	10 questions x 2 marks each Max. marks = 20 marks Min. marks = zero
Section C	5 MCQs (with 3 or 4 options each). Student has to prioritize/ rank the statements & choose only one option that is closest to their ranking or priority-combination.	5 questions x 2 marks each Max. marks = 10 marks Min. marks = zero
Section D	10 MCQs (with 3 options each). Student has to choose only one option.	10 questions x 3 marks each Max. marks = 30 marks Min. marks = 10 marks

Sample Question Paper Pattern:

Section A

Instructions: This section has a scenario. Read carefully before answering the subsequent questions. There are 4 questions in this section. All questions are compulsory. Each question has 3 or 2 options. Choose ONLY ONE option which you consider the most appropriate option. Read carefully before answering.

Maximum Marks: 10

E-retailer Flipkart has announced that it will use the services of Dabbawalas of Mumbai for delivering goods to customers.

The Dabbawalas have been in the profession of transporting lunch boxes with absolute accuracy for more than 120 years. Their unique delivery system has been smooth, and reliable under all conditions. Their business involves no paper or administrative team. This helps in keeping the costs down.

However the Dabbawalas are not technology savvy which can be a problem for Flipkart.

1. The biggest advantage of this partnership is that… *[3 marks]*

a] …it will reduce Flipkart's cost of delivery significantly.
b] …it is an unusual and beneficial partnership for all concerned.
c] …it will give Dabbawalas additional income.

2. Suppose a partnership fails, your learning from it would be… *[2 marks]*
   a] These things happen, don't think about it but go forward.
   b] I need to think through more carefully whom to partner with and how we work together.

Section B

Instructions: There are 10 questions in this section. All questions are compulsory. Each question has 2 statements. Select ONLY ONE statement you feel is closest to your thinking and mark it on the answer sheet given to you.

[10 Qs x 2 marks = max. marks 20]

3. An astronomer made a discovery of a new planet at a unique location in the galaxy after several years of work. This helped prove and support an already well-established theory in Physics. Will the astronomer be called a Contributor?
   a] No, not a contributor, as finally his work led to nothing substantial (the theory was already well established).
   b] Yes, he is a Contributor because he continued for long and didn't give up so that he could make a discovery.

4. a] "I won the 'Best Athlete Award' last year. I should practice well enough to win it again this year."
   b] "I won the 'Best Athlete Award' last year. For this year's sports day, I should practice to improve my stamina and speed."

Section C

Instructions: This section will have 5 questions. All questions are compulsory. Each question has some statements with a unique number (e.g. 1, 2, 3, 4) and 3 or 4 options (e.g. a, b, c, d). Each option is either a combination of statements or a specific order of the statements. Choose ONLY ONE option closest to your thinking and mark it on the answer sheet given to you.

[5 Qs x 2 marks = max. marks 10]

5. What makes a project successful? *(Rank in the order of most likely to least likely option)*
   1. An inspiring team leader who can delegate jobs to his team.
   2. Hardworking team members who complete the tasks which are assigned to them.
   3. A team who believes the project should be successful.
   4. People who think like a 'team'.

   a] 4-3-2-1 b] 2-1-4-3 c] 2-1-3-4 d] 4-3-1-2

6. What are the different I CANs required to crack a job interview?
    1. I CAN learn to articulate my thoughts in a better manner
    2. I CAN overcome the fear of others judging me
    3. I CAN train myself to build my stamina
    4. I CAN think calmly to answer difficult questions

    a] 1, 2, 3 b] 1, 2, 4 c] 1, 3, 4 d] 2, 3, 4

Section D

Instructions: There are 10 questions in this section. All questions are compulsory. Each question has 3 options. Select ONLY ONE option you feel is the most appropriate and mark it on the answer sheet given to you.

[10 Qs x 3 marks = max. marks 30]

7. Which is a Contribution to Self, that a football player can make in his role?
    a] Asking for personalized attention from the coach and better opportunities to prove himself in the team.
    b] Improving his dribbling and passing techniques and his ability to work in smooth co-ordination with other players
    c] Winning more matches and increasing the number of goals scored by him in different matches.

8. Vaibhav, a mechanical engineering student, guides his classmates in completing their lab and group project work, gives regular updates on the progress to the teacher and works with everyone so that the journals of the entire class are submitted in time for external evaluation. What roles is Vaibhav playing in his college/class?
    a] Student leader, friend, role model
    b] Student, classmate, class representative
    c] Student, mentor, coordinator, representative of the class, assisting the teacher

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Semester – IV

Course Title: Integrated Personality Development Course
(Course Code: 4340003)

Diploma programme in which this course is offered	Semester in which offered
All branches of Diploma Engineering	4th Semester

1. TYPE OF COURSE

Value-based holistic personality development course for university students.

2. RATIONALE

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

3. COURSE OUTCOMES

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India’s glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

4. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	25	25	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.

5. COURSE-CONTENT:

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module & Subject	Subject Description	Hours
IPDC-1 (First Phase/Semester)			
Intro-duction	The Need for Values	Students will learn about the need for values as part of their holistic development to become successful in their many roles - as ambitious students, reliable employees, caring family members, and considerate citizens.	2
1	**Module:** Remaking Yourself **Subject :** Restructuring Yourself	Students learn how self-improvement enables them to secure a bright future for themselves. They will learn 6 powerful thought-processes that can develop their physical, intellectual, emotional, and spiritual quotients.	2
2	**Module:** Remaking Yourself **Subject :** Power of Habit	Students will undergo a study of how habits work, the habits of successful professionals, and the practical techniques that can be used to develop good habits in their life.	2
3	**Module:** Learning from Legends **Subject :** Tendulkar & Tata	Students will learn from the inspirational lives of India's two legends, Sachin Tendulkar and Ratan Tata. They will implement these lessons through relatable case studies.	2
4	**Module:** From House to Home **Subject :** Listening & Understanding	Active listening is an essential part of academic progress and communications. Students will learn to listen with their eyes, ears, mind, and heart.	2
5	**Module:** Facing Failures **Subject :** Welcoming	This lecture enables students to revisit the way in which they approach challenges. Through the study of successful figures	2

	Challenges	such as Disney, Lincoln and Bachchan, students will learn to face difficulties through a positive perspective.	
6	**Module:** Facing Failures **Subject :** Significance of Failures	Failure is a student's daily source of fear, negativity, and depression. Students will be given the constructive skills to understand failure as formative learning experiences.	2
7	**Module:** My India My Pride **Subject :** Glorious Past - Part 1	India's ancient Rishis, scholars, and intellectuals have made tremendous contributions to the world, they developed an advanced, sophisticated culture and civilization which began thousands of years ago. Students will learn the importance of studying India's glorious past so that they could develop a strong passion and pride for our nation.	2
8	**Module:** My India My Pride **Subject :** Glorious Past - Part 2	Our ancient concepts can be used to seek revolutionary ideas and to generate inspiration. Students will develop a deeper interest in India's Glorious Past – by appreciating the need to read about it, research it, write about it, and share it.	2
9	**Module:** Learning from Legends **Subject :** A.P.J. Abdul Kalam	Dr Kalam's inspirational life displayed legendary qualities which apply to students (1) Dare to Dream (2) Work Hard (3) Get Good Guidance (4) Humility (5) Use Your Talents for the Benefit of Others	2
10	**Module:** Soft Skills **Subject :** Networking & Leadership	Students are taught the means of building a professional network and developing a leadership attitude.	2
11	**Module:** Soft Skills **Subject :** Project Management	Students will learn the secrets of project management through the Akshardham case study. They will then practice these skills through an activity relevant to student life.	2
12	**Module:** Remaking Yourself **Subject :** Handling Social Media	Students will learn how social media can become addictive and they will imbibe simple methods to take back control.	2
13	**Module:** Facing Failures **Subject :** Power of Faith	Students will learn about the power and necessity of faith in our daily lives.	2
14	**Module:** From House to Home **Subject :** Bonding the Family	Students will understand the importance of strong family relationships. They will learn how to overcome the generation gap and connect with their family more.	2

15	**Module:** Selfless Service **Subject :** Seva	Students will learn that performing seva is beneficial to one's health, wellbeing, and happiness. It also benefits and inspires others.	2

6. COURSE MATERIAL / MAIN COURSE WORKBOOK:

Workbook will be designed and presented by IPDC Team. These official workbooks would be the course-material for study of IPDC. These workbooks will solve the purpose of study, submission, viva and exams for students.

IPDC Workbook-1 (*published by Swaminarayan Aksharpith)*

7. IPDC REFERENCES:

These are the reference material for the IPDC lectures. This is not compulsory reading for the students as the essential information is contained in the workbook.

Module No.	Module	References
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013

3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011 2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010
7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020] 3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester-IV

Course Title: Estimating, Costing and Engineering Contracting

(Course Code: 4341901)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

This course is designed to develop the ability in the students to evaluate materials, consumables and process costs in the monetary units. Hence, it will help to increase the productivity of the organization and conservation of valuable resources. This course will also help in developing the skills required in the process of decision making and to plan, use, monitor and control resources optimally and economically. This will also be helpful in budgeting and contracting.

2. COMPETENCY

The theory should be taught in such a manner that students are able to acquire different learning objectives in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

3. COURSE OUTCOMES (COs)

CO-1	Understand the concept of estimation, costing and depreciation.
CO-2	Apply break even analysis to get optimum production level.
CO-3	Estimate cost for various conventional manufacturing processes.
CO-4	Estimate the cost of special process plant.
CO-5	Prepare budgets and engineering contracts related to mechanical domain.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	00	00	100

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T****– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES: N.A.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: N.A.

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course

competency.

a) Work as a leader/a team member.
b) Follow safety practices and Follow ethical practices
c) Practice environment friendly methods and processes. (Environment related)

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction	1a. Explain terminology and importance of ECC in industries. 1b. Explain the methods of costing 1c. Calculate elements of cost 1d. Find depreciation	1. Introduction of Estimation, Costing and contracting and their importance in industries. 2. Methods of costing (Explain actual examples for these methods) A. Specific order costing - Job costing - Contract costing - Batch costing B. Continuous operation costing - Process costing - Service costing - Operation costing - Unit costing 3. Calculation of catalogue price, selling price and various over heads (**Only** numerical). 4. Depreciation methods (1) Straight line method (2) Sinking fund method (**Only** numerical)
Unit – II Break even analysis	2a. Construct break even chart and find various parameters. 2b. Determine break even quantity for given data	1. Calculation of Break-even Quantity analytically and graphically (**Only** real time examples). 2. Safety Margin and it's importance. 3. Assumptions and Limitations of BEA.
Unit - III Costing in forging and casting	3a. Estimate material cost 3b. Estimate cost for a forging component 3c. Estimate cost for a casting component	1. Calculate volume of shapes of various combinations of cylinder, square, prism and sphere. 2. Calculate mass and material cost of given component (shape of component should be combination of above basic shapes like I-section, T-section, L-section, etc.). 3. List and calculate various forging losses for given data. 4. Estimate forging cost (for given data) 5. Estimate pattern making cost (for given data) 6. For a given component, Estimate casting

		cost including all losses.
Unit – IV Costing in Fabrication shop	4a. Estimate material and welding cost for a given component 4b. Estimate sheet metal work cost	1. Estimation of fabrication cost of real time object like safety grill (e.g. windows, doors, etc.), gate, various shades, etc. (Sizes are given) 2. Estimate Solar Roof Top costing for various capacities. It includes, cost of welding, framing, solar panel, labour, taxes, subsidies, etc. 3. Estimate **ONLY** material cost in sheet metal work for various jobs. (Concept of development of solid surfaces to be used. Consider regular shapes like cylinder and prism only) (**ONLY** numerical to be covered in this chapter)
Unit – V Costing in Production shop	5a. Calculate machining cost in lathe, drilling, milling, shaping and grinding machines	1. Calculate cost of various lathe operations like turning, facing, knurling etc. 2. Calculate cost of various drilling operations like drilling, boring, reaming, etc. 3. Calculate cost of shaping, grinding and milling operations. (**ONLY** numerical to be covered in this chapter)
Unit – VI Costing of various processes	6a. Identify various elements to estimate the process cost 6b. Estimate the cost of various processes	1. Estimate the cost of furniture work for given data. 2. Calculate running cost of power plant. 3. Calculate running cost of refrigerator, air conditioners, lift, cold storage, DG set, etc. (**ONLY** numerical to be covered in this chapter)
Unit VII Budget and Contracting	4a. Explain various Terminologies of budget. 4b. Prepare simple budget. 4c. Interpret parameters of given budget. 4d. Explain various terminologies of Contracting 4e. Prepare contract document 4f. Interpret given contract terms and conditions. 4g. Prepare data for tendering	1. Define budget. Objectives and advantages of budget. 2. Explain industrial budget with actual example. 3. Discuss Rail budget, Financial budget of State/country. 4. Budgetary control and it's advantages. 5. Explain actual contracts. e.g. Housekeeping contract, Labour contract, Security contract, Annual Maintenance contract like CCTV, Lift, Diesel Generator set, water purifier, vehicle, computer system, etc. 6. Explain Tendering process and E-tendering

	process.	with real time example. 7. Explain about GeM (Government E Market). How to become seller or buyer on GeM.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory marks			
			R Level	U Level	A Level	Marks
1	Introduction	4	4	6	0	10
2	Break even analysis	3	0	4	4	8
3	Costing in forging and casting	5	0	6	6	12
4	Costing in Fabrication shop	5	4	2	6	12
5	Costing in Production shop	5	2	4	6	12
6	Costing of various processes	3	0	2	6	8
7	Budget and Contracting	3	4	0	4	8
	Total	**28**	**14**	**24**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom learning, following are the suggested student- related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Do market survey and find prevailing hourly rates of CNC, Hacksaw cutter, lathe, milling, drilling, grinding and shaping machines and price of these machines.
b) Do market survey and find prevailing hourly rates of renting diesel generating sets. Specify output (HP or kW).
c) Do market survey and find prevailing rates of commonly used engineering materials like MS, brass, copper, stainless steel, Aluminum, etc.
d) Calculate cutting fluid cost. e.g. cost of lubricating oil, coolant, packaging oil, etc.
e) Calculate cutting tool cost. e.g. cost of drill, tips, carbide cutter, reamer, honing stick, etc.
f) Do market survey and find prevailing rates of boiler, furnace, condenser, evaporator etc.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and

provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS:

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

13. SUGGESTED LEARNING RESOURCES

Sr.	Title of Book	Author	Publication with place,year & ISBN
1	Mechanical estimating and costing	Banga and Sharma	Khanna Publishers. New Delhi.
2	Learning package in ECC	NITTTR, Bhopal	NITTTR, Bhopal
3	Mechanical estimating and costing	Shrimali and Jain	Khanna Publishers, New Delhi.

14. SOFTWARE/LEARNING WEBSITES

Refer following links to learn this subject in Gujarati Language.

(a) https://www.youtube.com/c/MechanicalEnggSubjectsGTU
(b) https://youtu.be/7F1n5OgnK4I
(c) https://youtu.be/btrxpgk4F-Q
(d) https://youtu.be/aTnDZF_C-XM
(e) https://youtu.be/hnfkUh3iYb4

15. PO-COMPETENCY-CO MAPPING

Semester IV		Estimating, Costing and Engineering Contracting (Course Code: 4341901) POs						
Competency & Course Outcomes		PO1 Basic & discipline specific knowledge	PO2 Problem Analysis	PO3 Design/Development of solution	PO4 Engineering tools, experimentation and testing	PO5 Engineering Practices for society	PO6 Project Management	PO7 Life long learning
Competency	Students are able to evaluate materials, consumables and process costs for increasing the productivity of the organization and conservation of valuable resources.							
CO-1	Understand the concept of estimation, costing and depreciation.	**2**	-	-	-	-	-	**2**
CO-2	Apply break even analysis to get optimum production level.	**3**	**3**	-	-	-	**1**	**2**
CO-3	Estimate cost for various conventional manufacturing processes.	**3**	-	**2**	-	-	**2**	**2**
CO-4	Estimate the cost of special process plant.	**2**	**1**	**2**	-	-	-	**1**
CO-5	Prepare budgets and engineering contracts related to mechanical domain	**3**	-	-	-	**2**	**2**	**2**

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S S Sonigra Lect. Mech. Engg.	Government Polytechnic, Jamnagar.	9427322129	sssonigra@gmail.com
2.	Dr. H K Trivedi Lect. Mech. Engg.	Sir Bhavsinhji Polytechnic Institute, Bhavnagar	9428408407	hetalktrivedi@gmail.com
3.	Smt. J R Patel	Government Polytechnic, Himmatnagar.	9824063572	jigishapreksha@gmail.com

BOS Resource Persons

Sr.	Name and Designation	Department	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS (Chairman HOD Mechanical Engg.)	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. R. D. Patel (BOS Member, HOD Mechanical Engg.)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah (BOS Member, Principal)	B. V. Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-IV

Course Title: Measurements and Metrology
(Course Code: 4341902)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering & Mechatronics Engineering	4th Semester

1. RATIONALE

The students of the mechanical engineering programme are basically concerned with manufacturing of various machine, components in shops as per given drawing. Today the industrial processing and manufacturing techniques have become complex and complicated, so their control is very much difficult by visual inspection only. Hence accurate and precise measurements by precision measuring instruments are the basic need of the industries. This course of Measurements and metrology provides practical exposure, skills and self-confidence in the students so that they can operate those precision measuring instruments accurately in the benefit of manufacturing industries.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Select and operate appropriate precision measuring instruments for the measurement of given manufacturing product/component.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

CO-1	Measure the given mechanical elements and assemblies using appropriate linear and angular measuring instruments.
CO-2	Measure geometrical tolerances and surface roughness of given components.
CO-3	Measure important dimensions of different types of gears and threads.
CO-4	Use appropriate limit gauges, transducers and sensors for given applications.
CO-5	Use appropriate temperature and pressure measuring devices for given application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). These PrOs need to be attained to achieve the Cos.

Sr. No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1	**Preparatory Activity:** a. S.I. basic, supplementary and derived units and their conversions. Convert given length, area and volume from one unit to another. (From mm to cm and m, from mm to inch, from m to yard and foot, from mm^2 to $inch^2$ and vice- versa, mm^3 to $inch^3$ and vice-versa, etc.). b. Convert given degree to radian and vice-versa. c. Various drafting, surface finish and geometrical symbols. d. Define axis, axes, center, angles, plane and solid angle.	I	02
2	**Linear And Angular Measurement:** Each student will select and bring at least such five mechanical components which will have use of instruments specified below. Same are to be approved by teacher. After approval, student will: a. Sketch each component. b. Sketch and label main parts of instruments to be used. c. Calculate least count of the instrument/s to be used. d. Measure and record applicable dimensions of each component using: i. Vernier caliper. ii. Inside & Outside micrometer. iii. Telescopic gauge iv. Height gauge/depth gauge. v. Slip gauges (Calibration of vernier caliper and micrometer) vi. Bevel protector and sine bar.	I	08
3	**Measurement of geometrical tolerances:** Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking various geometrical tolerances like: a) Straightness b) Flatness	II	04

Sr. No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
	c) Squareness, perpendicularity and parallity d) Roundness, Cylindricity, Concentricity, Runout and Ovality.		
4	**Surface Roughness:** a. Tabulate machining processes, and roughness values (Ra, mm), roughness grade number and roughness symbol. b. Demonstrate various surfaces having different roughness values. c. For given component, sketch the component, judge the roughness of surfaces and show surface roughness symbols on applicable surfaces. d. Measure surface roughness value of given machined surface.	III	02
5	**Gear Measurement:** a. Sketch gear tooth nomenclature. b. Sketch gear tooth vernier and label each part. c. Calculate chordal thickness and height of given gear. d. Determine tooth height. e. Measure and compare chordal thickness of given spurs gear using gear tooth vernier.	IV	02
6	**Thread Measurement:** For given external threaded part: a. Draw nomenclature for ISO screw threads (Internal and external both). b. Explain and derive best wire size. c. Sketch the part and show the dimensions to be measured. d. Sketch the set up and instruments used to measure/derive major diameter, minor diameter and effective diameter using two wire and three wire methods. e. Measure the pitch. f. Use threaded ring gauge. g. Record observations.	IV	03
7	**Limit Gauges:** a. Demonstrate use of various limit gauges. b. Select appropriate limit gauge for given dimension/part and check the dimension with gauge. c. Record your observations.	V	02
8	**Demonstration of Transducers and Sensors:** a. Demonstrate electrical (LVDT type, resistance type, capacitance type, inductance type and piezo-electric.) transducers and various sensors. b. Sketch each demonstrated transducers and sensors and tabulate specifications, range, resolution and applications of each.	V	02
9	**Temperature Measurement and Pressure Measurement:** **Temperature Measurement:** a. Sketch the set up and constructional sketch of thermocouple used to measure temperature. b. Measure the temperature of hot body/hot liquid with thermocouple.	VI	03

Sr. No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
	c. Record the observation. **Pressure Measurement:** a. Sketch the set up and constructional sketch of pressure gauge used to measure pressure. b. Measure the pressure with pressure gauge. c. Record the observation.		
		Total	28

Note

a. It is compulsory to prepare log book of exercises. It is also required to get each exercise/practical's recorded in logbook, checked and duly dated signed by faculty.
b. Term work report content of each experience should also include following.
    1. Reports.
    2. Student activities.
c. For 25 marks of ESE, students are to be assessed for competencies achieved. They should be given following tasks. (i and any one from ii, iii and iv.)
    1. Measure the linear/angular dimensions and geometrical tolerances of given part/assembly.
    2. Measure important dimensions of different types of gears/threads.
    3. Use appropriate limit gauge for given components.
    4. Explain working of transducers and sensors.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the Cos and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Knowledge of concept and Selection of instrument	25
2	Standard operating procedure	15
3	Measurement skill and data record	20
4	Result and Troubleshooting	25
5	Workplace safety and Ethical practice	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Criteria	Rating Scale			
	Excellent (4)	**Good (3)**	**Fair (2)**	**Poor (1)**
Knowledge of concept and Selection of instrument	Student has excellent knowledge of concept and precisely select appropriate instrument for high accuracy.	Student has good knowledge of concept and able to select appropriate instrument.	Student has fair knowledge of concept and managed to select instrument for measurement.	Student has poor knowledge of concept and unable to select appropriate instrument.
Standard operating procedure	Student always Follow all the standard Procedure with utmost precaution and in logical order.	Student Follow all the standard Procedure with precaution and in logical order.	Student Follow all the standard Procedure with some precaution.	Student not completely Follow all the standard Procedure.
Measurement skill and data record	Student demonstrate excellent measurement skill by taking all measurement very accurately and note it down in lab manual.	Student demonstrate good measurement skill by taking all measurement and note it down in lab manual.	Student demonstrate fair measurement skill by taking some measurement and note it down in lab manual.	Student demonstrate poor measurement skill by not taking measurement accurately and has poor record of data keeping.
Result and Troubleshooting	Student get very accurate result & has ability to detect and correct the error.	Student get accurate result & has managed to detect and correct the error.	Student get result within tolerance range & has managed to detect and correct the error with little help.	Student get result which is not accurate nor in tolerance range. Student has not able to detect error.
Workplace safety and Ethical practice	Student display excellent punctuality & always follow and also encourage others to follow all safety norms ethically during measurement.	Student display good punctuality and always follow all safety norms ethically during measurement.	Student display fair punctuality and follow safety norms during measurement.	Student is not punctual nor follow safety norms during measurement.

6. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	Practical No.
1	1. Surface plate, 500 x 500 mm. 2. Vernier calliper, 0 to 200 mm, least count 0.02 mm. 3. Vernier calliper, 0 to 200 mm, least count 0.01 mm, digital. 4. Inside micrometers, least count 0.01 mm, 50-75 mm. 5. Micrometer, least count 0.01 mm, 0-25mm, 25-50 mm, 50-75 mm. 6. Outside micrometer, least count 0.001 mm, 0-250 mm. 7. Telescopic gauge- 10-100 mm. 8. Height gauge- 300 mm with least count 0.02 mm. 9. Depth gauge- 200 mm with least count 0.02 mm. 10. Bevel protector with least count 5'. 11. Slip gauge box (Preferably M112/1) 12. Sine bar- 100 mm, 200 mm.	2
2	1. Straight edge, 500 mm. 2. Feeler gauge, radius gauge, thread pitch gauge. 3. Dial indicators magnetic stand. 4. Dial indicators, least count 0.01 mm. 5. V blocks.	3
3	1. Samples of various surface textures and different surface roughness. 2. Microprocessor- stylus-probe based surface roughness testing machine. 3. Microscope to compare various textures and surface roughness.	4
4	1. Gear tooth vernier. 2. Profile Projector 3. Set of best wire to measure thread dimensions. 4. Thread Micrometers	5 & 6
5	Set of limit gauges- sorted sizes, plug gauges, thread ring gauges and Snap gauges.	7
6	1. LVDT type, resistance type, capacitance type, inductance type and piezo-electric type transducers. 2. Sensors, position, proximate, velocity, force/strain	8
7	1. Thermometers. 2. Various types of thermocouples.	9

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain instruments and equipment.
e) Practice environment friendly methods and processes. (Environment related).

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

I. 'Valuing Level' in 1st year
II. 'Organization Level' in 2nd year.
III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Linear and angular measurement**	1a. Distinguish between accuracy, precision and error.	1.1 Inspection, quality and quality control-definitions and differences. 1.2 Define accuracy, precision and error. 1.3 Surface plates-types, important features, standards/important sizes, applications and precautions in use.
	1b. Determine least count of given measuring instrument. 1c. Select suitable linear measuring instrument and measure the linear dimension of given component.	1.4 Principle of vernier scale and least count. 1.5 Types, constructional sketch, major parts and their functions, least count, measuring methods and measurement illustration (for e.g., 12.48mm) of: i. Vernier caliper. ii. Micrometer. iii. Telescopic gauge. iv. Height gauge. v. Depth gauge.
	1d. Describe the procedure for wring the slip gauge and set given dimension.	1.6 Slip gauge-types, applications, and wringing method.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	1e. Select suitable angular measuring instrument. 1f. Describe the measurement procedure for the angular dimension of given component.	1.7 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of: I. Bevel Protector. II. Sine bar. III. Angle gauges. IV. Spirit level. V. Clinometers. VI. Auto collimator. 1.8 Calibration – concept and need.
Unit – II **Measurement of geometrical tolerances**	2a. Explain working of dial indicators. 2b. Select the measuring method and describe the measurement procedure for geometrical tolerance of given part/assembly.	2.1 Dial indicators/gauge-types, constructional sketch and applications. 2.2 Definition, symbol and measuring methods of: I. Straightness. II. ii. Flatness. III. Squareness. IV. Parallism. V. Perpendicularity. VI. Roundness. VII. Concentricity. VIII. Cylindricity. IX. Run out and ovality.
Unit – III **Measurement of surface roughness**	3a. Define various terminology used for surface roughness. 3b. Explain working of direct instrument methods.	3.1 Terminology used in connection with surface finish. 3.2 Comparison methods to inspect surface finish-concept and applications. 3.3 Direct instrument measurement methods-types and concepts. 3.4 Construction, working and applications of Talysurf surface roughness tester and Tomlinson tester.
	3c. Determine surface roughness of given data.	3.5 Centre line average and Root Mean Square systems of surface texture evaluation-terminology used, concept, equations and numerical examples. 3.6 Indication of various surface roughness characteristics with surface roughness symbols-interpretation.
Unit – IV **Gear and thread measurement**	4a. Define various terms used for gear nomenclature. 4b. Use gear tooth vernier to measure gear tooth thickness.	4.1 Types of gears. 4.2 Forms of gear teeth-types and concept. 4.3 Gear tooth Terminology. 4.4 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of gear tooth vernier. 4.5 Derivation and numerical example to measure gear tooth thickness using: I. Gear tooth vernier. II. Constant chord method. III. Base tangent method.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4c. Explain working of profile projector. 4d. Define various terms used for thread nomenclature. 4e. Determine best wire size. 4f. Use two and three wire methods to determine effective diameter of thread. 4g. Describe method for measuring the pitch of given thread.	4.6 Gear tooth profile measurement. 4.7 Threads-classification, elements, specifications and forms. 4.8 Measurement of major and minor diameters. 4.9 Three and two wire method of measuring effective diameter of external thread-concept, terminology used, best wire size, derivation of equation and numerical example. 4.10 Thread micrometer-sketch, method to use and determination of dimension. 4.11 Pitch measurement methods.
Unit – V **Limit gauges, Transducers and sensors**	5a. Select and check the given dimension using limit gauge.	5.1 Limit gauges-classification, sketch and applications. 5.2 Comparators-concept, types and applications.
	5b. Define static characteristics of instruments.	5.3 Instrumentation-introduction, performance characteristics. 5.4 Static characteristics of instruments.
	5c. Explain various transducers and sensors.	5.5 Transducers-concept, classifications, physical quantities which can be measured, advantages and disadvantages. 5.6 Electrical transducers-types, working principles and applications of: I. Linear Variable Differential Transducers (LVDT). II. Resistance type. III. Capacitance type. IV. Inductance type. V. Piezo-electric type. 5.7 Sensors- classification and applications. 5.8 Use of transducers and sensors as a safety measures.
Unit – VI **Temperature and Pressure measurement**	6a. Select and describe the method for using appropriate temperature measuring device to measure temperature of given hot body.	6.1 Introduction. 6.2 Classification, working principle, construction, working, advantages, limitations and applications of temperature measuring devices: I. Mercury in glass thermometer. II. Bimetallic thermometer. III. Resistance thermometer. IV. Thermistor. V. Thermocouple. VI. Radiation pyrometers. VII. Optical pyrometers.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	6b. Select and describe the method for using appropriate pressure measuring device to measure pressure.	6.3 Pressure measurement scales. 6.4 Types and applications of manometers (only list and applications). 6.5 Working principle, construction, working, advantages, limitations and applications of pressure measuring devices: I. Bellows type pressure gauge. II. Diaphragm type pressure gauge. III. Bourdon tube pressure gauge. IV. Dead weight piston gauge. 6.6 Concept of transducer-based pressure measuring devices resistance type, capacitance type and inductance type. 6.7 Use of Temperature and Pressure measurement as a safety measures.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Linear and angular measurement	10	06	08	06	20
II	Measurement of geometrical tolerances	06	02	03	03	08
III	Measurement of surface roughness	06	02	03	03	08
IV	Gear and Thread measurement	08	04	08	04	16
V	Limit gauges, transducers and sensors	08	02	06	04	12
VI	Temperature and Pressure measurement	04	02	04	00	06
	Total	**42**	**18**	**32**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the COs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Visit the workshop and identify the machined components which require geometrical tolerances.
b) Visit any industry/tool room and observe the working of inspection and testing department and also prepare the report.
c) Calibrate any one instrument having error in laboratory.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed byteachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular*** activities.
f) Guide students on how to address issues on environment and sustainability.
g) For this course teacher may use one or combine of any strategies from below for better teaching learning experience.
   - Demonstration of actual instrument.
   - Videos of measuring methods.
   - Perform virtual lab experiments.
   - Industrial visits.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Perform a Virtual lab experiment of any one from Linear measuring instrument/Angular measuring instrument/Temperature measurement/Pressure measurement/gear and thread measurement and prepare an observation table for the same.

b) Select a readymade mechanical component/product/assembly from college workshop/industry/market of distinct dimensions, prepare a drawing of it, select and

measure it with various available precision measuring instruments and note it down in drawing. (Select items with at least 5-6 dimensions and try to cover many varieties of instruments like linear, angular, indirect, analog, digital etc.)

c) Prepare a poster/PPT/Animation of any precision measuring instrument containing working principle, least count, construction, reading method, types etc.

d) Do an industrial visit of nearby manufacturing industries/calibration lab and prepare a detail report on list of instruments with its types, range and least count used in the particular industries.

e) Select a mechanical part, measure same dimensions with different instrument also having different least count and observe the change in readings.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Mechanical measurements and instrumentation	R.K.Rajput	KATSON
2	Engineering Metrology and Measurements	N.V. RAGHAVENDRA & L. KRISHNAMURTHY	OXFORD University press
3	Mechanical Measurement	Sirohi R.S., Radha Krishnan H.C.	New Age International
4	Practical Engineering Metrology	K.W.B.Sdarp	Pitman
5	Engineering Metrology	R.K.Jain	Khanna Publications.
6	Metrology & Measurement	Anand Bewoor & Vinay Kulkarn	Tata McGrawHill
7	Industrial Instrumentation & Control	S K Singh	Tata McGrawHill
8	Mechanical Measurement	Beckwith & Buck	Narosa publishing House
9	Mechanical Measurement and Control	D.S.Kumar	Metropolitan Book Pub.
10	Mechatronics	W.Bolten	PEARSON
11	Gear Metrology	C.A.Scoks	

14. SOFTWARE/LEARNING WEBSITES

MOOCS

- https://swayam.gov.in/ (SWAYAM Portal)
- Reference videos from IIT Kanpur MOOC on Engineering Metrology (Gear Metrology).
  i. https://youtu.be/7ZteZ5UTW6E (Part-1)
  ii. https://youtu.be/GzMPsjMQKGY (Part-2)
- Reference videos from IIT Roorkee MOOC on Inspection and Quality control in Manufacturing (Gear Measurement).
  1. https://youtu.be/X8KPNVZhvmo

Vertual Labs

- https://www.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4 (OLABS-Vernier Caliper).
- http://www.amrita.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4 (Vernier Caliper).
- https://amrita.olabs.edu.in/?sub=1&brch=5&sim=156&cnt=4 (Micrometer).

- https://kcgcollege.ac.in/Virtual-Lab/Mechanical/Exp-2/index.html (measurement of Major, Minor and Effective diameter of external screw thread using Floating Carriage micrometer).

You tube links

- https://www.youtube.com/watch?v=xgQYvEELbfc (Vernier Caliper).
- https://www.youtube.com/watch?v=FNdkYIVJ3Vc (Vernier Caliper).
- https://www.youtube.com/watch?v=O8vMFFYNIfo (Micrometer)
- https://www.youtube.com/watch?v=h98HPVuWjLA (depth micrometer)
- https://www.youtube.com/watch?v=SmXfGan_NXQ (telescopic gauge)
- https://www.youtube.com/watch?v=eVpoJzLJa0U(surface roughness)
- https://www.youtube.com/watch?v=3Od7vnoMwGg(surface roughness)
- https://www.youtube.com/watch?v=XnLiTPGE6pk (three wire thread measurement)
- https://www.youtube.com/watch?v=Gdvtw0pTAOs (thread pitch)
- https://www.youtube.com/watch?v=qMgXGedDffw (dial indicator)
- http://www.youtube.com/watch?v=lc4dsNvm2Ks (principle of mechanical measurement).
- http://www.youtube.com/watch?v=nv3GuJArjNU (Transducers).
- http://www.youtube.com/watch?v=iMIzApq1CQ0 (pressure measurement).
- http://www.youtube.com/watch?v=JKuoQ5FV2c8 (temperature measurement).
- http://www.youtube.com/watch?v=GNOI_7ftbQ0(temperature measurement).
- http://www.youtube.com/watch?v=QItuf6lNvmI (Capacitive sensors)
- http://www.youtube.com/watch?v=inLkCOwVgyM (force sensors).
- http://www.youtube.com/watch?v=0MP_9n08urA(force sensors).
- http://www.youtube.com/watch?v=zAddvPHfKnw (force sensors)
- http://www.youtube.com/watch?v=_fQSMVf3hdM (calibration).
- http://www.youtube.com/watch?v=ZymDMUuVuyY (geometrical Tolerance).
- http://www.youtube.com/watch?v=5eaSkU6Ecik (flatness measurement).
- http://www.youtube.com/watch?v=1JNCe9fwRUw (Measuring Perpendicularity)
- http://www.youtube.com/watch?v=eJ8a0k8kQIE (Roundness and cylindricity).
- https://youtu.be/jTfUFQ-sbas (Types of Gear in Hindi).
- https://youtu.be/bH3v2bGvLyM (Types of Gear in English).
- https://youtu.be/8AS15R_Q52o (Gear teeth form in Hindi).
- https://youtu.be/ococqpOzbt8 (Gear Tooth Terminology in Hindi).
- https://youtu.be/8hkmFClpwPU (Gear Tooth Terminology in English).
- https://youtu.be/fdz8x5Rgswo (Gear Tooth Terminology in English).
- https://youtu.be/LDhZJ5Ya5YI (Line of action and pressure angle in English).
- https://youtu.be/3L5ZlG8p9Co (measurement of gear tooth thickness in English).
- https://youtu.be/suWlbCsIomg (measurement of gear tooth thickness in Hindi).
- https://youtu.be/FR8Jxr-b3ds (Gear Tooth Vernier Caliper).
- https://youtu.be/Ws98uEZA1MY (Constant chord method in English).
- https://youtu.be/ZKx7jQYj0jk (Constant chord method in Hindi).
- https://youtu.be/_P2q9w49j_w (David brown base tangent comparator method in English)
- https://youtu.be/lyo2POzjslY (David brown gear tooth form testing).
- https://youtu.be/RuAnfLllaDY (Tool room microscope as projection method for small gear).
- https://youtu.be/DYUsqEzV5pY (Parkinson's gear tester in Hindi/English).
- https://youtu.be/qCSCR5RSiPI (Parkinson's gear tester in English).

15. PO-COMPETENCY-CO MAPPING

Semester IV	Measurements and Metrology (Course Code: - 4340902)						
	POS						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Competency & Course Outcomes	Basic and Discipline specific knowledge	Problem analysis	Design/ development of solutions	Engineering Tools, Experimentation and Testing	Engineering practices for society, sustainability and environment	Project Management	Life-long learning
Competency	Select and operate appropriate precision measuring instruments for the measurement of given manufacturing product/component.						
CO1-Measure the given mechanical elements and assemblies using appropriate linear and angular measuring instruments.	3	-	-	3	-	2	2
CO2-Measure geometrical tolerances and surface roughness of given components.	3	-	-	3	-	1	2
CO3-Measure important dimensions of different types of gears and threads.	3	-	-	3	-	2	2
CO4-Use appropriate limit gauges, transducers and sensors for given applications.	2	-	-	3	2	2	2
CO5-Use appropriate temperature and pressure measuring devices for given application.	3	-	-	3	2	1	2

*Legend: '**3**'for high, '**2**'for medium, **'1'**for low and **'-'**for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Hemang J. Parekh Lecturer in Mechanical Engg.	Government Polytechnic Jamnagar	9426481731	parekhhemang080@gmail.com
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3.	Mr. Dipak B. Harsora Lecturer in Mechanical Engg	Government Polytechnic Jamnagar	9913492919	Dipak.harsoraedu@gmail.com

BOS Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B.&B. Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-IV

Course Title: Fluid Mechanics and Hydraulic Machinery
(Course Code: 4341903)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

The main objective of this course is to understand the fundamentals of fluid mechanics, such as fluid and flow properties, fluid behavior at rest and in motion, and fundamental equations like mass, momentum, and energy conservation of the fluid flow, thereby developing an understanding of fluid dynamics in a variety of fields. Applications of these fundamental equations have been highlighted for flow measurements. Hydraulic machinery is essential in converting hydraulic energy to mechanical energy and vice-versa. Hydraulic turbines are used to meet our day-to-day power demands. Also, different types of pumps are essential equipment in all industries. It also tried understanding hydraulic devices generally used in industries through the course.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Select, operate and maintain fluid machinery based on fluid laws and characteristics.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify fluid properties and their effect on the flow system.
CO-2	Apply various laws of fluid mechanics to various real-life applications.
CO-3	Estimate various flow losses to select suitable pipe as per the given situation.
CO-4	Select a hydraulic machine for a particular application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Demonstrate various fluid properties.	I	02
02	Measure pressure using pressure measurement devices.	II	02
03	Verify Bernoulli's theorem.	II	02
04	Measure fluid flow by Venturi meter and orifice meter.	II	04
05	Determine the hydraulic coefficients(Cc,Cv & Cd) of an orifice.	II	02
06	Measure fluid flow using Notch.	II	02
07	Estimate Reynold's number using the given test rig.	III	02
08	Determine major and minor head losses through a pipe.	III	04
09	Perform a test on the centrifugal pump test rig.	IV	02
10	Perform a test on the reciprocating pump test rig.	IV	02
11	Perform a test on a hydraulic turbine test rig.	IV	02
12	Demonstrate the use of different hydraulic devices.	IV	02
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data (which and why) before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1& 12)		
1	Knowledge	30
2	Quality of Report	30

3	Participation	20
4	Punctuality	20
Total		**100**
Experimentation/performance type PrOs (PrOs Number: 2,3,4,5,6,7,8,9,10 & 11)		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number 1 &12)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Students give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale).	A few required elements (labelling/ notations) are missing.	Several require elements (content in paragraph, labels, figures, tables) are missing.
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Experimentation/performance type PrOs (PrOs number 2,3,4,5,6,7,8,9,10 & 11)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Procedure	30%	Student	Student follow	Student follow all	Student follow

follows		follow all the procedure with precaution in a logical order.	all the procedure with some precaution in a logical order.	the procedure without precaution in a logical order.	all the procedure without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Conclusion/ Summary	10%	Student concept is mostly clear.	Student concept is partly clear.	Student concept is somewhat clear.	Student concept is not clear.
Quality of Report	10%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale).	A few required elements (labelling/ notations) are missing.	Several require elements (content in paragraph, labels, figures, tables) are missing.
Punctuality	10%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Different manometers.	02
2.	Hydraulic test rig compressing facility to verify Bernoulli's theorem, venturi meter, orifice meter, orifice, and major & minor losses through pipes.	03, 04, 05, 06, 07, 08
3.	Centrifugal pump test rig.	9
4.	Reciprocating pump test rig.	10
5.	Hydraulic prime mover test rig.	11
6.	Working model of hydraulic devices.	12

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the COs mentioned above and PrOs. More could be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I Fluid and Fluid Properties	1.a Explain the effect of fluid properties on a flow system	1.1 Concept and classification of fluid. 1.2 Properties of fluid i. Density ii. Specific weight iii. Specific volume iv. Specific gravity v. Viscosity vi. Surface tension vii. Cohesion & Adhesion viii. Capillarity ix. Bulk modulus of elasticity x. Vapor Pressure 1.3 Simple numerical examples.
Unit-II Fluid Mechanics and Flow Measurement	2.a Explain Fluid Pressure and use the appropriate pressure measuring device. 2.b Identify the type of fluid flow patterns. 2.c Describe and use continuity equations for one-dimensional fluid flow situations. 2.d Explain and apply fluid equations in simple industrial situations. 2.e Select and use flow measuring devices based on a given	2.1 Fluid pressure, Pressure head 2.2 Concept of vacuum, gauge, atmospheric, and absolute pressure. 2.3 Pascal's law and its applications. 2.4 Classification of pressure measuring devices. 2.5 Working and application of pressure measuring devices: i. Simple manometers (Piezometer, U tube manometer and single column manometer) ii. Differential manometers (U tube and inverted) 2.6 Fluid energy and its types. 2.7 Fluid flow

	situation.	i. Continuity, momentum, and energy equation. ii. Flow patterns. iii. Types of fluid flow. 2.8 Bernoulli's theorem. (Without derivation) and its assumption, limitations, and application. 2.9 Flow measurement: Construction, working, and application of Pitot tube, Orifice, Venturimeter, and Orifice meter. 2.10 Hydraulic co-efficients and its measurement. 2.11 Concept of Notch and Weir (without derivation and numerical). 2.12 Concept of Impact of jet and its application (without derivation and numerical). 2.13 Simple numerical problems on all above.
Unit-III Flow Through Pipes	3.a Understand various losses. 3.b Explain the water hammer and surge tank. 3.c Select the appropriate pipe based on a given situation.	3.1 Introduction to pipe and pipe flow. 3.2 Major and minor losses. 3.3 Reynold's experiment, friction factor, Darcy's and Chezy's equations (without derivation), Moody's chart 3.4 Water hammer and cavitation, its cause, effect, and remedies. 3.5 Simple numerical examples.
Unit-IV Hydraulic Machines	4.a Explain the construction and working of hydraulic pumps. 4.b Estimate performance parameters of a given centrifugal and reciprocating pump. 4.c Explain the construction and working of the hydraulic turbine. 4.d Explain the construction, working, and application of hydraulic devices.	4.1 Concept, classification, and application of pumps. 4.2 Construction, working, and application of centrifugal pump. i. Types of impeller and casings. ii. Multistage. iii. Priming. iv. Minimum suction depth. 4.3 Construction, working, and application of reciprocating pump. i. Single acting pump ii. Double acting pump iii. Air vessel 4.4 Numerical on a reciprocating and centrifugal pump. 4.5 Concept of gear pump and vane pump. 4.6 Layout and features of a hydroelectric power plant. 4.7 Classification, construction, working principle, and applications of turbines:

		i. Pelton turbine ii. Francis turbine iii. Kaplan turbine 4.8 Types, construction, and working of draft tubes. 4.9 Concept of hydraulic devices. 4.10 Construction, working, and application of: i. Hydraulic press ii. Hydraulic accumulator iii. Hydraulic ram iv. Hydraulic coupling v. Hydraulic intensifier.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fluid and Fluid Properties	03	3	4	-	7
II	Fluid Mechanics and Flow Measurement	10	6	8	7	21
III	Flow Through Pipes	04	3	4	7	14
IV	Hydraulic Machines	11	8	6	14	28
Total		**28**	**20**	**22**	**28**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Prepare a chart/presentation to select particular pressure measuring device for a particular application.
2.	Prepare a chart/presentation for a selection criterion for flow-measuring devices.
3.	Prepare a chart/presentation for a selection criterion for pipes and pipe sizes.
4.	Prepare a chart/presentation to select a particular pump for a particular application.
5.	Prepare a chart/presentation to select a particular hydraulic pump for a particular application.
6.	Prepare a tabulated summary of the types of pipes available in the market. (Summary includes type, specification, size range, material, rate, and applications).
7.	Identify any one hydraulic pump and one prime mover available in the market in a group of five students with detailed specifications and current prices.
8.	Visit a nearby related industry and prepare a summary of hydro-pneumatic devices used and their specifications.
9.	Select at least three problems on the manometer and prepare a report containing their solutions.

10.	Select at least three problems on the manometer and prepare a report containing their solutions.
11.	Select at least three problems regarding the continuity equation and prepare a report containing their solutions.
12.	Select at least three problems regarding Bernoulli's equation, and p prepare a report containing their solutions.
13.	Select at least five problems regarding discharge measurement and prepare a report containing their solutions.
14.	Select at least three problems to determine major and minor losses and prepare a report containing their solutions.
15.	Select at least two problems to type of flow (Based on Reynold's number) and prepare a report containing their solutions.
16.	Select at least three problems to determine major and minor losses and prepare a report containing their solutions.
17.	Select at least two problems to determine the power/efficiency of the Reciprocating and Centrifugal pump and prepare a report containing their solutions.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Fluid Mechanics and Hydraulic Machinery being a fundamental subject, teachers are expected to lay considerable stress on understanding the basic concepts, principles, and applications. For this purpose, teachers are expected to give simple problems in the classroom and provide tutorial exercises to develop the necessary knowledge for comprehending the basic concepts and principles. As far as possible, teaching the subject is supplemented by demonstrations and practical work in the laboratory.

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Fluid and Fluid Properties	
II	Fluid Mechanics and Flow Measurement	o Real-life examples, Demonstration of natural systems, Movies/Animations, Numericals, Massive Open Online Courses (MOOCs).
III	Flow Through Pipes	o Real-life examples, Demonstration of natural systems, Movies/Animations, Numericals, Massive Open Online Courses (MOOCs).
IV	Hydraulic Machines	o Real-life examples, Demonstration of natural systems, Movies/Animations, Numericals, Massive Open Online Courses (MOOCs).

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-projects are group-based (groups of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more COs which are, in fact, an integration of PrOs, UOs, and ADOs. Each student must maintain a dated work diary consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the

COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty could add similar micro-projects in any form (chart/presentation/report/model):

1. Compare the following liquids concerning their density (for the same mass, compare the volume) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
2. Arrange the situations of H_2O at atmospheric pressure in ascending order (with reason) concerning their density.

   (a) Ice at -10℃, (b) Water at 30℃, (c) Water at 100℃, (d) Dry and saturated Steam at 100℃
3. Arrange the situations of H_2O at an atmospheric temperature in ascending order (with reason) concerning their density.

   (a) Water at atmospheric pressure, (b) Water at 10 bar, (c) Water at 40 bar
4. Compare the following liquids concerning their viscosity (for the same temperature, compare the velocity) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
5. Calculate the water weight when your home's water tank is completely filled with water.
6. Calculate the water pressure at different Discharge points (different floors) based on the equation $p = \rho gh$ and explain the phenomena variation of pressure at different floors.
7. Observe the working of a Hydraulic Jack at any garage and relate it with Pascal's law.
8. Measure the fluid pressure of the suction and discharge pipe of the pump and convert it into absolute pressure.
9. Observe the discharge water condition from a pipe at the time of car washing with a nozzle and without a nozzle and explain the difference considering Bernoulli's equation.
10. Observe discharge water condition from a pipe at fully and partially opened cock/valve/tap and explain the difference considering the continuity equation.
11. Draw a line diagram of the water supply & distribution line of your hydraulic lab and indicate the source of major and minor losses in it.
12. Visit the manufacturer's website for hydraulic pumps, collect the catalog, and select a suitable pump for your home application.
13. Calculate the major loss occurring in your hydraulic lab's water supply and distribution lines.
14. Indicate all sources of minor losses occurring in your hydraulic lab's water supply and distribution lines and give possible solutions to minimize these losses.
15. Prepare a demonstration model of the hydroelectric power plant.
16. Prepare a demonstration model of the hydraulic devices.
17. Gather information on prime movers of different hydroelectric power plants in Gujarat.
18. Select a pump for a coolant recirculation in a lathe machine, garage pump for car washing, Bore well pump, pump at a service station, pump used in water coolers, or pump in a purified water filter system with justification.
19. Download/collect a catalogue of pump manufacturers like Kirloskar, Shakti, Jyoti, Lubi, KSB, Havells, etc., and compare their parameters.

20. Prepare a display chart of types of pipes based on material. size and applications.
21. Observe pressure gauges used by roadside tire workers, blood pressure measurement by doctors., and pressure gauges mounted on a turbine test rig and write a report on it.
22. Visit nearby shops to identify different PVC and GI pipe fittings. Collect manufacturing catalogues related to the same.
23. Prepare any non-Newtonian fluid and compare its characteristics with Newtonian fluid.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	A Textbook of Fluid Mechanics & Hydraulic Machines	Dr. R.K.Bansal	Lakhsmi publication (P) Ltd
2	Hydraulic & Hydraulic Machines	R.C. Patel & A.D. Pandya	Acharya Book Depot
3	Fundamental of Fluid Mechanics (in SI units)	Dr. D.S. Kumar	Katson Pub. house
4	Fluid Mechanics, Fundamentals, and Applications	Yunus A. Cengel, John M. Cimbala	MC-Graw Hill, Higher Education
5	Hydraulics and Fluid Mechanics, Including Hydraulics Machines	Dr. P. N. Patel, Dr. S. M. Seth	Rajsons Publications Pvt., Ltd.
6	Fluid Mechanics and Hydraulic Machines	R. K. Rajput	S. Chand & Company Ltd.

14. SOFTWARE/LEARNING WEBSITES

1. https://nptel.ac.in/courses/112105206
2. https://nptel.ac.in/courses/112104117
3. https://nptel.ac.in/courses/112103249
4. https://www.classcentral.com/course/youtube-fluid-mechanics-concept-derivation-videos-53034
5. https://fmc-nitk.vlabs.ac.in/fluid-machinery/exp/centrifugal-pump/index.html
6. https://me.iitp.ac.in/Virtual-Fluid-Laboratory/
7. https://eerc03-iiith.vlabs.ac.in/List%20of%20experiments.html
8. https://fm-nitk.vlabs.ac.in/List%20of%20experiments.html

15. PO-COMPETENCY-CO MAPPING

Semester IV	Fluid Mechanics and Hydraulic Machinery (4341903)						
	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ developmentof solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Select, operate and maintain fluid machinery based on fluid laws and characteristics.						
CO-1: Identify fluid properties and their effect on the flow system.	3	-	-	-	-	-	3
CO-2: Apply various laws of fluid mechanics to various real-life applications.	2	3	2	3	-	-	3
CO-3: Estimate various flow losses to select suitable pipe as per the given situation.	2	3	-	2	2	-	2
CO-4: Select a hydraulic machine for a particular application.	2	3	-	3	3	-	2

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE(GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. Nisha Pandya	Government Polytechnic, Himatnagar	9426352574	nishacryo8@gmail.com
2.	Prof. (Dr.) Mihir Patel	B. & B. Institute of Technology, Vallabh Vidyanagar	9426033823	mihireagle@yahoo.co.in
3.	Prof. (Dr) Rakesh Bumataria	Government Polytechnic, Porbandar	9924402808	rakesh.bumataria@gmail.com
4.	Prof. Sumeet Kotak	Government Polytechnic, Jamnagar	9033906004	sumeetp.kotak@gmail.com

17 BOS Resource Persons

Sr. No.	Name and Designation	Department	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS (Chairman HOD Mechanical Engg.)	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel (BOS Member, HOD Mechanical Engg.)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah (BOS Member, Principal)	B. V. Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
IV – Semester

Course Title: Manufacturing Engineering-II
(Course Code: 4341904)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

This subject of Manufacturing Engineering Processes provides knowledge and embeds skill to students to develop different products using various machining process. Manufacturing processes are the most important element in any engineering industry. Mechanical Engineer is a key person for shop floor activities related to manufacturing. He/she should have knowledge and associated skill of machining processes to produce quality products at optimum cost. This course will make student familiar with fundamentals of cutting mechanics, kinematics, constructional features and selection criterion for various basic machine tools and automates with some basic exposure to conventional work holding devices and cutting tools and tool holders used on the same machines. Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Describe mechanics of cutting, calculate cutting parameters &its effects
CO-2	Demonstrate working of basic machine tools with kinematics.
CO-3	Select appropriate grinding processes, grinding machine, grinding wheels.
C0-4	Select tool and tool holder.
CO-5	Identify the machine tool, able to operate machine tool and select cutting parameters for given job.
CO-6	Produce the job as per given manufacturing drawing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25*	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken

during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Preparatory Activity:** **a.** For given work piece and tool material; select, set and observe cutting speed, feed and depth of cut on lathe machine. Also define these terms. **b.** Calculate metal removal rate (MRR) for above case. **c.** Calculate revolution per minute (RPM) for lathe, milling cutter and drill spindle based on given data.	1	04
2	**Effect of Various Input Variables on Output variables during machining processes:** Demonstrate type of chips, surface finishes and tool life for varying cutting parameters for different work piece material and tool material. Tabulate the observations.	1	02
3	**Turning Job:** Prepare a job on center lathe as per the given drawing. (Including plain turning, step turning, taper turning, threading, knurling, grooving, Etc.) Student will also prepare report including: **a.** Drawing of the job. **b.** Operation sequences including details of cutting parameters used. **c.** Sketch of cutting tools used. **d.** Specification of machines used.	2	08
4	**Milling Job:** Prepare a simple job using milling operations including use of indexing head (Excluding gear tooth cutting). Student will also prepare report including: **a.** Drawing of the job(like hexagon, pentagon) **b.** Operation sequences including details of cutting parameters used. **c.** Specification of machines used. **d.** Machine settings for indexing.	4	06
5	**Shaping and Drilling Job:** Prepare a job having plain surfaces on shaping machine with minimum two holes as per given drawing. Student will also prepare report including: **a.** Drawing of the job. **b.** Operation sequences including details of cutting parameters used. **c.** Specification of machines used.	3 & 5	04

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	**Grinding Process** Prepare a job on Grinding machine (surface and cylindrical) as per the given drawing. (Suggestion: use same job as prepared in 4&5 for grinding operation of flat and cylindrical surface). Student will also prepare report including: **a.** Drawing of the job. **b.** Specification of machines used. **c.** Grinding wheel used.	7	02
7	**Industrial Visit:** Visit a nearby machine shop and prepare a two page report comprises of list of machine tools including automates, its technical specification, machining parameters for various operations being performed, cutting tools and work holding devices used, observation of skill and safety criteria.	All	00
8	**Mini Project and Presentation:** For a given product (different for each student) prepare complete report in suggested format including selection of raw material type & section, sequence of various Machining operations, selection of machine, machining parameters, work holding device, tool , etc. For each machining operation. Each student will also present the outcome.	All	02
		Total	**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. Care must be taken in assigning and assessing study report as it is a Second-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify machine tools & their equipment's (Knowledge)	10
2	Able to operate, set the machine and select machining parameters. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No	Equipment Name with Broad Specifications	PrO. No.
1.	Hacksaw machine.	2 to 5
2.	Lathe with standard and special accessories.	2
3.	Milling machines-Vertical /horizontal with standard accessories and indexing/dividing head.	3
4.	Column drilling or Radial Drilling machine	4
5.	Shaper machine.	5
6.	Tool and cutter grinder	2 to 5
7.	HSS cutting tool and their tool holders	2 to 5
8.	Carbide inserts and their tool holders	6
9.	Drill bit and their tool holder	4
10.	Surface grinding machine	7
11.	Cylindrical grinding machine	7

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I **Introduction and mechanics of cutting**	1a. Explain mechanics of cutting.	1.1 Introduction of Machining Process used in industries & Safety 1.2 Mechanics of cutting action, 1.3 Forces acting on tool and chip, tool dynamometer 1.4 Orthogonal and oblique cutting. (Without derivation).
	1b. Explain the effect of varying cutting parameters.	1.5 Chip formation, types of chips. 1.6 Concept cutting parameter

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		1.7 Effect of cutting parameters on surface finish, tool life, economy, and mass production. 1.8 Cutting fluid- Properties, type, application
Unit – II **Basic machine tools Lathe Machine**	2a. Explain classification, working principles, construction and operation of lathe 2b. Describe mechanism & motion transmission in lathe. 2c. Explain work holding& Tool holding devices for lathe	2.1 Define and classify basic machine tools. 2.2 Lathe machine. i. Working principle (using block diagram). ii. Detailed specifications. 2.3 All geared head stock center lathe. i. Constructional features. ii. Kinematics (Drive, Feed mechanism, apron mechanism) constructional sketch, working, and application iii. Operations performed. iv. Work holding devices- (3 jaw chuck, 4 jaw chuck, face plate, centers). v. Thread cutting setting-concept methods and simple numerical. vi. Tapper turning Method 2.4 Metal removal rate (MRR) – concept and method to calculate on lathe.
Unit – III **Basic machine tools Milling Machine**	3a. Explain classification, working principles, construction and operation of milling machine. 3b. Describe mechanism & motion transmission in milling machine. 3c. Select appropriate Milling cutter for required milling operation.	3.1 Milling machine. i. Types.(Horizontal/Vertical) ii. Working principle (using block diagram). iii. Detailed sample specifications. 3.2 Construction & Operation. i. Constructional features. ii. Kinematics (drive, spindle speeds, feed mechanism, table movement, etc.) constructional sketch, working, and use. iii. Operations performed. iv. Up milling and down milling 3.3 Milling cutters-types and applications. 3.4 Work holding devices- constructional sketch, working and applications. 3.5 Simple indexing methods with simple numerical.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-VI **Basic machine tools Drilling Machine**	4a. Explain classification, working principles, construction and operation of drilling machines. 4b. Select work & Tool holding devices for drilling machines.	4.1 Drilling machine. i. Types. ii. Working principle (using block diagram). iii. Detailed specifications. 4.2 Radial drilling machining. i. Constructional features. ii. Operations performed. iii. Work holding devices- constructional sketch, working and application iv. Tool holding and setting methods. 4.3 Metal removal rate (MRR) – concept and method to calculate on drilling machine.
Unit – V **Basic machine tools Shaper & Planning Machines**	5a. Explain types, working principles, construction and operations of shaping, and planning machines. 5b. Select work & Tool holding devices for shaping and planning machines.	5.1 Shaping machine & Planning machine i. Working principle (using block diagram). ii. Constructional features and detailed specifications. iii. Quick return mechanisms- kinematic sketch, working and advantages. iv. Operations performed. v. Work holding & tool holding devices.
Unit VI **Cutting tools and tool holders**	6.a Select cutting tool material 6.b Select cutting tool for different operation to perform 6.c Interpret carbide insert and tool holder designation system. 6.d Explain tool angles of cutting tools and their importance. 6.e Explain factors affecting tool life.	6.1 Various cutting tool materials, their compositions and properties. 6.2 Cutting tools and its types. i. Various types Single point cutting tool. ii. Plain milling cutter. iii. Side and face milling cutter. iv. Centre drill. v. Twist drill. 6.3 Carbide inserts: i. Types of carbide Inserts ii. Needs and benefits of carbide inserts iii. ISO designation of carbide inserts iv. Mounting and replacement methods of carbide insert. 6.4 Tool Nomenclature and tool geometry i. Single point cutting tool ii. Plain milling cutter iii.Twist drill 6.5 Tool life, Tool wear and Machinability i. Definition ii. Methods for calculation with example

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit VII **Grinding processes.**	7.a Explain grinding process and its type 7.b Describe constructional features and working of various grinding machines 7.c Select appropriate finishing operation and grinding machine as per production drawing of the component. 7.d Select proper grinding wheels for various grinding process	7.1 Describe grinding Process i. Definition ii. Basic Working Principle 7.2 Grinding Machine i. Classification and construction of grinding Machines (Surface, cylindrical, Centre less, tool & cutter grinding machine) ii. Basic Detail specification iii. Grinding Operations 7.3 Honing, lapping and super finishing process i. Constructional & Working Principle ii. Difference between honing, lapping and super finishing 7.4 Grinding wheel i. Abrasive grain ii. Bonding material iii. Nomenclature of grinding wheel iv. Selection and application of grinding wheel 7.5 Terms Associated with grinding wheel i. Loading, Glazing, Trueing, Dressing ii. Self-sharpening action of grinding wheel

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction and mechanics of cutting	**4**	**3**	**3**	**2**	**8**
2	Basic machine tools-Lathe Machine	**8**	**3**	**4**	**7**	**14**
3	Basic machine tools- Milling Machine	**8**	**3**	**3**	**6**	**12**
4	Basic machine tools-Drilling Machine	**4**	**2**	**2**	**4**	**8**
5	Basic machine tools-Shaper & Planning Machines	**6**	**2**	**3**	**3**	**8**
6	Cutting tools and tool holders	**6**	**2**	**5**	**3**	**10**
7	Grinding processes	**6**	**2**	**3**	**5**	**10**
Total		**42**	**17**	**23**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Select two industrial components (approved by teacher) and list various machine tools and operations used to produce these components.
b) Prepare a list of surrounded items which are prepared by machining processes.
c) Collect/download at least four different machine tool catalogues and make report of that with price.
d) List various machine tools (min. 5 machine) currently using in market for different operation to perform.
e) Identify the process use for re-sharpening different types of tools and prepare report for minimum 3 tools

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) To acquire knowledge of basic machine, tool and their operation arrange two or more **industrial visit** of production industry. After visit student must be submit their industrial visit report.
c) Guide student(s) in undertaking micro-projects.
d) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
e) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
f) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a small useful product like various machining parts assembly/v-block/ cutting tools/work holding devices/small laboratory equipment/set-up utilizing laboratory resources.
b) Using Drafting software, prepare machining products drawing with tolerances, quality measure.
c) Survey/Visit nearby vendor lathe, drilling, milling and shaper etc. machining process and prepare report on products manufacture.
d) Maintenance of available infrastructure related to.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Machining and Machine Tools	A.B. Chattopadhyay	Wiley
2	Fundamentals of Machining Processes	Hassan Abdel-Gawad El-Hofy	CRC Press ISBN-13978-0849372889
3	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Company(P) Limited
4	Production Technology (Manufacturing Process)	Dr. P C Sharma	S Chand
5	All about Machine Tools	HEINRICH GERLING	New Age International Private Limited
6	Production Technology	R. K. Jain and S. C. Gupta	Khanna Publishers
7	Elements of Workshop Technology Volume No. II Machine Tools	Hajra Choudhary, Bose S. K., Roy Nirjhar	Media promotors and publishers pvt. Limited
8	Production Technology	HMT	Tata Mcgraw-Hill Publishing Co.

14. SOFTWARE/LEARNING WEBSITES

i. http://nptel.iitm.ac.in/video.php?subjectId=112105126
ii. http://nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Manuf%20Proc%20II/pdf/LM-01.pdf
iii. http://www.youtube.com/watch?v=H0AyVUfl8-k&list=PLEFE7D1579523C45D
iv. http://www.youtube.com/watch?v=FFzRIop5bpg&list=PL843C2A830C65E2EE
v. http://www.youtube.com/watch?v=81Fdif5e85c
vi. http://www.youtube.com/watch?v=A0dTvf_Q8BA&list=PL2C105C94D2955C8B
vii. http://www.youtube.com/watch?v=tDc0l9Gm8D4&list=PL3AFB507B668AF162
viii. http://www.youtube.com/watch?v=THVgkBnjLq0
ix. http://www.youtube.com/watch?v=6VpCBk7FahI
x. http://www.youtube.com/watch?v=7wC1u4WOV1o
xi. http://www.youtube.com/watch?v=VDIoUZuTunI

xii. http://www.youtube.com/watch?v=Mn9jpqI8rao
xiii. http://www.youtube.com/watch?v=8SuoH5aL1SY
xiv. http://www.youtube.com/watch?v=xxNZSQML_ZA
xv. http://www.youtube.com/watch?v=XXUHZxweBcw&list=PLD07DE61CB871A0CB
xvi. https://nptel.ac.in/courses/110106146
xvii. https://www.youtube.com/watch?v=gcWj4OcteTk
xviii. https://nptel.ac.in/courses/112103250
xix. https://www.youtube.com/watch?v=IXYZLxNd-a8
xx. https://www.youtube.com/watch?v=GNLQ81WOytU

15. PO-COMPETENCY-CO MAPPING

Semester IV	Manufacturing Engineering-II (4341904)						
	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	**Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**						
CO 1. Describe mechanics of cutting, calculate cutting parameters &its effects	3	3	2	2	--	--	--
CO 2. Demonstrate working of basic machine tools with kinematics.	3	--	--	2	--	--	--
CO 3. Select appropriate grinding processes, grinding machine, grinding wheels.	3	--	--	3	--	--	2
CO 4. Select tool and tool holder.	3	--	--	3	2	2	2
CO 5. Identify the machine tool, able to operate and select cutting parameters for given job.	3	2	2	3	2	3	2
CO 6. Make the job as per given manufacturing drawing.	3	--	--	3	2	2	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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BOS Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-IV

Course Title: Thermal Engineering-I
(Course Code: 4341905)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

Mechanical engineers are supposed to operate and maintain thermal utility equipment in industries. This course will provide the basic knowledge of thermal engineering, which will function as a foundation for applications in significant mechanical engineering and technology fields, notably in thermal power plants. This course would develop basic knowledge and skills related to boilers, boiler mounting and accessories, steam turbines, condensers, cooling towers, air compressors, heat transfer, and heat exchangers. This course will thus very essential for mechanical engineers, especially in power plants, processes, food, pharmaceutical, refineries, etc.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Apply basic concepts, laws, and principles of thermal engineering to operate and maintain the equipment and machines working on thermal systems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Determine steam properties using a steam table and a Mollier chart.
CO-2	Evaluate the boiler performance based on given parameters and operational data sheets.
CO-3	Identify various features of steam nozzles, steam turbines, condensers, and cooling towers.
CO-4	Calculate the power requirement and volumetric efficiency of air compressors.
CO-5	Determine heat transfer parameters related to heat exchangers for different situations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Determine the steam properties using: a) Steam table b) Mollier chart	1	04
02	Demonstrate Steam boilers.	2	02
03	Demonstrate boiler mountings and accessories.	2	02
04	Determinate boiler efficiency, equivalent evaporation, and heat balance sheet by collecting data from the industry.	2	04
05	Demonstrate various steam turbines.	3	02
06	Demonstrate steam condensers.	3	02
07	Performance test on the condenser to determine the condenser efficiency.	3	02
08	Demonstrate cooling towers.	3	02
09	Performance test on reciprocating air compressor and determine its volumetric efficiency.	4	04
10	Determine the overall heat transfer coefficient and LMTD of a heat exchanger.	5	04
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data (which and why) before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 2, 3, 5, 6 & 8)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Experimentation/performance type PrOs (PrOs Number: 1, 4, 7, 9 & 10)		
1	Knowledge	20
2	Procedure follows	15
3	Observation Skill	20
4	Analysis	10
5	Quality of Report	20
6	Punctuality	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 2, 3, 5, 6 & 8)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Experimentation/performance type PrOs (PrOs number: 1, 4, 7, 9 & 10)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Procedure follows	15%	Students follow all the procedures with precaution in a logical order.	Students follow all the procedures with some precautions in a logical order.	Students follow all the procedures without precaution in a logical order.	Students follow all the procedures without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Analysis	10%	Student understand the data and analyze correctly the obtained test results.	Student understand most of the data and analyze the obtained test results with help or support.	Student need help to understand some of the data and also in analyzing the obtained test results.	Student always need help to understand the data and also in analyzing the obtained test results.
Quality of Report	20%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Models of various steam boilers.	2

2.	Models of various boiler mountings and accessories.	3
3.	Models of various steam turbines.	5
4.	Models of various steam condensers.	6
5.	Models of various cooling towers.	8
6.	Two-stage reciprocating air compressor test rig.	9
7.	Parallel and counter flow heat exchanger test rig.	7, 10

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Steam Formation and its Properties	1.a Describe the steam formation process and terminology. 1.a Use of steam table and Mollier chart to determine the properties of steam.	1.1 Formation of steam with the concept of a two-phase system. 1.2 Steam types and their representation on PV, T-s, and h-s diagrams. 1.3 Determination of various steam properties: i. Sensible heat ii. Latent heat iii. Superheat iv. Enthalpy v. Entropy vi. Degree of superheat

		1.4 Use of steam table and Mollier chart. 1.5 Simple numerical examples based on steam properties.
Unit – II Steam Generators	2.a The layout of the Steam Power Plant. 2.b Explain the construction and working of boilers 2.c Function and location of boiler mountings and accessories. 2.a Calculate the boiler performance.	2.1 Concept and layout of a thermal power plant. 2.2 Steam boiler: Concept, definition as per Indian Boilers Regulation (IBR). Classifications and Applications. 2.3 Construction and working of steam boilers with draught concept: i. Cochran boiler. ii. Babcock and Wilcox boiler. iii. Packaged boiler. iv. Recent boilers in industries: (a) FBC Boiler (a.1) AFBC, (a.2) CFBC (b) Low NO_x boiler, (c) Waste heat recovery boiler. 2.4 Boiler mountings and accessories i. Function ii. Location. 2.5 Boiler performance i. Evaporative capacity ii. Equivalent of evaporation iii. Efficiency iv. Heat balance sheet, 2.6 Simple numerical examples
Unit-III Steam Turbines, Steam Condensers, and Cooling Towers	3.a Explain the construction and working principle of a Steam turbine. 3.b Importance of compounding in a steam turbine. 3.c Describe the working of surface condensers. 3.d Determine the Effectiveness of condensers. 3.a Describe the working of cooling towers.	3.1 Steam turbine: i. Concept ii. Classifications iii. Construction and working of impulse and reaction turbine iv. The necessity of compounding and its types 3.2 Steam condensers: i. Concept ii. Functions and classification iii. Construction and working of surface condensers. iv. Condenser efficiency v. Simple numerical example 3.3 Cooling Towers: i. Concept ii. Function and classification 3.4 Construction and working
Unit-IV Air Compressors	4.a Explain the principle, construction, and working of air compressors. 4.a Calculate power	4.1 Concepts, classification, and applications. 4.2 Construction and working of Reciprocating air compressor: i. Single stage

	requirement and volumetric efficiency of reciprocating air compressor.	ii. Multi-stage (without & with intercooler) iii. Power required and efficiency iv. Simple numerical 4.3 Construction and working of Dynamic air compressor: i. Centrifugal i. Axial
Unit-V Heat Transfer and Heat Exchangers	5.a Describe modes of heat transfer. 4.b Calculate the overall heat transfer coefficient and LMTD.	5.1 Concept of conduction, convection, and radiation. 5.2 Heat exchanger: i. Concept, classification, and application ii. Logarithmic Mean Temperature Difference (LMTD) (No derivation) 5.3 Simple numerical examples.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Steam Formation and its Properties	06	7	3	4	14
II	Steam Generators	07	4	4	7	15
III	Steam Turbines, Steam Condensers, and Cooling Towers	07	7	10	-	17
IV	Air Compressor	05	3	4	7	14
V	Heat Transfer and Heat Exchangers	03	3	-	7	10
Total		**28**	**24**	**21**	**25**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Prepare a chart/presentation to select a particular boiler for a particular application.
2.	Prepare a chart/presentation for a selection criterion for a condenser.
3.	Prepare a chart/presentation for a selection criterion for the cooling tower.
4.	Prepare a chart/presentation to select a particular air compressor for a particular application.
5.	Prepare a chart/presentation to select a particular heat exchanger for a particular application.
6.	Select at least three problems on the boiler performance and prepare a report containing their solutions.
7.	Collect/ download product catalogues with a specification of various types of energy conservation equipment/ devices and heat exchangers of recent trends.

8.	Identify and list at least ten devices that require heat transfer and prevention of heat transfer. Also, state the mode of heat transfer and methods used to prevent heat transfer.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Steam Formation and its Properties	
II	Steam Generators	
III	Steam Turbines, Steam Condensers, and Cooling Towers	o Real-life examples, Demonstration of natural systems, Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs)
IV	Air Compressor	o Real-life examples, Demonstration of natural systems, Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs)
V	Heat Transfer and Heat Exchangers	o Real-life examples, Demonstration of natural systems, Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs)

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. The number of studentsin the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more COs with in integration of PrOs, UOs, and ADOs. Each student must maintain a dated work diary (Logbook) consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model):

1. Prepare a demonstration model of the thermal power plant.
2. Collect information about different thermal power plant in plants located in Gujarat and compare major thermal devices.
3. Prepare a display chart of different types of condensers along the with application.
4. Prepare a display chart of different types cooling towers along the with application.
5. Prepare a tabulated summary of the types of air compressors available in the market. (Summary includes type, specification, rate, and applications).
6. Collect and analyze technical specifications of Reciprocating / Rotary Air Compressors from manufacturers' websites and other resources.
7. Carry out a comparative study of conventional boilers used in power plants and the upcoming latest technologies in a boiler.
8. Arrange a visit and prepare a Report on Thermal Power Plant.

9. Undertake 2 to 5 days of training in a Thermal Power Plant.
10. Make a PowerPoint presentation on the latest industry trends in turbines and condenser.
11. Make a Model of any heat exchanger with parallel and counter flow arrangement in a workshop with 4-6 students in a group.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	A Textbook of Thermal Engineering	R S Khurmi & J K Gupta	S. Chand & Co.
2.	Thermal Engineering	R K Rajput	Laxmi.Publications
3.	Thermodynamics and Heat Power Engg.	Mathur and Mehta	Tata Mcgraw- Hill
4.	Heat Engines	Pandya and Shah	Charotar Publishing House
5.	Heat and mass transfer	R K Rajput	S. Chand & Co.
6.	Heat and mass transfer	D S Kumar	S K Kataria & Sons
7.	Thermal Engineering	P. L. Ballaney	Khanna Publishers

14. SOFTWARE/LEARNING WEBSITES

1. https://www.spiraxsarco.com/resources-and-design-tools/steam-tables/superheated-steam-region
2. https://virtuallabs.hkust.edu.hk/TubularHeatExchanger/VirtualExperiment
3. https://www.youtube.com/watch?v=EGFDqqX_Iek&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=7
4. https://www.youtube.com/watch?v=h1Yt4ibYXfA&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=12
5. https://www.youtube.com/watch?v=DuLFDzQVTU4&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=16
6. https://www.youtube.com/watch?v=mHcZdknYtkY
7. https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=709&cnt=4
8. https://vlab.amrita.edu/index.php?sub=1&brch=194
9. Aspen plus simulation software
10. EES(Engineering Equation Solver) software

15. PO-COMPETENCY-CO MAPPING

Semester IV	Thermal Engineering-I (4341905)						
	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Apply basic concepts, laws, and principles of thermal engineering to operate and maintain the equipment and machines working on thermal systems.						
CO-1: Determine steam properties using a steam table and a Mollier chart.	2	2	-	-	-	-	3
CO-2: Evaluate the boiler performance based on given parameters based on operational data sheets.	2	3	-	-	-	-	2
CO-3: Identify various features of steam nozzles, steam turbines, condensers, and cooling towers.	2	-	-	-	2	-	2
CO-4: Calculate the power requirement and volumetric efficiency of air compressors.	-	3	-	3	-	-	2
CO-5: Determine heat transfer parameters related to heat exchangers and other situations.	2	3	-	3	-	-	2

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

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17. BOS Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-IV

Course Title: Plant Maintenance & Safety
(Course Code: 4341906)

Diploma Programs in which this course is offered	Offered in
Mechanical Engineering & Mech. Engg. (CAD/CAM)	4th Semester

1. RATIONALE

In industries, the mechanical engineers/technicians are supposed to manage functioning of equipment/machines. With proper planning, operation and adaption of maintenance schedule, one can manage to run the machines continuesly with good efficiency.

The objective of plant maintenance is **to achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost**. Machines and other facilities should be kept in such a condition which permits them to be used at their optimum (profit making) capacity without any interruption or hindrance

Students need to know about the combination of maintenance with safe conditions for better performance simultaneously. Students must be able to recognize the possible hazards and adverse effects while working for the maintenace work at site.

2. EXPECTED COMPETENCY

The importance of this course is closely related to the ability of the student to understand and analyse to find problem solutions for detected faults for machines and automation processes.

The course content should be taught and implemented with the aim to inculcate the safety practice while working on the machines and different types of skills so that students are able to acquire the following competency:

"Use ethics of assembly / dis-assembly in maintenance of various mechanisms, machines, and equipment with safety aspects"

3. COURSE OUTCOMES (COs)

The practical exercises, the relevant skills associated with this competency are to be developed in the student to satisfy the following COs:

CO	Statement
CO1	**Understand different types unit systems and types of toolings prevailing in the market.**
CO2	**Understand ethics of dismentaling and assembling the job with proper usage of tools for different machines and mechanisms**
CO3	**Justify the role of maintenance in engineering along with selection of suitable**

	maintenance procedures.
CO4	**Recognise the concept of safety for possible threats/hazards while working**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	50
0	0	2	1	0	0	25	25	

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, PA - Progressive Assessment; ESE - End Semester Examination.

5. SUGGESTED LIST OF EXERCISES/PRACTICALS

Sr No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs.
1	**Preparatory Activity:** i. Interpret and write various types of units (i.e.,Foot/Pound/Second (FPS) system prevails in the most of the industries till today. So compare it with MKS and SI units and their conversions by table. Also comopare the types of threads i.e., Metrics Vs BSW/BSP) ii. Demonstration and report writing of various types of tools (Spanners, allen keys, pliers, Taps & wrenches to get internal small threadings, dies and die holders to get threads on pipes, bearing pullers, flaring tool kit for tubing operations in ACs, Water coolers and Refrigerators …etc,). iii. Report writing regarding gauges whih are used for pipes, wires, metal sheets etc., along with their impact on cost. Also get list of commercial lubricants and the meanings of their properties to get proper selection for lubrication and overhauling to machines	06
2	**Study the types of plants and their maintenance** (i.e, Chiller palnt, Power plant, Process Plant, manufacturing..etc and preventive, predictive, condition monitoring, corrective, break down..etc)	02
3	**To study and perform the Maintenance of Mechanical Based Equipment/Device/Machine:** Overhauling/Servicing of following are to be done and make the report along with snapshots of students while on the work of that **(Approx. 4-5 students in each group)** i. Head stock /Tail stock /Carriage of lathe ii. Indexing head/Milling table mechanism / True Chuck iii. Water cooler / Window AC/ Split Ac / Refrigerator of the institute	04

Sr No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs.
	iv. Shutter/Gates / R O system / any other similar auxiliary of the institute	
4	**To study Fault Tracing / Decision Tree and preparation of detail report:** Develop decision tree to locate/identify the possible fault for following items i. If your petrol two wheeler vehicle doesn't start ii. If your domestic fluid/water pump doesn't work effectively iii. Jaw of the chuck doesn't rotate iv. Indexing mechanism of milling machine doesn't work properly and get stuck	04
5	**Prepare report on Preventive and periodic Maintenance for any workshops/plants:** (**Approx. 4-5 students in each group)** Collect and Prepare a preventive and periodic maintenance schedule of any institute/nearby workshop having- full fledge machines and mechanisms ie., near by manufacturing unit / power plant/ cold storage or chiller plant of mall or a theatre	02
6	**Prepare a report on recognition of threats at work place with sign boards/safety symbols along with causes of Accidents** i. Causes of Accident ii. Enlist / Designate the neccesary safety symbols required to create awareness among the industrial workers by using sign boards iii. Prepare and display different posters/sign boards for safety symbols (Attach group photo with posters/ banner in the report)	02
7	**Study the report on requirement and usage of safety equipments to prevent any hazards or accident :** i.e., safety helmets, gloves, eye protection/high-visibility goggles, safe clothing**,** safe footwear, and respiratory protective equipment (RPE).	02
8	**Study the impact of cost/time for various assembly methods** (i.e different ways of assembly / dis assembly methods)	02
9	**Mini Project And Presentation** a. Identify mechanical based any one equipment /device / machine at institute or near by industries which requires maintenance. b. Prepare general sketch. c. Perform fault tracing and prepare the decision tree. d. Dismantle the job. Write the sequence of dismantling. Also describe the steps. List the tools used for this activity. e. Attendnecessary maintenance tasks.Write thet asks performed. 1. f.Assemble, test and if necessary, modify. Write the steps. 2. g.Prepare power point presentation. Presentation for the project. This must include photographs / prepare video while working on project.	02

Sr No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs.
10	**Industrial Visit**	02

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

'Well Equipped machine shop and workshop will be sufficient for demonstration/study type work'

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfill the development of this course competency.

a. Follow ethical practices.
b. Work as a team leader/a team member.
c. Fault finding and ability to resolve it.

8. SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, the following are the suggested student-related ***co-curricular*** activities that can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct the following activities in a group and prepare reports of each activity. They should also collect/record physical evidence for their (student's) portfolio which will be useful for their placement interviews:

a) Charts can be prepared.
b) A short report on any topic given by concerned faculty
c) Small groups of students can be formed for assigned work. Assigned work should be such that it encompasses market survey, Model making, Powerpoint presentation, time management... etc.

9. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Plant equipment and maintenance engineering handbook 1st Edition	Duncan C, Rechardson PE	Publication Date & Copyright: 2014

Sr. No	Title of Book	Author	Publication with place, year and ISBN
			McGraw-Hill Education
2	Industrial maintenanace management	S K Srivastava	S chand & co
3	Process equipment malfunctions : Techniques to identify plant problems	Norman P. Lieberman	Publication Date & Copyright: 2011 McGraw-Hill Companies, Inc.

10. SOFTWARE/LEARNING WEBSITES

i. https://nptel.ac.in/courses/112105048
ii. https://onlinecourses.nptel.ac.in/noc20_ce09/preview
iii. https://youtu.be/ZEShNJX3kcg
iv. https://youtu.be/bzG8xGtj29U
v. https://youtu.be/jamEeEWUa5s
vi. https://youtu.be/222dZ6oKPyg
vii. https://youtu.be/ikbC5_6qTvs
viii. https://youtu.be/VhuZ6M7a8N8
ix. https://youtu.be/SPDKEZBsydg
x. https://youtu.be/Rr-xFmErOTk
xi. https://youtu.be/n7oUOUCIblg

11. PO - COMPETENCY - CO MAPPING

Semester IV	PLANT MAINTENANCE & SAFETY (4341906)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long Learning
CO 1. Understand different types unit systems and types of toolings prevailing in the market.	3	1	-	3	-	-	2
CO 2. Understand ethics of dismentaling and assembling the job with proper usage of tools for different machines and mechanisms	3	-	-	2	1	2	2

CO 3. Justify the role of maintenance in engineering along with selection of suitable maintenance procedures	3	1	-	-	1	1	2
CO 4. Recognise the concept of safety for possible threats /hazards while working relevant safety.	3	-	2	-	2	1	3

12. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
1.	Prof. G R Khunt Sr Lecturer in Mech Engg. Dept	R. C Technical Institute Sola, Ahmedabad.	8128291616	grkhunt@gmail.com
2.	Prof. R A Prajapati Lect. in Mech Engg. Dept.	Government Polytechnic, Ahmedabad	9429435748	raprajapati27@gmail.com
3.	Prof. D N Gondaliya Lect. in Mech Engg. Dept.	Government Polytechnic Porbandar	9909949905	gondaliyadhiren83@gmail.com

BOS Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B.&B. Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	asshah97@yahoo.in

5th Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-V

Course Title: Entrepreneurship & Start-ups
(Course Code: 4300021)

Diploma programmer in which this course is offered	Semester in which offered
All Branches of Diploma Engineering	5th Semester

1. RATIONALE

Entrepreneurs have significant impact on our country's current developing economy. The social expectations towards engineering professionals are certainly emerging as job creators especially with the thrust given to "Make in India" and "Vocal for Local" campaigns. Startup India is a well-known flagship initiative of the Government of India, intended to catalyze startup culture and build a strong and inclusive ecosystem for innovation and entrepreneurship. The last 6 years have witnessed tremendous growth of start-ups i.e. from 733 in 2016-17 to 14000 in 2021-22. This course focuses on the basic roles, skills and functions of entrepreneurship with special attention to startup. The course is directed to help students to enhance capabilities in the field of managing the given task as well as to understand peripheral influencing aspects for starting a new business. It will certainly help students to think in a direction to establish a small industry /start-up and develop /validate it using fundamental know how.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Establish a small enterprise /start-up validate it and make it scalable.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:

1) Understanding the dynamic role of entrepreneurship and Startups by Acquiring Entrepreneurial spirit and resourcefulness, quality, competency, and motivation
2) Identify a Business Idea and implement it
3) Select suitable Management practices like leadership and Ownership, resource institutes
4) Overview of Support Agencies and Incubators
5) Building Project Proposal & knowing CSR , Ethics, Ex-Im, & Exit strategies

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)	Total Credits (L+T+P/2)	Examination Scheme		
		Theory Marks	Practical	Total Marks

						Marks		
L	**T**	**P**	**C**	**CA**	**ESE**	**CA**	**ESE**	
3	0	0	3	30*	70	0	0	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED Soft PRACTICAL EXERCISES (During Theory)

The entrepreneurial or start-up journey begins by readying for your future dream from college projects and pursuing the same beyond college hours also. It is encouraged to go through COs and identify traits and search for various state and national agencies for your entrepreneurship / start-up journey and convert the same into successful product in market.

The following practical outcomes (SPrOs) are the sub-components of the Course Outcomes (COs). Some of the **SPrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Note

i. *Though the course does not contain any Practical work, a few **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The below table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Entrepreneur Traits and Behavior Modelling	30
2	Various State and Central Entrepreneurship Promotional Schemes and Start-up Policies	30
3	Business Model for a Startup and study of Unicorns*	40
Total		**100**

6. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a. Work as a leader/a team member (while doing a micro-project).
b. Model behavioral practices of an entrepreneur while planning for an enterprise
c. Practice ethics and consider methods/ processes that reduce waste and/or possibly conserve environment in designing a new business till it's commercialization.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year-Planning
ii. 'Organization Level' in 2nd year-Model Development
iii. 'Characterization Level' in 3rd year-Make it Scalable

7. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major LearningOutcomes (in cognitive domain)	Topics and Sub-topics
1) Introduction to Entrepreneurship and Start – Ups	1a) Define Entrepreneurship 1b) Discuss characteristics and functions of entrepreneurship. 1c) Identify different types of Entrepreneurships 1d) Compare the concepts entrepreneurand intrapreneur and find out the motivation behind it 1e) Distinguish between entrepreneur and managers 1f) Identify 7-M Resources 1g) Know MSME & Startup India, standup India, SSIP and its registration process for both.	1. Definition, Traits of an entrepreneur, 2. Functions of Entrepreneurship - Job Creation, Innovation, Inspiration, Economic Development 3. Types of Entrepreneurship 4. Motivation for Intrapreneurship 5. Types of Business Structures, 6. Similarities and differences between entrepreneurs and managers. 7. 7-M Resources 8. Micro, Small, Medium Enterprise/ MSME - Industry Registration Process 9. Startup India, Standup India and SSIP Gujarat & Startup registration process

2) Business Ideas and their implement ation (Idea to Start-up)	2a) Finding Ideas and making an activity map 2b) Develop the plans forcreating and starting the business 2c) To identify business using the ideation canvas and the business model canvas 2d) To know market research related terms 2e) To know market mix related terms 2f) Learn Product related terminologies 2g) Emphasize on Innovation 2h) Explain concept of Risk and SWOT	1. Discovering ideas and visualizing the business with Activity map 1.1 Idea Generation 1.2 Product Identification 2. Business Plan- The Marketing Plan and Financial Plan/ Sources of Capital 3. Business opportunity identification and evaluation 4. Market research 4.1.1. Questionnaire design 4.1.2. Sampling 4.1.3. Market survey 4.1.4. Data analysis & interpretation 5. Marketing Mix (4Ps- product,price, promotion place) 5.1.1. Identifying the target market 5.1.2. Competition evaluation and Strategy adoption 5.1.3. Market Segmentation 5.1.4. Marketing, Advertising and Branding 5.1.5. Digital Marketing 5.1.6. B2B, E-commerce and GeM 6. Product Terms- PLC, Mortality Curve and New product Development Steps, Inventory, Supply Chain Management 7. Importance and concept of Innovation, Sources and Process 8. Risk analysis and mitigation by SWOT Analysis
3) Management Practices	3a) Explain the concept and differences between industry, commerce and business. 3b) Describe various types of ownerships in the organization. 3c) Explain different types of leadership models. 3d) Analyze the nature and importance of various functions of management 3e) Discuss Financial organization Management 3f) Distinguish management and administration	1. Industry, Commerce and Business 2. Types of ownership in the organization -Definition, Characteristics, Merits &Demerits 3. Different Leadership Models 4. Functions of Management- Merits & Demerits 4.1 Planning 4.2 Company's Organization Structure 4.3 Directing 4.4 Controlling 4.5 Staffing- Recruitment and management of talent. 5. Financial organization and management 6. Differences between Management and Administration

4) Support Agencies and Incubators	4a) Identify support agencies and current promotional schemes for enterprise and startups 4b) Advocacy to investor 4c) To Explain various Legal Issues	1. State & National Level Support agencies and Current Promotional Schemes for new Enterprise 2. Start-up Incubation and modalities 3. Communication of Ideas to potential investors – Investor Pitch 4. Legal Issues 4.1. Contracts 4.2. Copyrights 4.3. Insurance 4.4. IPR 4.5. Licensing 4.6. Patents 4.7. Trade Secrets 4.8. Trademarks
5) Project Proposal & Exit strategies	5a) To work on the development of a project proposal 5b) Describe social responsibility and relate with economic Performance. 5c) Explain managerialethics 5d) To know Ex-Im Policies 5e) Identify suitable strategies of succession and harvesting	1. Project Planning i. Project planning and report ii. Feasibility study iii. Project cost estimation iv. Breakeven point, v. Return on investment and Return on sales 2. Corporate Social Responsibilities and Economic performance 3. Business Ethics 4. Ex-Im policies 5. Succession and harvesting strategy 6. Bankruptcy and avoidance

8. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Entrepreneurship and Start – Ups	08	4	6	2	12
II	Business Ideas and their implementation (Idea to Startup)	08	6	4	4	14
III	Management Practices	12	6	8	8	22
IV	Support Agencies and	08	4	4	4	12

	Incubators					
V	Project Proposal & Exit strategies	06	2	4	4	10
Total		**42**	**22**	**26**	**22**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should make a portfolio i.e. perform at least FIVE from following list of activities individually or in group (not more than 2). They should prepare reports of about 2-5 pages for each activity and collect/ record physical evidence for their portfolio which may be useful for their placement interviews:

i. Develop two products from household waste (attach photographs).
ii. Download product development and innovative films from internet.
iii. Prepare a collage for "Traits of successful entrepreneurs."/ "Motivation & Charms of Entrepreneurship"
iv. Invite entrepreneurs, industry officials, bankers for interaction. Interview at least four entrepreneurs or businessman and identify
v. Identify your hobbies and interests and convert them into business idea.
vi. Mock Business Model- Choose a product and design a unique selling preposition, brand name, logo, advertisement (print, radio, and television), jingle, packaging, and labeling for it.
vii. Develop your own website. Share your strengths and weakness on it. Declare your time bound goals and monitor them on the website.
viii. Choose any product/ advertisement and analyze its good and bad points/ cost sheet/ supply chain etc. (individuals should select different ads)
ix. Compare schemes for entrepreneurship promotion of any bank.
x. Visit industrial exhibitions, trade fairs and observe nitty-gritty of business. Get news of Vibrant Gujarat Events. (Upcoming in Jan 2024)
xi. Open a savings account and build your own capital.
xii. Arrange a visit to a Mall, observe products, supply chain management and prepare report.
xiii. Organize industrial visit and suggest modifications for process improvement. Conduct a market survey for a product /project before visit. In the visit collect data on machinery specifications, price, output/hour, power consumption, manpower requirement, wages, raw material requirement, specification, price, competitor's product price, features, dealer commissions, marketing mix etc. Make a detailed report at the end of the visit.
xiv. Select a social cause, set objectives, plan and work for its accomplishment. Find details about some famous NGOs
xv. Present Own Dream Start-up story as Seminar OR Analyze 2 products from Shark Tank program.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4 means*** different types of teaching methods that is to be employed by teachers to develop the outcomes.
d) Show animation/ video related to course content.
e) Various Apps related to subject topics/ sub-topics
f) Other Common instructions as under
    1) Instructors should emphasize more on exemplary and deductive learning.
    2) Students should learn to recognize, create, shape opportunities, and lead teams forproviding economic-social value to society.
    3) Business simulations should be used to enhance behavioral traits of successfulintrapreneurs and entrepreneurs amongst students.
    4) Emphasis should be on creating entrepreneurial society rather than only setting upof enterprise.
    5) They must be encouraged to surf on net and collect as much information aspossible.
    6) Each student should complete minimum ten activities from the suggested list.Minimum possible guidance should be given for the suggested activities.
    7) Students should be promoted to use creative ideas, pool their own resources, finishtheir presentation, communication and team skills.
    8) Alumni should be frequently invited for experience sharing, guiding andrewarding students.
    9) Display must be arranged for models, collages, business plans and othercontributions so that they motivate others.
    10) You may show video/animation film / presentation slides to demonstrate variousmanagement functions, traits of entrepreneur etc.
    11) Arrange a visit to nearby venture capital firm.
    12) Give 1 Mini project and 1project report for future business to all the students.
    13) The following pedagogical tools will be used to teach this course:
        a) Lectures and Discussions
        b) Role Playing
        c) Assignments and Presentations
        d) Case Analysis
        e) Quiz on Management and Entrepreneurship
        g) Mimic/ narrate examples from world's leading businessmen among the students.
        h) Guide students on how to address issues on environment and sustainability

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the guidance for micro project should be about **6-8 *(six to eight) student engagement hours*** during the theory/ course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects/ practical exercise is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:
(It can be a Seminar with bound /hand written notes/ ppts of individual students OR a product/ service portfolio)

1) Entrepreneur Traits and Behavior Modelling
2) Various State and Central Entrepreneurship Promotional Schemes and Start-up Policies
3) Business Model for a Startup and study of Unicorns
4) Make your own Product / Service portfolio/ Proposal with USP, logo, advertisement (print, radio, and television), jingle,packaging, labeling and branding for it.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Entrepreneurship in Action	Coulter	PHI 2nd Edition
2	Entrepreneurship Development	E. Gordon & K. Natarajan	Himalaya
3	Entrepreneurship	Robert D. Hisrich & Mathew J. Manimala	McGraw Hill Education; ISBN 978-1259001635
4	Entrepreneurial Development	S S Khanka	S Chand & Company; ISBN: 978-8121918015
5	Entrepreneurship Development and Management	A. K. Singh	Jain Book Agency (JBA) publishes, New Delhi
6	Entrepreneurship Development& Management	R.K. Singal	S K Kataria and Sons; ISBN: 978-8189757007
7	Small Scale Industries and Entrepreneurship	Vasant Desai	Himalaya 2008
8	Entrepreneurship	Roy Rajeev	Oxford University Press; ISBN: 978-0198072638
9	Industrial Engineering and Management	O.P.Khanna	Dhanpat Rai and Sons, Delhi
10	Industrial Organization and Management	Tara Chand	NemChand and Brothers; Roorkee
11	Industrial Management and Entrepreneurship	V. K. Sharma.	Scientific Publishers, New Delhi
12	Entrepreneurship Developmentand Small Business Enterprise	Poornima M Charantimath	Pearson Education; ISBN: 978-8131759196
13	Entrepreneurship Development	S Anil kumar	NEW AGE Intern. Pvt Ltd; ISBN: 978-8122414349

14	The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN – 978-0984999392
15	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN – 978-0670921607
16	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN – 978-0755388974
17	The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business	Clayton M. Christensen	Harvardbusiness ISBN: 978-142219602
18	How to write a business plan,	Brian Finch	2nd edition, 2007, Kogan Page India Pvt. Ltd.
	Advance Reading		
19	HBR - Creating business plan	-	20-minute manager series, 2014.
20	HBR – Creating business plan	-	Expert solution to everyday challenges, 2007.

14. SOFTWARE/LEARNING WEBSITES

[A] List of Software/Learning Websites:

Sr. No.	Topic Key Word	Link
1	MoCI	https://www.india.gov.in/website-ministry-commerce-and-industry
2	MSME	1)https://msme.gov.in/ 2) https://www.msmex.in/learn/government-schemes-for-startups-and-msmes-in-india/
3	Start-up, Stand-up India & SSIP Gujarat	1) https://www.startupindia.gov.in/ 2) https://www.standupmitra.in 3) https://udyamimitra.in/page/standup-india-loans 4) https://www.ssipgujarat.in/
4	Make in India	https://www.makeinindia.com/
5	Atmanirbhar Bharat Abhiyan Vocal for Local	https://indiancc.mygov.in › uploads › 2021/08
6	Skill India	https://skillindia.gov.in
7	MSDE	https://www.msde.gov.in/
8	Vibrant Gujarat	https://www.vibrantgujarat.com/
9	NABARD	www.nabard.com
10	PAN	https://www.onlineservices.nsdl.com/paam/endUserRegisterContact.html
11	I-hub	https://ihubgujarat.in
12	GSTIN	https://reg.gst.gov.in/registration

13	IEC Code	https://www.dgft.gov.in/CP
14	Mudra	https://www.mudra.org.in/
15	Export-Import	http://niryatbandhu.iift.ac.in/exim/
16	NSIC	https://www.nsic.co.in/
17	DIC	https://ic.gujarat.gov.in/dic -contact.aspx -District Industries Centre
18	EDI	https://www.ediindia.org/
19	CED	https://ced.gujarat.gov.in/home
20	NIESBUD	https://www.niesbud.nic.in/
21	Start-up Talky	https://startuptalky.com/list-of-government-initiatives-for-startups/
22	Invest India	https://www.investindia.gov.in/startup-india-hub
23	SAAC	https://www.saccindia.org/india/startups.html?utm_source=google&utm_medium=cpc&gclid=EAIaIQobChMIutLQ4dfW_wIVeppmAh1cOAAIEAMYASAAEgIJO_D_BwE
24	Action for India	https://actionforindia.org/afi-activity-accelerator-programs.html?gclid=EAIaIQobChMIutLQ4dfW_wIVeppmAh1cOAAIEAMYAiAAEgLVGvD_BwE
25	Indian Chamber of Commerce	https://www.indianchamber.org/
26	FICCI	https://www.ficci.in/api/home
27	GCCI	https://www.gujaratchamber.org/

[B] Some Films (To be seen on Sundays/holidays by students on their own, not to be shown in polytechnics in any case**)**

i. Any Body Can Dance (2013)
ii. Corporate (2006)
iii. Do Duni Char (2010)
iv. Guru (2007)
v. Oh My God (2013)
vi. Pirates of Silicon Valley (1999)
vii. The Pursuit of Happiness (2006)
viii. Rocket Singh (2010)
ix. Start-up.com (2001)
x. The Social Network (2010)
xi. Wall Street (1987)
xii. Band Baja Barat (2010)
xiii. You've Got Mail (1998)
xiv. Steve Jobs (2015)
xv. Chef (2014)
xvi. "Office Space (1999)
xvii. Erin Brockovich (2000)
xviii. The Founder (2016)

15. PO-COMPETENCY-CO MAPPING:

Semester V	Entrepreneurship & Startups

	(Course Code: **4300021**)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design / development of solution	PO4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Use concepts of management optimally to establish a small enterprise or start-up, validate it and make it scalable.						
CO1-Understanding the dynamic role of entrepreneurship and Startups by Acquiring Entrepreneurial spirit and resourcefulness, quality, competency, and motivation	3	1	2	-	-	2	2
CO2- Identify a Business Idea and implement it	3	2	2	1	1	3	3
CO3-Select suitable Management practices like leadership and Ownership, resource institutes	3	-	1	1	2	2	3
CO4- Overview of Support Agencies and Incubators	2	3	2	2	1	2	2
CO5- Building Project Proposal & knowing CSR , Ethics, Ex-Im, & Exit strategies	3	2	2W	1	1	3	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. Ujjval V Buch (MBA)	G.P.Ahmedabad	9825346922	uvbuch@gmail.com
2.	Dr. Satya Acharya	EDI, Bhat.	7600050606	satya@ediindia.org

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Summer Internship-II
(Course Code: 4351901)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mechanical CAD_CAM Engineering	5th semester

1. RATIONALE

The Concept of Embedded Internships: AICTE (All India Council for Technical Education) has introduced a mandatory 7-10 weeks summer internship program in the new curriculum. This initiative aims to provide students with hands-on experience and practical training in an industry or organization relevant to their field of study. The embedded internships offer an excellent opportunity for students to gain valuable insights into industry practices and enhance their understanding of real-world applications
We must agree that all Branches of Diploma Engineering are changing rapidly. New technologies are adding fast which effects can be seen in our society. Summer internship is a good option by which students to get flavor of such emerging technology and familiar with industry environment to identify scope and focus of their career development opportunities. Main objective of summer internship is hand-on practice to exposestudents for thinking about professional career by observing, understanding working mechanism of ongoing work of industry and to obtain various types of skills throughout internship program.

Six Weeks mandatory internship is to equip the students with practical knowledge and provide them exposure to real time industrial environments. Further, this internship, option is provided to do internship in Government Agencies/Private and public industries/ skill centers/etc.

The duration of internship will be of six weeks. It will be after completion of 4th Semester and before the commencement of 5th Semester. Any options from following can be chosen by the students:

1. **Offline internship in industry** - Student is supposed to produce joining letter and relieving letter once the internship is over in case of Offline internship in any industry.
2. **A Mini Project** - On some suitable topic related to respective Mechanical branch. It can be small fabrication / experimental results/ simulations/ Application development / Design and / or Analysis of System(s) etc. depending on the branch of the student. Preferably a single student should carry out a mini-project.

2. COMPETENCY

The purpose of this course is to help the student to attain flavor of the following industry identified competency through summer internship experiences:

- **Develop multiple types of skills such as planning, designing, manufacturing, machining, stores management, communication, collaboration, decision making / Problem solving and management skills along with selected technical knowledge.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Learn and adopt the engineer's role and responsibilities with ethics.
b) Get exposure to the industrial environment for professional activities.
c) Get possible opportunities to learn, understand and sharpen the technical skills required for technical advancement.
d) Develop managerial skills required for professional career.
e) Attain skill for writing technical report and prepare poster for presentation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	6	3	0	0	50	50	100

1. **Offline Internship in industry:** CA Assessment will be carried out based on submitted progress card byIndustry resource person and ESE Assessment will be carried out by institute resources person.
2. **A Mini Project:** CA and Assessment will be carried out based on project work by institute resources pers

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

List of Documents to be prepared for Submission:

1. Detail report duly signed and approved by the internal/external mentor
2. Presentation softcopy approved by the internal/external mentor
3. Poster of summer internship activities approved by the internal/external mentor.

5. METHODOLOGY

1. Student Application: -

Student will carry out search for undergoing internship and prepare the list of industries. Student will

prioritise their search in the form of at least 2/3 choice areas keeping in mind their choice of interest, suitability and availability factors. After making choice students will submit their application indicating their industry, contact person's phone no & address attached with their brief profile with interest justification & willingness to avail internship.

2. **Institute /College**

   Institute/ College will issue letter Addressed to industry and deliver the same to the student for consideration & offer Internship, indicating probable period and general guidelines and undertaking form.

3. **Student Joining Letter:-**

   Upon acceptance for internship student will submit the joining report duly signed by Industry mentor in the given Performa, to their institute faculty mentor (By e-mail or in person/ PDF/ photo)

4. **Progress Report at the mid of Internship Duration: -**

   Institute faculty will monitor the activities performed by the student somewhere between mid of total internship duration and endorse the same in the prescribe progress report after evaluating daily diary & sign and submit it to the department head. In case of any facilitation needed, institute faculty will do needful to enable student to undergo internship.

5. **Internship Report**

   After completion of internship student has to fill & submit the **"Internship Report"** in the given prescribed Performa to the department.

6. **Presentation on Internship: -**

   Students have to present the Internship report using MS Power Point. The presentation date, time & venue to be displayed on department notice board and all the students have to attend this session. Evaluation grade also have weightage of presentation & Question and Answer session.

7. **Training Certificate:**

   Students have to submit their internship training certificate having pertinent details as Name, Institute name, period of training with start and end dates and signature and stamp of industrial mentors.

8. **Record Keeping:**

   Institute will keep the record of internship in respective departments.

Summer Internship Registration Form

Note: Students needs to submit this registration form after finalizing mode of internship.

Student Details												
Enrollment Number												
Student Name												
Student Details	Mobile Number :											
	Email Address:											
Branch												
Code and Name of the Institute												
Mentor Details (Institute)	Name:											
	Designation:											
	Mobile No:											
	Email Address:											
Industry Details	Name:											
	Address:											
	Email:											
	Phone:											
	Website:											
Mentor Details (Industry)	Name:											
	Designation:											
	Mobile No:											
	Email Address											
Mode of Internship Carried Out	Offline/ Mini Project											
Title of the Project/ Internship carried out												
Nature of Work Carried Out	Skill developed/ Experimental results/ simulations/ Analysis of System(s)/Product or process development, etc… Other please Specify_____											

Student Signature Faculty Signature

Suggested Evaluation Rubrics for Institute

Enrollment No: _____ **Branch:** _____

Name of the Students: _____

Date of Evaluation: _____

Internal Evaluation – 50 Marks PA(I) **(To be carried out by the mentor in consultation with Industry)** **Minimum Passing Marks: 25**					
Parameter	Excellent	Good	Average	Not up the level of Satisfaction	Obtained Marks
Mark range	10-09	08-07	06-05	Below 5	
Knowledge acquisition in specific domain. **10 marks**					
Skill and attitude attainment in specific domain. **10 marks**					
Feedback and suggestions given are incorporated? **10 marks**					
Quality of the prepared report and poster **10 marks**					
Quality of the presentation. **10 marks**					
Total Marks Obtained Out of 50 PA(I)					

Internal Examiner Name: _____

Signature: _____

Note: For Summer Internship / Projects / Seminar etc. Evaluation is based on work done, quality of report, performance in, presentation etc.

Suggested Evaluation Rubrics for Industry

Enrollment No:_____ **Branch:**_____

Name of the Students: _____

Date of Evaluation: _____

Parameter	Excellent	Good	Average	Not up the level of Satisfaction	Obtained Marks
Mark range	10-09	08-07	06-05	Below 5	
Student regularity during the Internship period and pro-activeness / responsiveness towards the given tasks (**10 Marks)**					
Work Plan, Execution and quality of work in forms of Outcome achieved (**10 Marks)**					
Engineering Tools and Techniques (**10 Marks)**					
Quality of poster design and presentation (**10 Marks)**					
Quality of the report and Skill **(10 Marks)**					
Total Marks Obtained Out of 50 ESE(V)					

External Examiner Name:_____

Signature:_____

Note: For Summer Internship / Projects / Seminar etc. Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

6. AFFECTIVE DOMAIN OUTCOMES

The following affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member as role of Engineer.
b) Practice environmentally friendly methods and processes.
c) Follow safety precautions and ethical practices.

7. SUGGESTED STUDENT ACTIVITIES

Following are the suggested student-related curricular, which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities and prepare reports and give presentation in front of students and faculty members. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a. Perform various tasks given by industry resources person during offline internship.
b. Perform various tasks required to complete mini project work under guidance of faculty member.
c. Summer Internship program Interns are required to give a presentation before review committee consisting of a group of academic staff members.
d. The review committee gives feedback and suggests possible improvements inthe work.
e. At the end of the program all the Summer Internship program Interns make a poster presentation of the work carried out. The poster presentation is open tothe public. It is also evaluated by faculty members.
f. A completion certificate will be issued to all Summer Internship program Interns only after the completion of internship tenure.

8. SOFTWARE/LEARNING WEBSITES

- https://www.internshala.com
- https://swayam.gov.in
- https://nptel.ac.in/
- **https://neat.aicte-india.org/**
- **https://www.edx.org/**
- **https://www.coursera.org/**
- **https://www.udemy.com/**

9. PO-COMPETENCY-CO MAPPING

Semester V	Summer Internship (Course Code: 4351901)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimen-tation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Use principles of basic electronics to maintain various electronics circuits and equipment						
CO1) Learn and adopt the engineer's role and responsibilities with ethics.	3	2	2	2	2	2	2
CO2) Get exposure to the industrial environment for professional activities.	3	2	2	2	2	-	-
CO3) Get possible opportunities to learn, understand and sharpen the technical skills required for technical advancement.	3	2	2	2	2	2	2
CO4) Develop managerial skills required for professional career.	2	-	-	-	-	2	2
CO5) Attain skill for writing technical report and prepare poster for presentation.	3	-	-	2	-	-	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

10. COURSE CURRICULUM DEVELOPMENT

COMMITTEE<u>GTU Resource Persons</u>

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. R.D.Patel	BBIT, V.V.Nagar	9825523982	
2	N.G.Parmar	RCTI Ahmedabad	9426333054	
3	Joseph Soni	BBIT, V.V.Nagar	9898915991	

Application Performa

Name of student_____
Enrolment No _____
Division _____
Address _____
_____
Email –id _____
Mobile No_____
Date _____

To,
The Head,
_____Department
_____Name of College.

Subject: -Application for Internship Training Phase –II

Respected Sir,

I, the undersigned _____ (name of student) requesting you to issue me Internship Training letter.

My choice is indicated below:

Sr. No	Name & Address Of Industry	Contact Person's Name & Designation	Contact Person's Mobile No.

I will strictly follow the guidelines during Internship. I will follow instruction of my mentor.

Thanking you

Yours Faithfully

Enclosure:

1. My brief profile
2. Undertaking Form
3. My justification for choice

Letter to Industry by Institute

On

(Institute Letterhead / Department Letterhead)

Ref no_____ Date_____

To,

_____

_____

Subject: - **According permission for Summer Internship-II**

Dear Sir,

1. Para –I (Context of GTU Internship scheme)
2. Para –II(Institute information)
3. Details -

Name of student	rolment no & Division	Email of student	Mobile no of student	Name of faculty	Contact no of faculty

Period of Internship: from _____to _____ (6 weeks)

4. Closing Para

Thanking you,
Sd/-
(seal)

Note: -

1. Enclosed General Guidelines of Internship.
2. Candidate will submit his brief profile with this letter.
3. Candidate will be fully under your control during Internship period.
4. Candidate will submit 'Undertaking Form' at the time of joining.

Joining Letter / Permission Letter

(On the letterhead of Industry)

No._____ **Date: _____**

TO WHOM IT MAY CONCERN

This is to certify that Mr./ Ms. _____

Enrolment No. _____student of _____ has shown interest in undergoing Internship for a period of 6 weeks with us.

During the period of his/her Internship with us, He / She will be trained and exposed to various technical processes and we are agree to provide Internship as per our company policy, rules and regulations.

His / Her Industry Mentor will be _____.

(Name of Authorised Person)

Designation.

Progress Report Performa

Name of Institute / Industry_____

Name of Department _____

Name of Intern: _____

Enrolment No _____ **Division** _____

Date & Day	Period From to	Detailed Description about exposure to processes and inputs provided till the date
		(Description should be in line with the student daily diary)

Remarks: - Internship progress found Very good/ good / satisfactory

Signature of Endorsing Faculty Mentor

Enclosure: If any

Internship report

(To be submitted by the students at the end of internship)

Name of Student: _____

Enrolment No. _____ Div_____

Name of Institute _____ Mobile No._____

Name of Industry:_____

Period of Internship _____ to _____

Name of Industry Mentor _____

Contact No. of Industry Mentor _____

(At least 5 or 10 pages A4 size paper with detailed description of outcome achieved during the period of Internship, mention basic details of Inputs gained in terms of Knowledge, Processes, Skills and Development enhancement. The details should be in line with daily diary).

The internship report should be prepared containing Student institute certificate (like project submission), industry certificate, acknowledgement, index, and following details.

Name of the industry :

Address of Industry :

Duration of internship :

Name of Student :

Industry Profile :

Product details and production capacity:

Turnover of the Industry :

Client's details (if available):

Machinery & Equipments details with major specifications:

Raw material details with consumables :

Processes carried out with parameters and detailed description:

Various Departments and its functions :

Knowledge / skill achieved during internship :

Miscellaneous if any :

Conclusion :

Signature of Student **Signature of Industry Mentor**

Internship Certificate

(On the letterhead of Industry)

No. _____ Date: _____

TO WHOM IT MAY CONCERN

This is to certify that Mr./ Ms. _____

Enrolment No. _____student of _____ has successfully completed two weeks Internship in the field of _____ during the period _____ to _____.

During the period of his/her internship with us, he/ she had been exposed to Different processes and have gained adequate technical traits. During the Internship his/her attitude was found satisfactory.

Authorized Person / Signatory **Industry Mentor**

UNDERTAKING FORM

વર્ષ 2023 થી અમલીકૃત કરાયેલ અભ્યાસક્રમમાં ગુજરાત ટેક્નોલોજિકલ યુનિવર્સિટીએ ઇન્ટર્નશિપ- II (૬ અઠવાડિયા) ને આગવા વિષય તરીકે નિદર્શિત કરેલ છે. આથી હું નીચે સહી કરનાર વિધાર્થી તથા તેના વાલી બંને આ બાંહેધરી પત્રક સુપ્રત કરી રહયા છીએ જેમાં દર્શાવેલ વિગતોનું અમો સંમતિપૂર્વક પાલન કરીશું .

બાંહેધરી પત્રક

વિધાર્થીનું નામ: _____

એનરોલમેન્ટ નંબર : _____ ડિવિઝન : _____

ડિપાર્ટમેન્ટ :_____

મોબાઈલ નંબર : _____

ઇમેઇલ આઈ.ડી : _____

આથી , અમો સંમતિપૂર્વક બાંહેધરી આપીએ છીએ કે ,

1) ફાળવાયેલા / પસંદગી કરેલ ઇન્ડસ્ટ્રીમાં હું નિયમિતપણે ગેરહાજર રહયા વિના મારો ઇન્ટર્નશિપ કાળ પૂર્ણ કરીશ.

2) ઇન્ટર્નશિપ અવધિ દરમિયાન જે તે ઇન્ડસ્ટ્રીની સમય સારણી નું અચૂકપણે પાલન કરીશ અને સંસ્થાના ઓળખપત્ર (આઈ કાર્ડ)ને હંમેશા સાથે રાખીશ.

3) ઇન્ડસ્ટ્રી મેન્ટર મને જે સૂચના , નિર્દેશો , આપે તેનું પાલન કરીશ.

4) ઇન્ટર્નશિપ અવધિ દરમિયાન હું સલામતી અંગેના નિયમોનું પાલન કરીશ

5) સંપૂર્ણ ઇન્ટર્નશિપ દરમિયાન હું મારી સલામતીની સંપૂર્ણ જવાબદારી લઉં છું . મારી નિષ્કાળજી કે

લાપરવાહીથી થનાર નુકશાન માટે કોલેજ કે ઇન્ડસ્ટ્રી જવાબદાર રહેશે નહિ .

6) હું મારી પ્રવુતિ થકી ઇન્ડસ્ટ્રી ને કોઈ નુકસાન નહિ થાય તેની સંપૂર્ણ કાળજી રાખીશ અન્યથા થનાર નુકસાનની જવાબદારી મારી રહેશે .

7) સંસ્થા તથા ઇન્ડસ્ટ્રી દ્વારા મને મારે કરવાની કાર્યવાહી ની સંપૂર્ણ સમજ અપાયેલ છે જે મેં સમજી લીધેલ છે અને તે અનુસાર તેનું ચુસ્તપણે પાલન કરવા બંધાઉં છું.

વિધાર્થીનું નામ અને સહી : _____ વાલીનું નામ અને સહી : _____

તારીખ : _____

સ્થળ : _____

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester - V

Course Title: Manufacturing Engineering-III
(Course Code: 4351902)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

This subject of Manufacturing Engineering-III provides knowledge and embeds skill to students to develop different products using various machining process, rapid prototyping, and non-conventional machining process. Manufacturing processes are the most important element in any engineering industry. Large numbers of industrial parts have features like teeth, threads, slots, splines, surfaces etc. Quality of these parts depends on parameters aspects such as accuracy of profile, dimension & surface finish controls. Correct selection of process & its parameters on such machines; plays a vital role in obtaining required quality product at optimum cost. This course will make student familiar with fundamentals of cutting mechanics, kinematics, constructional features and selection criterion for various basic machine tools, rapid prototyping and advance machining process Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different type of skills so that students are able to acquire at least following competencies:

- **Produce the part as per given drawing/specifications by adopting conventional machine tools and/or non-conventional machining processes using optimum process parameters, safe working procedures, suitable work & tool holding devices and appropriate cutting tools.**
- **Plan and supervise manufacturing operations at a shop floor of machine tools based manufacturing industries.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify effect of machining parameter on quality of products.
CO-2	Produce the job with appropriate process, cutting tools, machine tools and cutting parameters for given work piece like gear, mechanical job with thread.
CO-3	Expose the students to different types of Rapid prototyping processes, materials used in RP systems.
C0-4	Select appropriate non – conventional machining method for different machining operations.

CO-5	Outline the role of computer and automation in manufacturing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25*	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Preparatory Activity** (Includes Home Assignments)**:** Demonstrate various cutting parameters, carbide inserts with ISO designation system and explain the steps to calculate cutting speeds. Student will prepare the report on following. a. Tabulate various cutting tools materials with main elements, properties and applications. b. Calculate RPM for lathe, milling cutter and drill spindle strokes/minute for shaping/planning; based on given data. Use equations. Each student should be given different data for diameters and cutting speeds.	1 & 2	04
2	**Kinematics and motion transmission systems:** Demonstrate motion and power transmission path, transmission systems, work mounting systems, tool mounting systems and tool holders/holding. System of lathe, gear hobbing, gear milling, gear shaping, threading on lathe, drilling machine. **a.** Sketch and label main elements of machine kinematics. **b.** Write specification of Machine	2, 4	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	c. Sketch cutting tools with nomenclature, Sketch tool holders.		
3	**Produce job with various machining methods:** **a.** Sketch the production drawing of the part. Part should include plain/taper turning, step turning, cylindrical/surface grinding, etc. **b.** Outline the processes. **c.** Calculate/select, set, observe and record the cutting parameters for each process. **d.** List the cutting tools you have used. Also state specifications of each. **e.** List the work holding devices you have used. Also state specifications of each. **f.** Produce the part.	1, 2, 4	08
4	**Gear cutting:** Prepare a simple spur gear using milling operations including use of indexing head .Student will also prepare report including: **a.** Drawing of the job Gear. **b.** State equations to find module, pitch circle diameter, outside diameter, circular pitch and number of teeth. **c.** Produce spur gear on milling machine using indexing head. Calculate/select, set, observe and record the cutting parameters. **d.** List the cutting tools and work holding device you have used. Also state specifications of each.	2	06
5	**Thread cutting:** Prepare a job having threaded surfaces on lathe machine **a.** Sketch the production drawing of the part. **b.** Prepare a multi start/square threaded bolt and nut. Calculate/select, set, observe and record the cutting parameters for the process. **c.** List the cutting tools you have used. Also state specifications of each. **d.** List the work holding devices you have used. Also state specifications of each.	4	04
6	**Rapid prototyping machine(3D printer) (Demonstration)** To study the part builds mechanism of a Rapid prototyping machine. **a.** To develop CAD models using 3D Scanner/Software for 3D printer. **b.** To select a specific material for the given application.	3	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	c. To produce a simple product using 3D printing or Additive Manufacturing (AM)		
7	**Presentation:** **a.** Teacher will assign any one topic to each batch student from Unit number V &VI. Each student will have different topic. **b.** Using power point presentation, each student will present the topic. Presentation must include related Videos/images. **c.** Present the topic and submit the report of same.	1,3,6	02
8	**Technical visit/participation:** Visit manufacturing related industries (one must be having non-conventional manufacturing facilities) and prepare industry wise technical report. Hint: Before visit, faculty will remind student regarding portion of subject content (especially practice) not covered within institution premises (due to non-availability of resources). Faculty will also direct student's attention towards all possibility/scope available at the industries to be visited. Student will observe and record all such details like Specifications, Operating procedure, Selection of operational parameters, Details about tool/work holders used, Machine setting, Product details being manufactured for each method/machine like gear forming/generating, honing/lapping/buffing machine, Non-conventional machine, Jig boring machine, Broaching machine etc.	All	
		Total	**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. Care must be taken in assigning and assessing study report as it is a third-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No	Sample Performance Indicators for the PrOs	Weightage in %

Sr. No	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify machine tools & their equipment's (Knowledge)	10
2	Able to operate, set the machine and select machining parameters. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Hacksaw machine.	3 to 6
2.	Lathe with standard and special accessories.	3
3.	Milling machines-Vertical /horizontal with standard accessories and indexing/dividing head.	4
4.	Column drilling or Radial Drilling machine	4
5.	Shaper machine.	4
6.	Rapid Prototyping Machine	6
7.	HSS cutting tool and their tool holders	3 to 5
8.	Carbide inserts and their tool holders	4 ,5
9.	Drill bit and their tool holder	4

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I. Introduction to Manufacturing Engineering-III.	1a. Importance of Manufacturing engineering III	1.1 Introduction of process used in Industries like Gear manufacturing, thread production, Rapid Prototyping, Computer integrated manufacturing. Non-conventional and advance Methods of machining.
	1b. Machine shop supervisor skill.	1.2 Need of attitude, knowledge & skill required for shop floor supervision in Machine tools based industries for quality and cost effective production.
	1c. The effect of different machining parameters on quality and cost of product.	1.3 Importance of processes and required parameters (like material removal rate, cutting power, cutting time, cutting speed, feed, depth of cut, number of cuts, tool signature, tool life etc) on quality and cost of product.
Unit– II **Gear manufacturing and finishing processes.**	2a. List types of gears 2b. Assimilate the Gear manufacturing & finishing processes. 2c. Describe constructional features and working of various gear manufacturing machines. 2d. Select appropriate gear manufacturing machine as per the given situation. 2e. Select gear cutting parameters for given materials and work- piece 2f. Gear finishing process	2.1 Types of gears and application, nomenclature of spur gear. 2.2 Gear generating and forming processes-concept, differences and applications. 2.3 Classification, constructional features, working and application of gear milling, gear hobbing and gear shaping machines. 2.4 Nomenclature and sketch of gear hob and gear shaping cutter. 2.5 Gear Cutting parameters for commonly used materials and work-piece. 2.6 Gear finishing methods, requirement of gear finishing.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– III **Rapid Prototyping**	3a.Explain Introduction, classification, application of rapid prototyping.	3.1 Fundamentals of Rapid Prototyping, advantages and limitations. 3.2 Classification of Rapid prototyping methods 3.3 Applications of rapid prototyping methods
	3b.Rapid prototyping methods, working principle, detail of process	3.4 Working principle, process detail of Stereo lithography apparatus, selective laser sintering and fused deposition modeling.
Unit– IV **Thread production Methods.**	4a. Explain thread production processes.	4.1 Thread nomenclature and important terminologies used in threads. 4.2 Various threads production processes like turning, rolling, grinding, taping, etc. their applications, advantages and limitations.
	4b. Describe constructional features and working of Various thread production machines. 4c. Select appropriate thread production machine as per the given situation. 4d. Explain different steps for producing thread on thread production machine.	4.3 Constructional features including coolant and lubrication systems, motion and power transmission path, working and application of various threads production machines/ processes like lathe, rolling, grinding, taping, etc. 4.4 Thread cutting parameters for commonly used materials and work-piece. 4.5 Tool mounting methods on thread production processes.
Unit-V **Computer integrated Manufacturing (CIM)**	5a. Concept and scope of Computer integrated Manufacturing (CIM) 5b. Role of management in CIM 5c. Role Manufacturing engineers in CIM	5.1 Introduction to CIM Concepts & scope of CIM, 5.2 Nature & type of manufacturing system. 5.3 Evolution, Benefits of CIM. 5.4 Role of management in CIM, Expert system & participate management. 5.5 Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel.
Unit-VI **Non-conventional and advance methods of**	6.a Overview and requirement of Non- conventional Machining methods. 6.b Explain working principles and working parameters of non-	6.1 Need of nonconventional machining and comparison between conventional & non-conventional machining methods. 6.2 Classification, working principles, application and working parameters of following non-conventional machining methods:

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Machining.	conventional machining methods. 6.c Selection of nonconventional machining methods	i. Electro chemical machining (ECM). ii. Electro discharge machining (EDM) including wire cut and dies sinking. iii. Ultrasonic machining (USM). iv. Laser beam machining (LBM). v. Abrasive jet machining (AJM). vi. Plasma arc machining (PAM) vii. Water jet machining (WJM) 6.3 Criterion for selection of non-Conventional machining methods. 6.4 Introduction and application of MEMS.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Introduction to Manufacturing Engineering- III.**	**4**	**1**	**3**	**0**	**4**
2	**Gear manufacturing and finishing processes.**	**8**	**4**	**6**	**4**	**14**
3	**Rapid Prototyping**	**8**	**4**	**6**	**4**	**14**
4	**Thread production Methods.**	**6**	**2**	**4**	**4**	**10**
5	**Computer integrated Manufacturing (CIM)**	**6**	**4**	**5**	**3**	**12**
6	**Non-conventional and advance methods of Machining.**	**10**	**5**	**6**	**5**	**16**
Total		**42**	**20**	**30**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

1. Prepare a report on at least one industrial component/product with its complete technical details covering the points like design criterion, features included with Dimensional/Geometric constraints, manufacturing resource requirements, challenges in controlling its quality and cost, etc.
2. Prepare report on product manufactured by rapid prototyping.
3. Collect the technical details about all production facilities available at nearby industry/industries.

4. Visit or participate in the technical events, exhibition, conference, seminar etc.
5. Collect/download at least four different machine tool catalogues including at least one special purpose, non-conventional or advance machine.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) To acquire knowledge of basic machine, tool and their operation arrange two or more **industrial visit** of production industry. After visit student must be submit their industrial visit report.
c) Guide student(s) in undertaking micro-projects.
d) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
e) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
f) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed six.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a small useful product like various machining parts assembly/gear box/rapid prototyping model/useful thread assembly /small laboratory equipment/set-up utilizing laboratory resources.
b) Prepare a model for types of gear / types of different thread.
c) Design and manufacture various die or Jigs studied in Tool engineering subject

d) Prepare a report on product manufactured with various non-conventional process (design, machining methods, specification, parameters..)

e) Using Drafting software, prepare machining products drawing with tolerances, quality measure with operation sheets for manufacturing.

f) Survey nearby vendor for rapid prototyping, non-conventional machining, and gear and thread manufacturing etc. machining process and prepare report on products manufacture to reduce rejection, quality improvement, production rate etc..

g) Maintenance of available infrastructure related to Machining.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Production Technology (Manufacturing Process)	Dr. P C Sharma	S Chand
2	Elements of Workshop Technology Volume No. II Machine Tools	Hajra Choudhary, Bose S. K., Roy Nirjhar	Media promotors and publishers pvt. Limited
3	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Company(P) Limited
4	Machine tools technology	G. S. Kandasami	Khanna publisher
5	Fundamentals of Metal Machining and Machine Tools	W. A. Knight and Geoffrey Boothroyd	CRC Press
6	Modern Machining Processes	P. C. Pandey	Tata McGraw Hill, New Delhi
7	M.E.M.S.: Fundamental Technology and Application	VikasChoudhary, Krzysztof Iniewski	CRC Press
8	Production Technology	R. K. Jain and S. C. Gupta	Khanna Publishers
9	Production Technology	HMT	Tata Mcgraw-Hill Publishing Co.
10	All about Machine Tools	HEINRICH GERLING	New Age International Private Limited
11	Computer integrated manufacturing	S. Kant Vajpayee	Prentice Hall of India

14. SOFTWARE/LEARNING WEBSITES

1. https://nptel.ac.in/courses/112/105/112105126/

2. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-32.pdf
3. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-31.pdf
4. https://nptel.ac.in/courses/112/104/112104028/
5. https://archive.nptel.ac.in/courses/112/104/112104289/
6. https://www.me.iitb.ac.in/~ramesh/courses/ME338/non_trad.pdf
7. http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf
8. http://www.youtube.com/watch?v=bmooEZyivxo
9. http://www.youtube.com/watch?v=mWy9awGv6so
10. http://www.youtube.com/watch?v=mKES5Fyz9l0
11. http://www.youtube.com/watch?v=BgGXQUeYNKw
12. ihttp://www.youtube.com/watch?v=eaeEn1Gs4aQ
13. http://www.youtube.com/watch?v=49GpJ7yhecg
14. http://www.youtube.com/watch?v=XfYXelZ4IaY
15. http://www.youtube.com/watch?v=SNWF_4jQ2pU
16. http://www.youtube.com/watch?v=pI1QGpmKqow
17. https://www.youtube.com/watch?v=NkC8TNts4B4
18. https://www.youtube.com/watch?v=KJj8CfnC0Ek
19. https://onlinecourses.nptel.ac.in/noc21_me115/p

15. PO-COMPETENCY-CO MAPPING

Semester IV	Manufacturing Engineering-III (4351902)						
	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	**Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**						
CO 1. Identify effect of machining parameter on quality of products.	3	2					
CO 2. Produce the job with appropriate process, cutting tools, machine tools and cutting parameters for given work piece like gear, mechanical job with thread.	3			2	3	2	2
CO 3. Expose the students to different types of Rapid prototyping processes, materials used in RP systems.	3	2		2	2		
CO 4. Select appropriate non – conventional machining method for different machining operations.	3			3	2		2
CO 5. Explain the knowledge about role of	3			2			

computer and automation in manufacturing.							

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
1.	S. M. Tank, Lecturer in Mechanical Engineering.	RCTI, AHMEDABAD	9825631840	Suresh.a1987@gmail.com
2.	I.R. Momin, Lecturer in Mechanical Engineering.	RCTI, AHMEDABAD	9586970802	Iqbal.momin786@gmail.com

BOS Resource Persons

Sr. No.	Name and Designation	Department	Contact No.	Email
1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B.&B. Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	Asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Thermal Engineering-II
(Course Code: 4351903)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

The course on thermal engineering covers a wide range of topics related to the principles of thermodynamics and their practical applications in various engineering systems. Students will learn about Internal Combustion Engines (ICEs), gas turbines, refrigeration, air conditioning, and IC engine fuels, which are all critical components of thermal system/device. The course will deliver the working principles of IC engine, including the several type of engines, their components, and their applications. The course will cover ICE fuels and their properties. It also covers the gas turbine cycles, effect of variable and its applications. Finally, course will also cover refrigeration and air conditioning systems, including the principles of heat transfer, refrigerants. Overall, this course provides a comprehensive understanding of thermal systems/devices and their applications, which are essential for engineers who is working in various industries.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Apply basic concepts, laws, and principles of thermal engineering to select and operate the IC engines, gas turbines, refrigerators and air conditioners.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Analyze performance of internal combustion engines using performance parameters and heat balance sheet.
CO-2	Select IC engine fuels and related support system for internal combustion engines.
CO-3	Identify salient features of open and closed cycles gas turbines.
CO-4	Analyze the performance of refrigeration system using standard procedures.
CO-5	Estimate air conditioning parameters for particular appliances.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Demonstrate various IC engine and its components. *	I	02
02	Prepare an actual valve timing diagram of given IC engine. *	I	02
03	Perform a test on four stroke Petrol engine test rig. also prepare a heat balance sheet. *	I	04
04	Perform a test on four stroke Diesel engine test rig. also prepare a heat balance sheet. *	I	04
05	Measure a friction power of multICylinder petrol engine using Morse test.	I	02
06	Measure and analyze the emitted gases from IC engine (in context of pollution).	II	02
07	Demonstrate various gas turbines and its components. *	III	02
08	Demonstrate various tools for refrigeration tubing operation. *	IV	02
09	Determine the COP of VCRS system. *	IV	02
10	Demonstrate leak detection with various leak detection techniques, evacuation and refilling of refrigerant	IV	02
11	Determine of properties of air. *	V	02
12	Determine of capacity of window / split air-conditioner. *	V	02
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Third-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1, 7, 8 & 10)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Experimentation/performance type PrOs (PrOs Number: 2, 3, 4, 5, 6, 9, 11 & 12)		
1	Knowledge	20
2	Procedure follows	15
3	Observation Skill	20
4	Analysis	10
5	Quality of Report	20
6	Punctuality	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 1, 7, 8, & 10)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Experimentation/performance type PrOs (PrOs Number: 2, 3, 4, 5, 6,9, 11 & 12)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Procedure follows	15%	Students follow all the procedures with precaution in a logical order.	Students follow all the procedures with some precautions in a logical order.	Students follow all the procedures without precaution in a logical order.	Students follow all the procedures without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Analysis	10%	Student understand the data and analyze correctly the obtained test results.	Student understand most of the data and analyze the obtained test results with help or support.	Student need help to understand some of the data and also in analyzing the obtained test results.	Student always need help to understand the data and also in analyzing the obtained test results.
Quality of Report	20%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Models of: - 4-stroke Petrol engine cut section	01

	- 4-stroke Diesel engine cut section - 2-stroke Petrol engine cut section - 2-stroke Diesel engine cut section - Carburetor cut section - Spark plug cut section - Fuel Injector cut section - Fuel pump cut section - MPFI system	
2.	Actual cut section of 4-stroke Diesel engine for valve timing diagram.	02
3.	Four stroke Petrol engine test rig.	03
4.	Four stroke Diesel engine test rig.	04
5.	MultICylinder 4-stroke Petrol engine test rig for Morse test.	05
6.	Exhaust gas analyzer: - Petrol engine - Diesel engine	06
7.	Models/charts of: - Gas turbines	07
8.	Refrigeration tubing operation kit.	08
9.	VCRS test rig.	09
10.	I. Leak detection kit. II. Evacuation and refilling station for refrigeration system.	10
11.	Psychometer and thermometer for wet bulb and dry bulb temperatures.	11
12.	Window/split air conditioner test rig.	12

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices.

d. Maintain tools and equipment.

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Internal Combustion Engines	1.a Describe ICEs with classification. 1.b Explain various components and terminology used in ICEs. 1.c Describe the working principle, construction and working of the ICEs. 1.d Explain various systems used for ICEs. 1.e Calculate the ICEs performance parameters.	1.1 IC Engine - Concept - Working principle - Major components & Its functions - Terminology - Classifications 1.2 Cycles on P-v and T-s diagram on which IC engines work 1.3 Four Stroke Petrol Engine - Construction & Working 1.4 Four Stroke Diesel Engine - Construction & Working 1.5 Two Stroke Engines - Construction & Working of Petrel Engine - Construction & Working of Diesel Engine 1.6 Theoretical and actual valve timing diagrams 1.7 Fuel Injection system - Carburation - Fuel pump - Multi Point Fuel Injection (MPFI) - CRDI 1.8 Cooling System 1.9 Lubrication system 1.10 Ignition system 1.11 Governing & Scavenging system 1.12 Exhaust system (considering pollution reduction) 1.13 Supercharging & Turbocharging 1.14 Performance testing of IC engines - Performance parameters (Indicated power, Brake power, Friction Power, A/F ratio, specific fuel consumption, efficiencies) - Heat balance sheet - Morse test 1.15 Simple numericals.
Unit– II IC Engine Fuels	2.a List characteristics and properties of fuels used for ICEs. 2.b Explain various petroleum	2.1 Fuels - Concept - Types/classifications - Properties/characteristics

	and alternative fuels for ICEs. 2.c Measure and analyze the pollution parameters.	2.2 Petroleum fuels - Natural gas - Gasoline or petrol - Diesel - Fuel Oil - Kerosene 2.3 Alternative fuels - Alcohols - Hydrogen - LPG - Biogas - CNG - Biofuel - Supply requirement for CNG and LPG 2.4 Rating of engine fuels - Octane Number - Cetane Number 2.5 Pollution and control - Emission norms - Effect emitted gases 2.6 Analysis of exhaust gas
Unit-III Gas Turbines	3.a Describe the concept of gas turbine. 3.b Explain a working of open and closed cycle gas turbines. 3.c List the effect of operating variables in gas turbines. 3.d Calculate the performance parameter of gas turbines.	3.1 Concept and classifications 3.2 Brayton cycle - P-v and T-s diagram - Actual cycle 3.3 Open and closed cycle gas turbine 3.4 Performance improvement methods - Intercooling - Reheating - Regeneration 3.5 Essential gas turbine power plant components - Compressor - Combustion chamber - Turbine 3.6 Usages of gas turbine 3.7 Gas turbine fuels 3.8 Simple numericals
Unit– IV Refrigeration	4.a Describe the processes and elements of VCRS with functions of each element. 4.b Operate VCRSs, observe the changes in properties of refrigerant during each process on VCRS and calculate / analysis the performance using thermodynamic charts/ diagrams.	4.1 Concept of refrigerators and heat pumps 4.2 Reverse Carnot cycle and Bell column cycle 4.3 Vapor Compression Refrigeration Cycle - Major components - P-v, T-s and P-h diagram - Working - Mathematical analysis 4.4 Performance of VCRS 4.5 Effect of Change in operating condition 4.6 Simple numerical on VCRS performance 4.7 Application of VCRS

	4.c Calculate various performance parameters of VCRS. 4.d List characteristics of refrigerants used for VCRSs.	- Domestic refrigerator - IC plant - Water cooler 4.8 Vapor Absorption Refrigeration System (VARS) 4.9 Refrigerant - Characteristics - Properties of refrigerants - Commonly used refrigerants - Eco friendly refrigerants
Unit–V Air-Conditioning	5.1 Plot and interpret various air conditioning processes on psychometric chart. 5.2 Measure various air properties. 5.3 Explain working of various air-conditioners.	5.1 Air conditioning - Concept - Types - Applications 5.2 Properties of air - Psychometric relations - Humidity and temperature measurement 5.3 Psychometric chart - Psychometric processes 5.4 Simple numericals 5.5 Air conditioner - Window air conditioner - Split air conditioner

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Internal Combustion Engines	14	7	7	7	21
II	IC Engine Fuels	06	3	7	0	10
III	Gas Turbines	08	3	4	7	14
IV	Refrigeration	09	4	4	7	15
V	Air-Conditioning	05	3	0	7	10
Total		**42**	**20**	**22**	**28**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Enlist IC Engine specifications which is available in your laboratory.
2.	Search different ICE components from scrap and identify type of defect/ failure.
3.	Visit any Industry working on IC Engine manufacturing/ running or power plant working on IC Engine.
4.	Visit any automobile service center in nearby area.
5.	Visit any Petrol/ Diesel/ CNG/ LPG station and study different fuel filling systems along with different parameters affected.

6.	Enlist VCRS system specifications which is available in your laboratory.
7.	Prepare chart VCRS/ VARS.
8.	Visit cold storage plant, ice plant and air-conditioning Plant to observe VCRS or VARS.
9.	Preparation of small model of VCRS.
10.	Built up/ evacuate VCRS available at your institute.
11.	Prepare property table for different types of refrigerants/ alternate fuels.
12.	Undertake 2 to 5 days of training in an automobile workshop.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Internal Combustion Engines	o Real-life examples, Demonstration of natural systems, Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs).
II	IC Engine Fuels	
III	Gas Turbines	
IV	Refrigeration	
V	Air-Conditioning	

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned at the beginning of the semester. The number of studentsin the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass at least COs with in integration of PrOs, UOs, and ADOs. The duration of the micro project should be about **4-5** ***(four to five) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model/animation):

1. Prepare a demonstration model of IC engine parts on wooden board.
2. Prepare a demonstration model of pistons of different size on wooden board.
3. Prepare a demonstration model of connecting rods of different size on wooden board.
4. Prepare a display chart of different types IC engine systems.
5. Prepare a display chart of different types of IC engine fuels.
6. Make a PowerPoint presentation on the latest industry trends in IC engines.
7. Prepare a tabulated summary of the types of four-stroke Petrol engines used in a vehicle which are available in the market. (Summary includes number of cylinders, capacity, types

of cooling system, types of ignition system, types of governing system, types of fuel supply system etc).

8. Prepare a tabulated summary of the types of two-stroke Diesel engines used in a vehicle which are available in the market. (Summary includes number of cylinders, capacity, types of cooling system, types of ignition system, types of governing system, types of fuel supply system etc).
9. Prepare a tabulated summary of the types of four-stroke Diesel engines used in a vehicle which are available in the market. (Summary includes number of cylinders, capacity, types of cooling system, types of ignition system, types of governing system, types of fuel supply system etc).
10. Prepare a chart of possible minor fault and remedies while driving two wheelers and four wheels.
11. Prepare chart of CNG/LPG/Diesel/ Petrol engine fueling system.
12. Make a PowerPoint presentation on the latest trends in IC engines fuels.
13. Carry out a comparative study of gas turbines used in power plants and the upcoming latest technologies in a gas turbine.
14. Make a PowerPoint presentation on the latest industry trends in gas turbines.
15. Prepare a tabulated summary of the types of refrigerators used for domestic, dairy products, soft drinks which are available in the market. (Summary includes cooling capacity, types of compressors, types of refrigerants, types of expansion system, types of evaporation system etc).
16. Prepare a tabulated summary of the types of air conditioners used in a home, office, mall, cinema and vehicle which are available in the market. (Summary includes tonnage capacity, types of compressors, types of refrigerants, types of expansion system etc).
17. Prepare a chart of installation and maintenance of A.C. at home or office.
18. Collect and analyse technical specifications of split air conditioner from manufacturers' websites and other resources.
19. Collect and analyze technical specifications of refrigerator from manufacturers' websites and other resources.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Thermodynamics: An Engineering Approach	Yunush A. Cengel Michael A. Boles	Tata Mcgraw- Hill.
2.	Heat Engines	Pandya and Shah	Charotar Publishing House.
3.	Thermodynamics and Heat power Engineering	Mathur and Mehta	Tata Mcgraw- Hill.
4.	Heat Engines	D. A. Wrangham	Cambridge University Press.
5.	Thermal Engineering	R K Rajput	Laxmi. Publications
6.	A Text book of Thermal Engineering	R S Khurmi & J.K. Gupta	S Chand & Co.
7.	Thermal engineering	P.L.Ballaney	Khanna Publication

8.	Thermal Science and Engineering	Dr. D.S.Kumar	S.K.Kataria & Sons.
9.	IC Engine	Mathur and Sharma	DhanpatRai Publication
10.	Principles of Refrigeration	Dossat	Pearson Education
11.	Refrigeration and air conditioning	Arora & Domkundwar	Khanna publication.
12.	A Text Book of Refrigeration and Air Conditioning	R S Khurmi	Eurasia Publishing House
13.	Refrigeration & Air-Conditioning	R.K.Rajput	S.K.Kataria & Sons.

14. SOFTWARE/LEARNING WEBSITES

1. http://nptel.ac.in/courses/112105128/
2. http://www.youtube.com/playlist?list=PLE2DA184A2E479885
3. http://www.kolpak.com/asset/?id=tuqvr
4. https://www.kwangu.com/work/psychrometric.htm
5. http://people.tamu.edu/~i-choudhury/psych.html
6. https://www.youtube.com/playlist?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC
7. http://vlabs.iitkgp.ernet.in/rtvlas/exp1/index.html#

15. PO-COMPETENCY-CO MAPPING

Semester V	**Thermal Engineering-II (4351903)**						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Apply basic concepts, laws, and principles of thermal engineering to select and operate the IC engines, gas turbines, refrigerators and air conditioners.						
CO-1: Analyze performance of internal combustion engines using performance parameters and heat balance sheet.	2	3	2	3	-	2	3
CO-2: Select IC engine fuels and related support system for internal combustion engines.	2	-	-	-	3	-	2
CO-3: Identify salient features of open and closed cycles gas turbines.	2	-	-	-	-	-	2
CO-4: Analyze the performance of refrigeration system using standard procedures.	-	3	2	3	2	2	2
CO-5: Estimate air conditioning parameters for particular appliances.	2	3	-	-	-	-	2

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU RESOURCE PERSONS)

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17. BOS RESOURCE PERSONS

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4.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Mechanical Engineering Project-I
(Course Code: 4351904)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

Functionality, Reliability, Durability, Safety, Maintainability, Sustainability, Ergonomics, Aesthetics, Cost-effectiveness, and Manufacturability of a product is always a prime concern for a designer. Even a well designed product may have the scope of improvement looking at the situation's demand. It is a moral duty of an engineer to work proactively to provide a new product to the customer or modify the existing product for a safer, qualitative, cost effective or sustainable solution. This course provides an opportunity to the students to demonstrate their abilities to address at least one of such problems in a product. This course also aims to develop in a student an engineering skill like diagnose the problem, design an innovative/optimal solution and management skills like conduct the visit or survey, leadership, coordination, team-work, decision making, planning for the resources, reporting etc.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- Apply systematic approach for problem selection and provide its safer, qualitative, cost effective or sustainable solution.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO	CO Statement
CO-1	Conduct the visit and/or survey to search the problem.
CO-2	Select the problem and outline the conceptual model of its solution.
CO-3	Modify the conceptual model of a solution based on safety, quality, cost or sustainability.
CO-4	Prepare plans and estimates for the solution and Project-I report.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	0	0	50	50	100

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE-End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (COs). Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Exercise No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
01	**Project Initialization:** Mechanical Engineering Project-I activities should be initialized at the end of semester IV but well before the start of semester-V. Following activities should be done during this exercise. a. Refer to the curriculum of courses Mechanical Engineering Project-I and Mechanical Engineering Project–II. b. Understand the importance of a project. c. Understand Project domains/areas and project constraints. d. Understand Dos and Don'ts in context of the project. e. Understand product design criterion and parameters on which the performance of a product depends. f. Overview/showcase the previously completed projects. g. Understand the relationship between the Project and Intellectual Property Rights (IPRs) h. List of various agencies funding the projects, if any. i. Explore the probability with the nearby industries to see if they have any projects that students can work on. j. Consult faculties/guides, industry professionals and/or anybody who have expertise in the field of engineering to find suitable project.	-	-

Exercise No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
02	**Data collection for the project:** a. Conduct research in the field/industry or explore online platforms to gain an understanding of the current mechanical engineering projects being undertaken. Additionally, perform a literature survey of relevant resources such as journals, websites, and blogs that focus on mechanical engineering projects. This will help gather information for problem selection. b. Record key findings and collect essential data about the identified problem from the site visit or literature survey. Note: 1. This exercise will be completed individually by each student. 2. Students have the flexibility to work on any real-life problem related to the field of mechanical engineering. This may include a User Defined Problem (UDP), a live problem sourced from the industry (IDP), or an extension/modification of an existing product/project. It is not limited to the creation of physical models exclusively.	-	16
03	**Project Selection.** Refer to the data collected during exercises No. 01 & 02 and do the following. a. Each batch member should present their key findings. b. Form groups for Mechanical Engineering Project-I from the batch members. c. Select a problem and prepare a project definition. d. Create a schedule for the group's work allocation, covering all the milestone activities/tasks of the project for the entire duration of the term, both planned and actual. e. Apply relevant product/system design and/or management techniques such as Root Cause Analysis (RCA), Finite Element Analysis (FEA), Failure Mode and Effects Analysis (FMEA), Computational Fluid Dynamics (CFD), Fault Tree Analysis (FTA), 5W2H critical examination technique, Ishikawa (Fishbone) Diagram, Pareto Analysis, Statistical Process Control (SPC), Design of Experiments (DOE), Value Stream Mapping (VSM), Simulation and Modeling, 5S strategies, 7S framework, SWOT analysis, Life Cycle Management (LCM), Lean Manufacturing, Six Sigma, Total Quality Management (TQM), etc. Then, outline the conceptual model of the solution with key data. Note: 1. The group size for students is preferably in the range of 3 to 8, based on the requirements of the project. 2. Interdisciplinary groups may be allowed based on the specific demands of the project. 3. Each project group will be assigned a guide. Ideally, the majority, if not all, of the department's faculties should be assigned the duty of Project-I guide-ship. 4. The group may proceed with the process of Intellectual Property Rights (IPR) based on advice from the guide, if necessary.	-	12

Exercise No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
04	**Plans & estimates of the project.** Refer to the details collected during exercises No. 01 and 02 and follow the instructions provided below, based on their applicability. a. Prepare a user manual containing project specifications and other key details. b. Create detailed assembly and production drawings. c. Develop an Operation Process Chart (OPC), process plans, quality/test plans, a statement of bought-out parts, a statement of raw material, budget estimation, and any other relevant documents.	-	16

Exercise No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
05	**Project-I report.** a. Prepare a computerized project report following the guidelines provided below. PAGE : A4 (print on both side of paper) MARGIN : TOP 15mm BOTTOM 15mm INSIDE & OUTSIDE 30mm (mirror margining) FONT : ARIAL FONT SIZE: TITLE:12 BOLD, CONTENT:12, SPACING :18pt HEADER: PROJECT TITLE, PAGE No ON TOP RIGHT. FOOTER : ACADEMIC YEAR, SHORT NAME SAMPLE FORMAT OF UDP PROJECT-I REPORT The Report may include the following. Text shown in the square bracket [] is an explanation on the chapter/topic. Certificate (in the Format given in Appendix-C) Acknowledgement Index 1. Abstract: [A brief summary of the project, including its objectives, methodology, and results.] 2. Introduction: [An introduction to the project, including its background and scope.] 3. Literature Review: [A review of the existing literature related to the project, including any relevant theories or concepts. This may include Prior Art Search.] 4. Methodology: [A description of the research methodology used in the project, including data collection and analysis methods.] 5. The Outline of the solution: [This may include output of exercise-01 to 03] 6. Results and Discussion: [A presentation of the project's probable results, including any statistical analysis, charts, or graphs. This section should also include a discussion of the results and their implications.] 7. Conclusion: [A summary of the project's main findings.] 8. Recommendations: [Suggestions for future research or improvements.] 9. References: [A list of all sources cited in the report.] 10. Appendices: [Any additional materials that support the report, such as work allocation schedule (planned and actual), photographs, technical drawings, circuits, software or data sets.] b. Print the required number of copies of the Mechanical Engineering Project-I report after obtaining approval from the guide. c. Submit the hard and/or soft copies of the following documents: • Mechanical Engineering Project-I report • Mechanical Engineering Project-I logbook • Additional records referred to in appendices, if any Note: The report format for an IDP (Industry-Defined Problem) may differ from the UDP (User-Defined Problem) report format suggested above.	-	12
Total (Hours)		**-**	**56**

Note: Each project group will present its work upon completing each exercise, following the department's plan.

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop

the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data (which and why) before the group starts their market survey.

6. Sample rubrics Performance Indicators for the PrOs

Criteria	%	5	4	3	2
Logbook	10%	Always maintains proper order of meetings and assigned tasks	Consistently maintains proper order of meetings and assigned tasks	Sometimes maintains proper order of meetings and assigned tasks	Rarely maintains proper order of meetings and assigned tasks
Literature Survey	10%	Always lists journals, websites etc. and generate idea with scope of product	Consistently lists journals, websites etc. and generate idea with scope of product	Sometimes lists journals, websites etc. and generate idea with scope of product	Rarely lists journals, websites etc. and generate idea with scope of product
Concept development and finalization of topic	10%	Always compares existing concepts and derives final topic	Consistently compares existing concepts and derives final topic	Sometimes compares existing concepts and derives final topic	Rarely compares existing concepts and derives final topic
Drawings, plans and estimates	20%	Always provides required no. of views of each part with required details in detail and assembly drawings and prepare necessary plans & estimates	Consistently provides required no. of views of each part with required details in detail and assembly drawings and prepare necessary plans & estimates	Sometimes provides required no. of views of each part with required details in detail and assembly drawings and prepare necessary plans & estimates	Rarely provides required no. of views of each part with required details in detail and assembly drawings and prepare necessary plans & estimates
Budget Analysis	10%	Always list parts used in the assembly and costing with competitive rates	Consistently list parts used in the assembly and costing with competitive rates	Sometime list parts used in the assembly and costing with competitive rates	Rarely list parts used in the assembly and costing with competitive rates
Presentation	10%	Always discuss all content with outline and methodology used	Consistently discuss all content with outline and methodology used	Sometime discuss all content with outline and methodology used	Rarely discuss all content with outline and methodology used

Criteria	%	5	4	3	2
Report write-up	10%	Always preparer basic category/section and summary	Consistently preparer basic category/section and summary	Sometime preparer basic category/section and summary	Rarely preparer basic category/section and summary
Conclusion, Future Scope	10%	Conclusion and future scope derived appropriately	Conclusion and future scope derived but partial	No relevant conclusion or future scope	No conclusion or future scope

7. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

Sr.No.	Equipment Name	PrO.No.
1.	Computer with word processor and modeling software	4

8. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes.(Environment Related)

9. SOFTWARE/LEARNING WEBSITES

- https://www.theengineeringprojects.com/
- https://asmedigitalcollection.asme.org/mechanicaldesign
- https://blog.creationcrate.com/mechanical-engineering-projects/
- https://plagiarisma.net/

10. PO-COMPETENCY-CO MAPPING

Semester V	POs						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	Apply systematic approach for problem selection and provide its safer, qualitative, cost effective or sustainable solution.						

Semester V	POs						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
CO.1 Conduct the visit and/or survey to search the problem.	3	-	-	-	-	2	2
CO.2 Select the problem and outline the conceptual model of its solution.	2	2	-	-	2	2	2
CO.3 Modify the conceptual model of a solution based on safety, quality, cost or sustainability.	3	2	3	2	2	2	2
CO.4 Prepare plans and estimates for the solution and Project-I report.	-	-	-	2	-	2	2

Legend:'3' for high, '2' for medium, '1' for low, and '-'for no correlation each CO with PO.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Jitendra P. Parmar, Lecturer Mechanical Engineering	609 – C U Shah Polytechnic Surendranagar	9429942662	jpparmar66@gmail.com
2.	Muhammad Azharuddin U. Badi, Lecturer Mechanical Engineering	627 - Government Polytechnic, Porbandar	9558800951	muhammadbadi92@gmail.com

12. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. S. H. Sundarani, BOS Chairman & HOD Mechanical	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2	Dr. Rakesh D. Patel, BOS Member & HOD Mechanical	B. & B. Institute of Technology, V. V. Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in

Appendix-A

SAMPLE LOGBOOK

Enrolment No: Name of the Student:

Date: Time from: to (Total hrs)

Place/s of work or visit:	
Detailed description of work done:	
Name of concerned person/s, if any	
Document/s referred, collected, created or modified, if any	
Financial details, if any	
Student’s dated sign	Guide's dated sign

Appendix-B

SAMPLE PROCESS PLAN

Drawing No: Part No/Id: Name of the Part:

Raw material: Raw wt: Finish wt:

Op. No	Name of Operation	Size, tol., surface finish etc req'd	Machine details	Machining Parameters	Cutting Tools, Jig/ Fixture, coolant etc req'd	Measuring, inspection, Test instruments required	Time in Hr	
							Set-up	machining

Student's dated sign Project guide's dated sign

Appendix-C

SAMPLE CERTIFICATE

This is to certify that Enrolment No: _____

Mr./Ms._____

from_____College has completed Mechanical Engineering Project-I Report of Semester-V having title _____(Project Id: _____) in a group consisting of _____ students under the guidance of the Faculty Guide _____ in the academic year: _____

The mentor from the industry for the project, if any:

Name:

Industry:

Contact Details:

Institute Guide Industry Guide Head of Department

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Tool Engineering
(Course Code: 4351905)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

Tools are as basic component for any machining process. The quality and efficiency of any machining operation basically depends upon quality of tools which in turn depends upon the proper shape, size and material of the tools. Productivity and quality of machining operations may further be enhanced by proper and quick mounting of tools and jobs on machines. Jigs and fixture play an import roll in this process. Therefore, this course attempts to develop abilities in students to select a tool of proper size and shape for required machining operation. The design of press tools, jigs, fixtures and limit gauges is also dealt with in this course. This course is therefore a core course for mechanical engineers.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Develop the ability to select and/or design cutting tools, tool holders, dies, jigs and fixture for given simple component.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Use relevant cutting tools for given manufacturing operations.
CO-2	Identify and select locating and clamping devices for given component.
CO-3	Design jig and fixture based on components' geometry and machining operations.
CO-4	Identify appropriate press working operations for mass production of sheet metal parts.
CO-5	Select and design dies and limit gauges for a given simple component.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Introduction & demonstration of cutting tools re-sharpening	I & II	02
02	Draw production drawings of all parts of fixture (Detail Drawing).	III & IV	04
03	Draw assembly of fixture with BOM.		03
04	Draw production drawings of all parts of jig (Detail Drawing).		04
05	Draw assembly of jig with BOM.		03
06	Draw production drawings of die block, die shoe and stripper plate of progressive die.	V	04
07	To draw assembly which include punches, die, die shoe and stripper plate of progressive die.		04
08	Select & design limit gauge for given component.	VI	04
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Use only sketch-book to carry practice work as term work.

III. Production drawings include-drawings with dimensions-scale, surface finish symbols, limits/fits, tolerances, surface treatment/s, heat treatment/s and other notes/details required to manufacture the part.

IV. Assembly drawing include minimum two views (one preferably sectional view if required) and parts list i.e. Bill of Material (BOM).

V. In examination, students are required to sketch freehand only.(For all questions).

VI. Faculty should encourage students for optimum use of drawing sheet space. Further, instruct them to use both sides of a drawing sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Design/drawing type PrOs (PrOs Number: 2 to 8)		
1	Design	30
2	Detail/Assembly Drawing	20
3	Drawing General	20
4	Participation	10
5	Punctuality	20
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 1)					
Criteria	**%**	**5**	**4**	**3-2**	**1**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Design/drawing type PrOs (PrOs Number: 2 to 8)				
Criteria	**%**	**5**	**3**	**1**
Design	30%	Select proper type of Jig/Fixture/Die and develop suitable clamp and locating system/components.	Select proper type of Jig/Fixture/Die but not idea about development of suitable clamp and locating system/ components.	Not able to select proper type of Jig/Fixture/Die and develop suitable clamp and locating system/ components.
Detail/Assembly Drawing	20%	All required parts drawings are drawn with material and dimension tolerances/ballooning & BOM.	All required parts drawings are drawn with material but sufficient dimension tolerances/ballooning & BOM are not given.	All required parts drawings are not drawn with material and dimension tolerances/ballooning & BOM.
Drawing General	20%	Drawing lines are clear and well oriented. There are almost no erasures or stray marks on the paper. Overall, the quality of the drawing is excellent.	Drawing lines are clear but not well oriented. There are smudged lines or stray marks on the paper, but they do not greatly detract from the drawing. Overall, the drawing is good.	Drawing lines are not clear and not well oriented. There are several erasures, smudged lines or stray marks on the paper, which detract from the drawing. Overall, the quality of the drawing is poor.
Participation	10%	Used time well in lab and focused attention on the exercise.	Attend the lab but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Punctuality	20%	Drawing work is completed within time limit	About 70 % to 90 % of work is completed within time limit	Less than 70 % of work is completed.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name
1.	Tool and cutter grinding machine.

2.	Cutting tools, mainly set consisting assorted sizes of drill bits, set consisting assorted sizes of end mills, set consisting assorted sizes of side and face milling cutters, set consisting assorted sizes of center drills-Type A and B, assorted carbide inserts.
3.	Tool holders for carbide inserts, drill spindles/quills, milling machine quills,
4.	Most commonly used set of locators and clamping devices, jigs and fixtures.
5.	Models of jigs and fixtures.
6.	Press-2.5 to 5 Tonnes, (Hydraulic or electrical operated), set of assorted sizes punches and dies.
7.	Set of various hand tools, cutting tools, models, Different types of limit gauges.

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices.

d. Maintain tools and equipment.

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Introduction	1.a Explain role of tool engineering in industries. 1.b Establish importance of process planning in tool engineering.	1.1 Concept, meaning and definitions of tool, tool design and tool engineering. 1.2 Tools-types, classification, features & applications. 1.3 Tool engineering-functions and importance to enhance productivity and quality. 1.4 Importance of process planning in tool engineering.

Unit– II Cutting tools and tool holders	2.a List cutting tool materials. 2.b Interpret ISO- designation for carbide inserts. 2.c Describe process for re-sharpening commonly used cutting tools. 2.d Interpret ISO- designation for tool holders for carbide inserts.	2.1 Cutting tool materials-types, composition, properties and applications. 2.2 Carbide inserts-types, ISO-designation and applications. 2.3 Re-sharpening methods of following cutting tools: a. Drill. b. Side and face milling cutter. c. End mill. d. Centre drill, type A and B. e. Gear hob. 2.4 Tool holders for turning and milling carbide inserts-types, ISO-designation and applications.
Unit-III Locating and clamping devices	3.a Explain location and 3-2-1 principle of location. 3.b Establish importance of degree of freedom in location. 3.c Select and use suitable locator for given work piece. 3.d Select and use appropriate clamping device for given work-piece situation.	3.1 Concept, meaning and definitions of location and clamping. 3.2 Use of locating and clamping principles in day-to-day supervision on shop floor. 3.3 Degree of freedom - concept and importance. 3.4 3-2-1 principle of location. 3.5 Locators & clamping devices: a. Types b. Sketches with nomenclature. c. Working. d. Applications. 3.6 Fool proofing and ejecting.
Unit– IV Jigs and fixtures	4.a Differentiate between jigs and fixtures. 4.b Select and design appropriate jig or fixture for given simple work piece.	4.1 Concept, meaning, difference and benefits of jigs and fixtures. 4.2 Types, sketches with nomenclature, working and applications of jigs & fixtures. 4.3 Steps to design jigs and fixture. 4.4 For given simple component: a. Select type (Jig or fixture). b. Develop locating method. c. Develop clamping method. d. Design jig and fixture. e. Prepare details and assembly drawing.
Unit–V Press tools	5.a Select suitable press tool 5.b operation for given simple press tool component. 5.c Calculate press tonnage and center of pressure for given press tool component. 5.d Determine dimensions of punch and die for given press tool component. 5.e Determine shear angle.	5.1 Press working processes-types, sketches and applications. 5.2 Press tools: types, working, components and their functions 5.3 Concept, meaning, definitions and calculations of press tonnage and shut height of press tool. 5.4 Shear action in die cutting operation and Centre of pressure: Concept, meaning, definition, methods of finding and importance.

	5.f Prepare scrap strip layout for given press tool component. 5.g Design progressive cutting die for given simple press tool component.	5.5 Die clearance: Concept, meaning, definition, reasons, effects and methods of application and Cutting force: Methods to calculate and methods of reducing. 5.6 Shear angle- concept, need and method to give shear angle on punch and die. 5.7 Scrap strip layout: - Concept, importance, method to prepare, and determining percentage stock utilization. 5.8 Types, working, and applications of stock stop, pilots, strippers and knockouts. Cutting dies-types and applications. 5.9 Design of progressive cutting die: a. Sketch the component. b. Prepare scrap strip layout. c. Calculate tonnage. d. Determine center of pressure. e. Determine dimensions of punches, die block and die shoe. f. Prepare sketch of stripper plate. g. General assembly sketch of h. Punches arrangement, die block, die shoe and stripper plate.
Unit–VI Dies, moulds and limit gauges	6.a Calculate bend radii, bend allowance and spring back for given Simple part. 6.b Describe working of various dies. 6.c Select type of die/mould for given part. 6.d Design limit gauges for given part.	6.1 Bending: a. Types. b. Parts and functions of bending die. c. Definition, calculations and factors affecting bend radii, bend allowance and spring back. d. Method to compute bending pressure. e. Types, sketch, working and applications of bending dies. f. Types, sketch, working and applications of drawing dies (embossing, curling, bulging, coining, swaging and hole flanging). 6.2 Classifications of Limit Gauges. Desirable properties of gauge materials. Advantages and disadvantages of Limit gauges. 6.3 List of factors to be considered in selection of gauge. 6.4 Taylor's Principle of gauge design. 6.5 Design steps for plug gauges and snap gauges.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	3	2	4	2	8
II	Cutting tools and tool holders.	7	4	4	4	12
III	Locating and clamping devices.	7	3	4	4	11
IV	Jigs and fixtures.	10	3	4	7	14
V	Press tools	10	4	2	8	14
VI	Dies, moulds & limit gauges	5	4	4	3	11
Total		**42**	**20**	**22**	**28**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Download the catalogues for cutting tools, jigs and fixtures and prepare report on their features and specifications.
2.	Visit nearby manufacturing unit and prepare the list with specifications of cutting tools, hand tools, press tools, measuring tools and consumables being used there.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction.	Movie, Industrial visit.
2	II	Cutting tools and tool holders.	Demonstration of physical cutting tools and tool holders.
3	III	Locating and clamping devices.	Demonstration of physical locating and clamping devices in operation, video movies,
4	IV	Jigs and fixtures.	Demonstration with operations, video movies, Industrial visits.
5	V	Press tools.	Demonstration with operations, video movies, Industrial visits.
6	VI	Dies, moulds & limit gauges.	Video movies, Industrial visits.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned at the beginning of the semester. The number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass at least COs with in integration of PrOs, UOs, and ADOs. The duration of the micro project should be about **4-5** ***(four to five) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model/animation):

1. Prepare individual components of Jig as per design using wood or plastic. Assemble them by using components of 3-4 student groups.
2. Prepare a tabulated summary of the types of Jig Bushes used in industry which are available in the market.
3. Prepare individual components of Fixture as per design using wood or plastic. Assemble them by using components of 3-4 student groups.
4. Prepare individual components of Progressive Die as per design using wood or plastic. Assemble them by using components of 5-6 student groups.
5. Prepare a display chart of different types of cutting tool holder.
6. Prepare a display chart of different types of material inserts.
7. Make a PowerPoint presentation on the latest industry trends in tool engineering field.
8. Prepare a tabulated summary of the types of Locators used in industry which are available in the market.
9. Prepare a tabulated summary of the types of Clamping devices used in industry which are available in the market.
10. Make a PowerPoint presentation on the latest industry trends available in cutting tool types.
11. Visit and prepare report on types of industry which have small, medium & larger size of tool room availability.
12. Prepare actual model of Plug Gauge you have designed for given component.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Fundamentals of tool design	ASTME	PHI.
2.	Tool design.	Cyril Donaldson and George H Lecain	TME
3.	Tool engineering	Doyal.	
4.	Principles of tool & jig design	M. H. A. Kempster.	
5.	Jigs and fixture	P. H. Joshi	TMGH
6.	Design Of Jigs Fixtures and Press Tools	C. Elanchezhian, T. Sunder Selwyn, B.Vijaya Ramnath	Eswar Press, 2007, 2nd Edition
7.	Cutting tools standards.	-	BIS
8.	Production technology	-	HMT
9.	PSG Design data book	PSG, Coimbatore	PSG, Coimbatore
10.	Tool Engineering and Design"	G R Nagpal. ..	Khanna publishers
11.	Metal Cutting and Tool Design	Ashok Kumar Singh	

12.	Tool Engineering	Vilas S Teli	Nirali Prakashan
13.	Tool Engineering Die design fundamentals	Vukota Boljanovic & J R Paquin	

14. SOFTWARE/LEARNING WEBSITES

1. https://www.youtube.com/watch?v=TsCcBT6FZKw (Dual curl)
2. https://www.youtube.com/watch?v=8XOKE8cMAi4&t=82s (Progressive dies)
3. https://www.youtube.com/watch?v=LKEG3p3yx1g (combination dies)
4. https://www.youtube.com/watch?v=YuQFhbRaWD0 (comparison of forging dies)
5. https://www.youtube.com/watch?v=ECA390jloJg (Press working operations)
6. https://www.youtube.com/watch?v=jhBBEBDk4P4&t=182s (Sheet metal operations)
7. https://www.youtube.com/watch?v=QfDb8FjaqNg (Punching and blanking operations)
8. https://www.youtube.com/watch?v=9GHUQBTDC9E (Press tools)
9. https://www.youtube.com/watch?v=HVbbSl5WreA (Jigs and fixtures animation)
10. https://www.youtube.com/watch?v=J_d8IRT9r7E (Press working operations Animation)
11. https://www.youtube.com/watch?v=FaEt0q7YRFQ (Jigs and fixtures concepts)
12. https://www.youtube.com/watch?v=04V6x1fkqQs (Locating and supporting devices)
13. https://www.youtube.com/watch?v=ABAIKYyiEg0 (Jigs and fixtures for drill machine)
14. https://www.youtube.com/watch?v=5YmKwVAkZgo (Single point cutting tool)
15. https://www.youtube.com/watch?v=i0P_uELEuJw&t=14s (Types of Cutting Tools and Uses)

15. PO-COMPETENCY-CO MAPPING

Semester V	**Tool Engineering (4341905)**						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Develop the ability to select and/or design cutting tools, tool holders, dies, jigs and fixture for given simple component.						
CO-1: Use relevant cutting tools for given manufacturing operations.	3	-	-	2	-	-	-
CO-2: Identify and select locating and clamping devices for given component.	3	2	-	-	-	-	-
CO-3: Design jig and fixture based on components' geometry and machining operations.	3	2	3	-	2	-	2
CO-4: Identify appropriate press working operations for mass production of sheet metal parts.	2	2	3	-	-	-	-
CO-5: Select and design dies and limit	2	2	-	-	2	-	2

gauges for a given simple component.							

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU RESOURCE PERSONS)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. Altaf Nalbandh	Government Polytechnic, Porbandar	9904230786	altaf.nalbandh85@gmail.com
2.	Prof. Joseph Soni	B. & B. Institute of Technology, Vallabh Vidyanagar	9898915991	soni_joseph_2000@yahoo.com

17. BOS RESOURCE PERSONS

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS Chairman & HOD Mechanical	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel, BOS Member & HOD Mechanical	B. & B. Institute of Technology, V. V. Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Advance Manufacturing System
(Course Code: 4351906)

Diploma program in which this course is offered	Semester in which offered
Mechanical & Mechatronics Engineering	5th Semester

1. RATIONALE

Manufacturing processes converts raw material to finished product for customer usage. Now a day's customer is the king in the market and needs and desires of customer has increased the varieties and features in products. This has increased the complexities at almost all the stages of manufacturing. In modern manufacturing system it is very important to listen voice of customer and deploy his needs in entire manufacturing system. In modern era of the liberalized economy, we are facing world class competition in our own country. Global industries in the form of advanced manufacturing systems, is compelling Indian industries to reorganize their manufacturing strategies for competing on the dimensions of cost, quality, flexibility and deliverability. Hence it is important for us to understand the various modern-manufacturing systems available today.

Recent advance manufacturing system /techniques / electronics devices provide precision machine control compare to conventional machines. With higher accuracy quality and productivity. Objective of leaning this subject is to make aware the students about the advance manufacturing practices/systems being implemented at leading industries across the globe, which ultimately leads to more customer satisfaction in terms of low cost and high quality.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

• Identify and use the proper manufacturing systems to manufacture products with available resource at internationally competitive price with innovation, creativity and better quality.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following Cos.

CO-1	Identify role of computers and information technology in manufacturing systems with concept of technological life cycle and product life cycles.
CO-2	Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per

	their attributes.
CO-3	Recognize use of Automation and control technology in industries.
CO-4	Discuss use of robotics Industrial automation, programmable logic controllers in modern manufacturing system and Industry 4.0
CO-5	Describe application of recent trends in modern manufacturing system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Total Credits	Examination Scheme				
				Theory Marks		Practical Marks		Total
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the 'Precision level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	**Presentation on "How it's made" with type of manufacturing process and system** Faculty will assign any one part from Annexure-I. (Each student will have different part in a batch). Student will download movies/content and will present with the concept "How it's made.	1	02
02	**Development of GT codes:** Faculty will ask each student to bring at least one component having mechanical features and having more than 5-6 machining operations. Each student will also prepare the drawing and process plan (As per attached Annexure-II). Then the data will be interchanged by batch students. Collection of parts and making drawing and	2	04

	process plans will be as home assignment. Faculty will assign this task in very first period of practice. Students would: a. Prepare drawing of part brought by the student. b. Prepare process plan as per Annexure-II for the part brought by student. c. Interchange part drawings and process plans. (No photo copies are allowed. Each student in a batch will have total drawings and process plans equal to number of students in a batch who have brought parts. This may be also given as home assignment). d. Prepare feature matrix. Select GT coding system and assign GT code to each.		
03	**Preparation of FMS layout: Students would:** a. Develop part family (May be 3-6 parts) from all parts. (Taken in Ex. No. 2 above.) This is to be carried out logically from feature matrix. b. Assume quantities of each part of part family developed in an above. c. Assume additional data for following: i. Number of shifts and working hours in each shift. ii. Average number of working days in a month. iii. Utilization factor of FMS unit. d. Prepare process time matrix. e. Determine type and number of work stations. Perform necessary calculations and prepare conceptual FMS layout.	3	04
04	Prepare report/Case study on Industrial Automation and process control system.	4	02
05	**Demonstration:** Students would: a. Demonstrate working of following: i. Robot-anyone. ii. Sensors-each one from force & torque type, velocity and acceleration type, proximity type, position type and vision type. iii. Programmable logic controller (PLC). b. Sketch following. i. Configuration sketch of robot demonstrated. ii. Working sketch of sensors demonstrated. iii. Block diagrams of PLC.	5 & 7	04
06	**Industry 4.0** Prepare report /Case study on Industry 4.0	6	02
07	Demonstration and simulation of computer integrated manufacturing system on various free access software.	8	02
08	Prepare report /Case study on lean manufacturing and	8	02

	green manufacturing.		
09	Prepare report/Case study on Computer aided process planning and concurrent engineering.	8	02
10	**Industrial visit and report :** Students would: Visit any one advanced manufacturing system/CAD-CAM/ Robotics/Additive manufacturing based industry/Centre of excellence/Exhibition and prepare brief report on it.	ALL	02
11	**Seminar presentation:** Students would: Prepare and present seminar topic individually. (Seminar topic has to be given by faculty).	ALL	02
Total (Hours)		**-**	**28**

Note:

I. More Practical Exercises can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list.

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data (which and why) before the group starts their market survey.

The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed Practical Exercises of this course, which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Demonstration type PrOs (PrOs Number: 5 & 6)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	25
4	Punctuality	15
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Experimentation/performance type PrOs (PrOs Number: 2,3,4,7 & 8)		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Presentation type PrOs (PrOs Number: 1,10)		
1	Presentation & Organization	25

2	Content (MATTER+PPT)	20
3	Subject Knowledge	20
4	Communication Skill (VERBAL+NONVERBAL)	25
5	Time Taken	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 5 & 6)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labeling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Participation	25%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Punctuality	15%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

Experimentation/performance type PrOs (PrOs Number: 2,3,4,7 & 8)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Procedure follows	30%	Student follow all the	Student follow all the	Student follow all the	Student follow all the

		procedure with precaution in a logical order	procedure with some precaution in a logical order	procedure without precaution in a logical order	procedure without precaution in an illogical order
Observation Skill	20%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Conclusion/ Summary	10%	Student concept is mostly clear	Student concept is partly clear	Student concept is somewhat clear	Student concept is not clear
Quality of Report	10%	Neat Handwriting, figure, and table. Complete labeling of figure and table	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labelling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Punctuality	10%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

Presentation type PrOs (PrOs Number: 1,10)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Presentation & Organization	25%	Student shows enthusiasm and presents information in logical, interesting sequence which engages the audience	Student presents information in logical sequence which audience can follow	Audience has difficulty following presentation because student jumps around	Delivery not smooth and audience attention lost because there is no sequence of information
Content (MATTER + PPT)	20%	Accurate and in depth information, sufficient amount of information, proper citing of resources	Accurate information, sufficient information, some resources not cited	Some information is inaccurate, sufficient information, some resources are not cited	Information is inaccurate, most sources are not cited
Subject	20%	Student	Student is at	Student is	Student does

Knowledge		demonstrates full knowledge (more than required) and answers all questions with explanations and elaboration	ease with information and gives expected answers to all questions, but fails to elaborate	uncomfortable with information and is able to answer only rudimentary questions	not have grasp of information; student cannot answer questions about subject
Communication Skill (VERBAL + NONVERBAL)	25%	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation
Time Taken	10%	The presentation was of the proper duration	Presentation speech is 10% short or over the allotted time	Presentation speech is 20% short or over the allotted time	Presentation speech is 30% or more short or over the allotted time

6. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrO is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1	Kits on robotics.	5
2	Set of sensor / transducer demonstration and operation trainer kit. (This should include sensors/transducers as per syllabus.)	5
3	Analog to digital and digital to analog trainer modules.	5
4	Digital logic trainer board.	5
5	PLC trainer or Demo software	5

7. AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the COs mentioned above and PrOs. More could be added to fulfill the development of this course competency.

a. Work as a leader/team member.
b. Follow safety practices.
c. Follow ethical practices
d. Maintain tools and equipment.
e. Practice environment-friendly methods and processes (Environment related).

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's Affective Domain Taxonomy, should gradually increase as planned below:

I. Valuing Level in 1st year
II. Organization Level in 2nd year.
III. Characterization Level in 3rd year.

8. UNDERPINNING THEORY

Based on the higher level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes(UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction.**	1a. Develop familiarity with manufacturing systems and its features. Components and types. 1b. Describe role of computers in manufacturing industries. 1c. Identify the stage of given product on product life cycle. 1d. Identify the stage of specified technology on technology life cycle. 1e. Explain the need to manufacture products at international competitive price with better quality & Innovation.	1.1 Manufacturing system definition & Features of Manufacturing system. 1.2 History of the industrial revolution and Manufacturing evolution. 1.3 Components and types of manufacturing system. 1.4 Role of computers and information technology in manufacturing and manufacturing systems. 1.5 Product life cycle its importance &Technology life cycle. 1.6 Scope, trends and challenges in Indian and global market.
Unit – II	2a. Select type of production layouts for given parts.	2.1 GT - concept, definition, need, scope, & benefits. 2.2 Production layout-types,

Group Technology (GT) & Cellular Layout.	2b. Select and develop GT codes for given parts. 2c. Identify features and develop part families of the given parts. 2d. Prepare cell layout of given part family.	features and applications. 2.3 GT Layout -concept, need, benefits, comparison with conventional layout with examples. 2.4 GT- codification systems- types, method of coding and examples. 2.5 Part features- concept, types and examples. 2.6 Part family- concept, method to form and approach to form cell using part families. 2.7 Types and comparison of cell: manual and automatic cell, assembly cell. 2.8 Cell layout.
Unit – III **Flexible Manufacturing Cell and System.**	3a. Identify role of major Elements of FMC/FMS. 3b. Explain Major Elements of FMC/FMS. 3c. Develop simple FMC/FMS layout for given data and family of components. 3d. Illustrate cases in which flexible manufacturing systems are effectively applied and suggest possible applications.	3.1 Flexible Manufacturing Cell (FMC) System (FMS) a – concept, definition and comparison with other manufacturing systems. 3.2 Major elements of F M C / FMS and their functioning: i. Tool handling system. ii. Material handling system. iii. Automated guided Vehicles (AGV). iv. Automated storage and retrieval system (AS/RS). v. Main frame computer. 3.3 FMS layout - concept, types and applications. 3.4 Data required developing an FMS layout. 3.5 Signal flow diagram and line balancing in FMS. 3.6 Alternatives Approaches to flexible manufacturing system.
Unit – IV **Automation and control technology**	4a. Identify basic elements of an automated system. 4b. Explain various level of Automation. 4c. Explain Industrial control	4.1 Introduction to Automation &Basic elements of Automated System. 4.2 Level of Automation. 4.3 Introduction to Industrial

	system. 4d. Identify difference between process industries and discrete manufacturing. 4e. Identify Control technology.	control system. 4.4 Process industries verses discrete manufacturing. 4.5 Continuous verses discrete control. 4.6 Sensors and Actuators used in Automation.
Unit – V **Robotics.**	5a. Identify the basic parts of a Robot. 5b. Differentiate between different robotic configurations and their functions. 5c. Identify different types of sensors used in Robotics. 5d. List the three general areas of industrial robot application. 5e. Evaluate the use of robots in manufacturing Industries.	5.1 Robots-concept, definition, benefits and various areas of application in Manufacturing systems. 5.2 Terminology used in Robotics. Robots-types, physical configuration, classification and selection criterion. 5.3 Axes nomenclature of Robots. Types and uses of Manipulators & Grippers. 5.4 Sensors- types, classifications, working principle and applications of position, force & torque, proximity, vision, velocity & acceleration sensors. 5.5 Overview of robot programming methods & languages.
Unit – VI **Discrete control Programmable Logic Controller (PLC)**	6a. Identify need of process control logic control and sequence control. 6b. Explain the various components of a 6c. Explain about need and types of PLC. .	6.1 Introduction to Discrete Process Control. 6.2 Logic Control. 6.3 Sequence Control. 6.4 Introduction and need of Programmable Logical Controller (PLC). 6.5 Components of PLC. .
Unit –VI **Industry 4.0**	7a. To impart basic idea in Industry 4.0. 7b. To provide students knowledge of need design principle of	7.1 Historical evolution, origin and key understandings of Industry 4.0 7.2 Need, Design principal

	Industrial 4.0 7c Identify and aware with various technologies of Industry 4.0	and current and future trends in Industry 4.0 7.3 .Industry 4.0 Technologies 7.4 Environmental Management and its technology in Industry 4.0
Unit – VIII **Recent Trends in manufacturing system.**	8a. Identify the applications of various advance techniques used in Manufacturing. 8b. Identify and aware with environmental friendly Manufacturing system.	8.1 Computer Aided Process Planning (CAPP) – concept, types, features, methods and importance and introduction to concurrent engineering. 8.2 Computer Integrated Manufacturing (CIM): need, block diagram, functional areas covered and their importance. Computer Aided Inspection (CAI) – concept, benefit, types, working and examples. Coordinate Measuring Machine (CMM) - its working and applications. Concept of reverse engineering. 8.3 Factory of future (FOF) and smart factory. 8.4 Artificial intelligence concept, definition and application areas. 8.5 Lean Manufacturing and waste reduction, Toyota Production System principles and Methodologies. 8.6 Just in Time (JIT) manufacturing – Pull and push types of manufacturing systems. 8.7 Green Manufacturing. 8.8 Additive manufacturing: concept and types

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching	Distribution of Theory Marks

		Hours	R Level	U Level	A Level	Total Marks
I	Introduction.	04	02	04	00	06
II	Group Technology (GT) & Cellular Layout.	06	03	03	06	12
III	Flexible Manufacturing System (FMS).	06	03	03	06	12
IV	Automation and control technology.	04	04	02	00	06
V	Robotics.	06	04	03	03	10
VI	Discrete control Programmable Logic Controller (PLC).	04	03	03	00	06
VII	Industry 4.0	04	03	03	00	06
VIIi	Recent Trends in Manufacturing system.	08	06	06	00	12
		42	**27**	**28**	**15**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student- related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course.

Sr. No.	Activity
1	Prepare a list of mechanical features based innovative product/products in the market that faces challenges related to quality or cost.
2	Prepare a list of mechanical features based creative ideas that can be converted into products.
3	Visit nearby industry or other technical institute (having more infrastructure and facilities) and present a case study covering the scope of this subject.
4	Visit or participate in the technical events, exhibition, conference, seminar (with Presentation).
5	Collect / download videos / presentations / case study on advances in Manufacturing systems.
6	Watch innovative technical shows or documentary on television or other social media.
7	Download and study at least two research paper related to advance manufacturing system and write review on it.
8	Participation in various technical events, project competition, quiz organized by various technical institute in state.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (If any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Sr. No.	Unit No.	Unit Title	Strategies
1	I	Introduction.	Presentation, Video.
2	II	Group Technology (GT) & Cellular Layout.	Presentation, Video, Assignment, Industrial Visit, demonstration of real parts with features identification.
3	III	Flexible Manufacturing System (FMS).	Presentation, Video, Simulated models.
4	IV	Automation and control technology.	Presentation, Video, Simulated models.
5	V	Robotics.	Demonstration, Video, Presentation, Industrial Visit, Mini Project.
6	VI	Industry 4.0	Demonstration, Video, Presentation, Industrial Visit, Mini Project
7	VII	Discrete control Programmable Logic Controller (PLC).	Demonstration, Video, Presentation, Simulated models.
8	VIII	Recent Trends in Manufacturing system.	Video, Case study, Industrial Visit, Seminars. Various softwares

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-projects are group-based (groups of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed here**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more Cos which are, in fact, an integration of PrOs, Uos, and ADOs. Each student must maintain a dated workdiaryconsistingofindividualcontributionstotheprojectworkandgiveaseminarpresentationbefore submission. The duration of the micro project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit a micro-project by the end of these semesters to develop the industry-oriented Cos.

A representative list of micro-projects is given here. This has to match the competency and the Cos. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty could add similar micro-projects in any form (chart/presentation/report/model):

List of Sample Micro project (Indentify similar type of micro project by Faculty)

Sr. No.	Unit No.
1	Prepare detail report on history of manufacturing.
2	Prepare detail list of various industries with its main products.
3	Code the given part using GT coding system.
4	Prepare simple FMS layout based on given inputs.
5	Prepare simple ladder diagram for given conditions for PLC.
6	Select the suitable sensor for given conditions.
7	Identify various terminologies with robot model/sketch.
8	Select the suitable sensor for given conditions.
9	Sketch geometrical configuration of given type of robot.
10	Identify robotic elements. Select suitable gripper for given part.
11	Identify various terminologies with robot model/sketch.
12	Identify 7 waste in nearby industry and apply principal of lean manufacturing.
13	Prepare detail report on history of Flexible manufacturing system and group technology.
14	Prepare Case study on rank order clustering method for group technology.
15	Prepare detail report with example group technology machine sequence method.
16	Identify various additive manufacturing process and system and prepare report

- **Faculty member can give their own creative and innovative micro project related to subject and topic covered**

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	CAD/CAM/CIM	P. Radhakrishnan & S. Subranarayan	New Age Intentional
2	Computer Integrated Design & Manufacturing	Bedworth, Wolfe and Anderson	McGraw Hill International Publication
3	Mechatronics	-	HMT
4	Introduction to Robotics	Arthur J. Critchlow	McMillan publication
5	Robotics for engineers	Yorom Koran	McGraw Hill Publication
6	Computer aided manufacturing	Rao, Tiwari & Kundra	Tata McGraw Hill Publication
7	Computer Aided Design & Manufacturing	Dr. Sadhu Singh	KP
8	Computer Integrated Manufacturing	S. K. Vajpayee	PHI
9	Automation, Production and Computer integrated Manufacturing	Mikell P. Groover	PHI
10	Mechatronics	Bradleg and Offers	Chapman and Hall
11	Practical Robotics	William C. Burns Jr. & Janet Evans Worthington	PHI
12	Lean Six Sigma Pocket Tool book	George Metal	McGraw-Hill Publishers
13	Materials and Processes in Manufacturing	E.P. DeGarmo, J.T. Black, R. Kohser & B. Klamecki	Hoboken, NJ: John Wiley & Sons Inc.
14	Industrial Automation and Robotics	A.K.Gupta S.K.Arora JR.Wescott	Mercury learning and Information
15	Industry 4.0 Current Status and Future Trends	Edited by Jesús Hamilton Ortiz	Intech Open(Published in UK)

14. SOFTWARE/LEARNING WEBSITES

I. http://www.vlab.com
II. http://www.mtabindia.com
III. www.cadcim.com
IV. https://www.leanproduction.com/
V. https://intelitek.com
VI. https://instrumentationtools.com/plc-trainer-demo-download

VII. https://www.siemens.com/global/en/products/automation
VIII. https://www.tinkercad.com/

15. PO-COMPETENCY-CO MAPPING

Advance Manufacturing System (Course Code: 4351906)							
Competency & Course Outcomes	**POs and PSOs**						
	PO 1 Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design / development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning
CO 1: Explain role of computers and information technology in manufacturing systems with concept of technological life cycle and product life cycles.	3	-	-	-	-	-	3
CO 2: Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per their attributes.	3	2	2	2	-	-	2
CO 3: Recognize use of Automation and control technology in industries.	3	3	2	3	2	-	3
CO 4: Recognize use of robotics Industrial automation, programmable logic controllers in modern manufacturing system.	3	2	3	3	2	2	2
CO 5: Recognize use of recent trends in modern manufacturing system.	3	-	-	-	-	2	2

Legend: '3' for high, '2' for medium, '1' for low ,and '-'f or no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Vinitkumar K. Modi	B.& B Institute of Technology, Vallabh Vidyanagar	9428661810	modi_vinit@yahoo.com
2.	Vimalkumar Palsanwala	Dr. S & S S Ghandhy College of Engineering and Technology, Surat	9824703832	vppalsanawala@rediffmail.com
3.	Suhailkhan Zafarullakhan Pathan	Government Polytechnic, Jamnagar	9925479189	er.suhailkhan@gmail.com

17. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS (Chairman & HOD Mechanical Engineering)	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel (BOS Member & HOD Mechanical Engineering)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S.Shah (BOS Member & Principal)	B. V. Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in

ANNEXURE – I

LIST OF PARTS FOR "HOW IT'S MADE"

SR. NO.	TOPIC	SR. NO.	TOPIC
1	Glass.	31	Plastic bags.
2	Capsules (medicine).	32	PVC room/mobile house.
3	Tablets (medicine).	33	Pipes-ERW, seam less, PVC/steel, small to very large size.
4	Safety pin.	34	Oil paint.
5	Plastic chair.	35	Refilling of gas cylinders.
6	Springs.	36	Televisions / computer monitors.
7	Chain (cycle).	37	Drug (liquid) manufacturing.
8	Bearings.	38	Diamond polishing.
9	Plastic bottle.	39	Lamps- conventional (resistance).
10	Milk/oil pouch packaging.	40	CFL lamps.
11	PCBs.	41	LED lamps.
12	Nut/bolts.	42	Car assembly.
13	Crank shaft.	43	Truck assembly.
14	Piston/cylinder.	44	Aero plane assembly.
15	Vitrified tiles.	45	Screw Driver
16	Electrical wires / cables.	46	Glass bottles
17	Steel wire ropes.	47	Flange couplings
18	Electrical switches.	48	Worm Gear
19	Pouch printing.	49	Helical Gear
20	Cloth manufacturing. (Textile).	50	Mobile phone
21	Cloth printing (Textile).	51	Turbine Blade
22	Embroidery machine working.	52	Direction Control valves
23	Bottling. (Of soda, beverages, etc.)	53	Pulley and Belt
24	Lathe bed.	54	Screw Conveyor
25	Bikes engine.	55	Stepper Motor
26	Computer's hard disc.	56	Servo motor
27	Circlips.	57	Piston and piston ring
28	Oil seals.	58	Spark plug
29	Semiconductors.	59	Carburetor
30	Product made from Micro machining.	60	Any other specified by faculty

ANNEXURE –II

PROCESS SHEET/DETAILS- TO BE MADE FOR EACH PART SEPARATELY.

Part No/Id:		**Raw material:**	
Name of the Part:		**Raw weight:**	
Drawing No:		**Finished wt:**	

Op. No	**Name of Operation**	**Size, tolerance, surface finish, etc. required**	**Machine details**	**Machining Parameters**			**Tools, Jig, Fixture, coolant, etc. required**	**Measuring instruments required**	**Locating surface (Give surface**	**Clamping surface (Give surface**	**Time**		**Remarks**
				speed	**feed**	**Depth of cut**					**Set up (Min.)**	**Machining (Min.)**	

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Renewable and Green Energy
(Course Code: 4351907)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

Renewable & Green Energy technologies are emerging as Energy Sources and technologies of the Future. The Energy Sector has been identified as a sector having maximum impact on global warming and Climate Change. More than 70% of environment related issues are caused by our energy demand and utilization which is mostly 'hydrocarbons' based. 'Decarbonization of Economy' is the modern mantra for saving Planet Earth from a potential environmental disaster. Promoting and facilitating rapid development of these 'hydrocarbon-free' technologies has become a priority worldwide. Deployment of Renewable Energy Sources for meeting our present and future energy demand is an immediate need for any nation. There is going to be huge demand of engineers/ technical professionals / manpower with in-depth knowledge, exposure and understanding about Renewable and Green Energy technologies. This course will provide the basic knowledge of prospective RE technologies, viz. solar energy, wind energy, bio energy, ocean energy, geothermal energy etc. This course would develop skills related to proper designing, constructing, operating, and monitoring RE systems. This course is concerning "Energy" which is subject for all disciplines of engineering and mechanical engineers will have an important role to play in effective deployment of RE Systems in the Industries.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- Basic understanding of new Renewable Energy (RE) technologies and relate to the concepts, laws, and principles to design, deployment, operation, and maintenance of these new & renewable technologies.

3. COURSE OUTCOMES (COs)

The underpinning knowledge about rapidly depleting energy resources of the world and its environmental impacts and the relevance of advancements in the renewable & green energy sector in the country and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs: -

CO-1	Understand the Energy Scenario of the India and evaluate Renewable energy potential in India.
CO-2	Demonstrate the importance of solar energy collection & storage and evaluate the performance of various solar conversion systems.

CO-3	Determine the principle of wind energy and evaluate the potential of wind energy conversion system.
CO-4	Illustrate the biomass energy and its application.
CO-5	Illustrate the geothermal, tidal, ocean, wave energy and its application

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Total Credits	Examination Scheme				
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	Total
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following Practical activities will be included in the course to provide valuable insight to the immense potential renewable energy sources have to supplement the conventional energy in coming times. Practical activities will help in understanding RE in the same context as conventional energy sources, and in establishing a better understanding of REs which have greater advantages for a sustainable future:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Introduction of various Renewable energy sources.	1	02
02	Introduction to Instrumentation for measuring technical parameters of Solar, Wind and Bio Energy Sources. Viz. Solari Meter, Anemometer, Lux Meter, Digital Temperature Meter with different types of probes for different measurements.	2, 3	06
03	Demonstration on Working of different Solar Thermal Devices & their construction – Box Solar Cooker, Dish Solar Cooker, Solar Water Heater – FPC/ETC, insulated piping, and Hot Water Storage Tank.	2	06
04	Demonstration on Working of Solar Photovoltaic Devices & their components, viz, Solar PV Panel, Solar Inverter, Storage Battery and Charge Controller and their technical specifications.	2	04

05	To study the various types of wind mill and evaluate the performance parameter of wind mill Measurement of Wind Velocity (Power) and direction at a Site, using anemometer.	3	04
06	To study the various types of biomasses and biogas plant	4	04
07	To study about different green energy viz, tidal, geothermal, MHD, OTEC, wave, ocean	5	02
08	Field Visits / Virtual Visits of different RE installations	-	-
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

The following are some **sample 'Technology**' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1,2,3,4,6,7)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Experimentation/performance type PrOs (PrOs Number: 5)		
1	Knowledge	20
2	Procedure follows	15
3	Observation Skill	20
4	Analysis	10
5	Quality of Report	20
6	Punctuality	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 1,2,3,4,6,7)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or	Students give the correct answers between 70-89%.	Students give the correct answers between 50-69%.	Student give the correct answers less than 50%.

		more.			
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Experimentation/performance type PrOs (PrOs number: 5)

Criteria	%	10	9-8	7-6	5
Knowledge	20%	Student give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Procedure follows	15%	Students follow all the procedures with precaution in a logical order.	Students follow all the procedures with some precautions in a logical order.	Students follow all the procedures without precaution in a logical order.	Students follow all the procedures without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Analysis	10%	Student understand the data and analyze correctly the obtained test results.	Student understand most of the data and analyze the obtained test results with help or support.	Student need help to understand some of the data and also in analyzing the obtained test results.	Student always need help to understand the data and also in analyzing the obtained test results.

Quality of Report	20%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables , use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Measuring Instruments: - • Soleri Meter (Pyranometer), • Multimeter, • Anemometer, • Sunshine recorder, • Digital Thermometer with different probes (surface, air, liquid)	2
2.	Models of various solar energy collectors • Flat plate Collector (FPC) • Cylindrical Parabolic Collectors • Evacuated Tube Collector (ETC) • Solar Photo Voltaic (SPV)	2
3.	Box type solar cooker, Solar Air Heater	3
4.	Various of models of Wind mill • HAWT • VAWT	3
5.	Various of model hydro turbine using running tap	5

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of

achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Energy and Environment Scenario	1.a Understand the Energy as a vital resource of development and know the current energy scenario of the World vis-à-vis India 1.b Relevance of Renewable Energy and Green Energy in current day context of energy scarcity and environmental impacts of 'energy use'	1.1 Energy and Energy Sources 1.2 Energy Scenario of the World 1.3 Impact of Energy Use on global environment and the need to reduce these impacts. 1.4 Introduction of REs and its potential as energy sources of the future, importance, Classification of REs, comparison with Conventional & Non-conventional energy sources. 1.5 Need of RE, advantages & limitations of RE, Present Energy scenario of conventional and RE sources
Unit – II Solar Energy Technology	2.a Knowledge about Solar Energy Science and Potential of Solar Energy and understanding different conversion methods for producing green-clean and long-lasting energy for meeting future needs.	2.1 Solar Physics / Science – understanding different terminologies, like Solar Spectrum, Solar Irradiance, Insolation, Solar Constant, etc. related to energy flowing from the Sun and its conversion to different useable forms for meeting energy requirements of different category consumers – domestic to industrial. 2.2 Solar Thermal Systems – solar heaters, Solar PV (Electrical) Systems, Solar cell, modules & arrays, Solar cell types, Solar Concentrators, Solar Collectors, Solar ponds, Solar cookers, Solar distillation & drying, Solar energy thermal storage, Solar space heating, Central Power tower – system configuration and basics of sizing system and system components. 2.3 Installation, operation & maintenance of and troubleshooting in solar

		systems.
Unit-III Wind Energy Technology	3.a Understanding Wind Energy as a potential source of green power and the different conversion techniques for producing electricity on large scale.	3.1 Physics of Wind Energy – Energy available from wind, defining Wind Energy, like wind power density, wind speed, turbine power, tip speed ratio, etc. 3.2 Types of Wind Turbines – Horizontal axis wind turbine (HAWT) and vertical axis wind turbine (VAWT), on-shore & off-shore WTG 3.3 WTG construction and configuration 3.4 Estimation of Wind Power, Turbine Power, Annual Generation, Wind energy potential & site selection 3.5 Wind energy potential & installation in India
Unit-IV Bio Energy Technologies	4.a Introduction to different bio energy sources and conversion technologies and their potential to provide clean energy.	4.1 Type of biomass and their properties and the conversion technologies, sources of biomass 4.2 Types of Biogas Plant and different types 4.3 Biomass Gasification Process, pyrolysis, factors affecting on biogas generation, advantages & limitations 4.4 Biocoal: - Introduction, briquetting machines 4.5 Biofuels, Biodiesel
Unit V: Green Energy Technology	5.a Introduction to immerging clean energy technology	5.1 Tidal: - energy from tidal power, tidal power plant, single & double basin plant 5.2 Wave energy conversion devices, advantage, and disadvantage 5.2 Geothermal energy: - Vapour & liquid dominated systems, binary cycle, hot dry rock resources, magma resources, applications 5.3 Ocean thermal energy, OTEC (Open, Closed) 5.4 Fuel Cell Technology and their present status and future prospects 5.5 MHD Power generation: - Concept & working principle

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Energy and Environment Scenario	04	4	4	-	08
II	Solar Energy Technology	14	10	10	4	24
III	Wind Energy Technology	08	4	8	2	14
IV	Bio Energy Technologies	06	4	6	0	10
V	Green Energy Technology	10	6	8	-	14
Total		**42**	**28**	**36**	**06**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity
1.	Make an easy solar oven at home for cookies. (for instructions: - Click here)
2.	Prepare a display chart of Solar PV System
3.	Prepare a display chart of different types of Solar Collectors (FPC, ETC)
4.	Prepare a chart/presentation of HAWT power generation
5.	Prepare a chart/presentation of VAWT power generation
6.	Make a Power Point presentation on the MHD
7.	Prepare display chart of Ocean Thermal Energy Conversion (OTEC)
8.	Identify the potential of RE in India and total RE installed capacity (MW) of India

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Energy and Environment Scenario	• Real-life examples, Demonstration of RE systems, Movies/Animations. • Numerical, Massive Open Online Courses (MOOCs)
II	Solar Energy Technology	
III	Wind Energy Technology	
IV	Bio Energy Technologies	
V	Green Technology Technology	

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. The number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more COs with in integration of PrOs, UOs, and ADOs. Each student must maintain a dated work diary (Logbook) consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative **list of micro-projects** is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model):

1. Collect information about present energy scenario of Conventional & RE sources and prepare a display chart.
2. Prepare a model of the Solar roof top system & wind mill (reference: - Click here)
3. Prepare a model of the clean energy model (reference: - Click here)
4. Prepare a display chart of Solar PV System
5. Prepare a display chart of different types of Solar Collectors (FPC, ETC)
6. Prepare a tabulated summary of the Wind energy potential India and installed capacity in India (Summary includes potential and installed capacity in MW) Reference- Click here
7. Make an easy solar oven at home for cookies. (For instructions: - Click here)
8. Prepare a display chart of Horizontal Axis Wind Turbine (HAWT)
9. Prepare a display chart of Vertical Axis Wind Turbine (VAWT)
10. Prepare a display model of Biogas Plant (Reference- Click here)
11. Make a Power Point presentation on the MHD
12. Prepare a display model of Tidal energy (Reference- Click here)
13. Prepare display chart of Ocean Thermal Energy Conversion (OTEC)
14. Arrange a visit at Solar Park, Charanka, Gujarat and prepare a Report on Solar Power Plant.
15. Undertake 2 to 5 days of training in Solar Park, Charanka, Gujarat

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Solar Energy – Principles of Thermal Collection and Storage	Sukhatme S.P. and J. K. Nayak	McGraw Hill Education
2.	Principles of Solar Engineering	D. Yogi Goswami, Frank Krieth & John F Kreider	Taylor & Francis
3.	Non-Conventional Energy Sources	G.D. Rai	Khanna Publication

4.	Renewable Energy Technologies	R. Ramesh & Narosa	Narosa publishing house
5.	Non- Conventional Energy Resources	B. H. Khan	Tata McGraw Hill
6.	Non- Conventional Resources of Energy	G.S. Sawhney	PHI
7.	Non- Conventional Energy Resources	Shobh nath singh	Person India
8.	Solar Energy Engineering	Soteris Kalogirou	Elsevier/Academic Press
9.	Renewable Energy, power for a sustainable future	Godfrey Boyle, 2004	Oxford

14. SOFTWARE/LEARNING WEBSITES

1. http://vlab.amrita.edu/
2. https://nptel.ac.in/courses/112/105/112105051/
3. https://nptel.ac.in/courses/108/105/108105058/
4. https://nptel.ac.in/courses/121/106/121106014/
5. http://ocw.mit.edu/courses/energy-courses/
6. National Renewable Energy Laboratory (NREL), USA
7. Solar Energy Corporation of India Limited (SECI)
8. US Department of Energy, Energy efficiency & Renewable Energy
9. Ministry of New and Renewable Energy , New Delhi
10. Bureau of Energy Efficiency
11. Centre for Wind Energy Technology
12. The Energy Resource Institute

15. PO-COMPETENCY-CO MAPPING

Semester IV	Thermal Engineering-I (4341905)						
Semester IV	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Basic understanding of new technologies and relate to the concepts, laws, and principles to design, deployment, operation, and maintenance of these new & renewable						

	technologies

CO-1: Understand the Energy Scenario of the India and evaluate Renewable energy potential in India	2	-	-	-	1	2	3
CO-2: Demonstrate the importance of solar energy collection & storage and evaluate the performance of various solar conversion systems	2	2	2	2	3	-	2
CO-3: Determine the principle of wind energy and evaluate the potential of wind energy conversion system	2	-	2	-	3	-	2
CO-4: Illustrate the biomass energy and its application	2	-	2	-	2	-	2
CO-5: Illustrate the geothermal, tidal, ocean, wave energy and its application	2	-	-	3	1	-	2

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. Rajendra Pandya – Sr Project Executive	Gujarat Energy Development Agency	9909922451	rnpandya58@gmail.com
2.	Mr. Shivam R Modi – Lecturer Mechanical	K. D. Polytechnic Patan	9724717421	ershivammodi69@gmail.com

17. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. S. H. Sundarani, BOS Chairman & HOD Mechanical	Government Polytechnic, Ahmadabad	9227200147	**gpasiraj@gmail.com**
2	Dr. Rakesh D. Patel, BOS Member & HOD Mechanical	B. & B. Institute of Technology, V. V. Nagar	9825523982	**rakeshgtu@gmail.com**
3.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	**asshah97@yahoo.in**

6th Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-VI

CourseTitle: Industrial Engineering and Management
(CourseCode: 4361901)

Diploma program in which this course is offered	Semester in which offered
MechanicalEngineering	6thSemester

1. RATIONALE

In today's era of globalization, productivity of organizations and quality of product are key indicators for growth of any nation.There is continuous demand from management to meet and improve set standards of production in terms of quality, quantity and productivity for competing not only domestic but also international market. It is necessary to implement and exploit principles of industrial engineering and management for optimum utilization of (6M) Men, Materials, Machines, Money, Methods and Management. Therefore, this course attempts to develop abilities in students to achieve higher productivity and better-quality tools/standards through constant endeavor in designand installation of integrated systems of 6M.

2. COMPETENCY

The course content should be taught and implemented to develop differentskills so that students can acquire the following competencies.

- **To take the right decisions to optimize resources utilization by improving productivity of Men, Materials, Machines, Money, Methods and Management effectively.**
- **To eliminate unproductive activities under the control of the Management, Men and Design of Products and Processes.**

3. COURSEOUTCOMES(COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated withtheidentifiedcompetencyaretobedevelopedinthestudentfortheachievementofthefollowingCOs :

CO-1	Explain the different types of layouts and plant maintenance with safety.
CO-2	Analyze work content and calculate standard time in a given situation.
CO-3	Apply production planning and statistical quality control with its functions.
CO-4	Understand the basic principles, approaches and functions of management and identify concepts to specific situations.

CO-5	Appreciate the emerging trends in industrial engineering and management.

4. TEACHINGANDEXAMINATIONSCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment;ESE-EndSemesterExamination.

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

5. SUGGESTEDPRACTICALEXERCISES

Following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs).Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the'PrecisionLevel'ofDave'sTaxonomyrelated tothe 'PsychomotorDomain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	To study about different plant layout and types of maintenance followed.	I	02
02	To study about safety practices followed by industry and provisions of Indian Factories Act 1948.		02
03	To Study & Prepare Operation Process Chart (OPC) for given assemblies.	II	04
04	To Study & Prepare Flow Diagram & Flow Process Chart for given assemblies.		02
05	To study & Prepare Man-Machine Chart for the given situation.		02
06	To study & calculate co-efficient of correlation for time study person using performance rating technique.		02
07	To study & calculate standard time for a given job.		02
08	To construct and interpret X bar & R chart for given data of production.	III	02
09	To construct and interpret c & p chart for given data of production.		02
10	To calculate all required data & prepare charts given in experiment no 8&9 using software tool.		02
11	To prepare sampling plan & decide about acceptance or rejection of a particular product using specific sampling plans for given data.		04
12	Presentation/Seminar on any topics given in **Unit– IV**.	IV	02

13	*Industrial Visit:* Visit at least one/two related industries. Prepare the report as per given guidelines provided in notes.	ALL	-
Total (Hours)		**-**	**28**

Notes:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher todevelop the industry-relevant skills/outcomes to match the COs. The above table is only arepresentative list**.**

II. It is compulsory to prepare log book/continuous records of exercises. It is also required to get each exercise recorded in log book/continuous records, checked and duly dated signed by teacher. CA component of practical marks is dependent on continuous and timely evaluation of exercises.

III. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.

a. Brief details of industry visited.
b. Type, location, products,rough layout, human resource, etc., of industry.
c. Details,descriptionandbroadspecificationsofmachineries/processes observed.
d. Safetynorms and precautions observed.
e. Student'sownobservationonindustrialenvironment,productivity concepts, quality consciousnessandquality standards,costeffectiveness,cultureand attitude.
f. Anyother details /observations askedbyaccompanyingfaculty.

IV. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given any one experience to perform.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleteddepending on the course) that occur in the above-listed **Practical Exercises** of this course required,whichareembedded intheCOsand,ultimately,thecompetency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For study type		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
For experiment type		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

SamplerubricsPerformanceIndicatorsforthePrOs

For study type PrOs					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
		3	2.7-2.4	2.1-1.8	1.5
Quality of Report	30%	Neat Hand writing, figure and table. complete labeling of figure and table.	Only formatting is not proper	Few required elements are missing	Several require elements are missing
		3	2.7-2.4	2.1-1.8	1.5
Participation	20%	Used time well in lab focused attention in exercise	Used time mostly in lab focused attention in exercise	Used time moderate in lab focused attention in exercise	Participation is minimum
		2	1.8-1.6	1.4-1.2	1
Punctuality	20%	Timely Submission	Submission late by 1 laboratory	Submission late by 2 laboratories	Submission late by more than 2 laboratories
		2	1.8-1.6	1.4-1.2	1

For experiment type PrOs					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
		2	1.8-1.6	1.4-1.2	1
Procedure follows	30%	Student Follow all the Procedure with precaution in logical order	Student Follow all the Procedure with some precaution in logical order	Student Follow all the Procedure without precaution in logical order	Student Follow all the Procedure without precaution in illogical

					order
		3	2.7-2.4	2.1-1.8	1.5
Observation skill	20%	Used time well in lab focused attention in exercise	Used time mostly in lab focused attention in exercise	Used time moderate in lab focused attention in exercise	Participation is minimum
		2	1.8-1.6	1.4-1.2	1
Conclusion/ Summary	10%	Student concept is mostly clear	Student concept is partly clear	Student concept is somewhat clear	Student concept is not clear
		1	0.9-0.8	0.7-0.6	0.5
Quality of Report	10%	Neat Hand writing, figure and table. complete labeling of figure and table.	Only formatting is not proper	Few required elements are missing	Several require elements are missing
		1	0.9-0.8	0.7-0.6	0.5
Punctuality	10%	Timely Submission	Submission late by 1 laboratory	Submission late by 2 laboratories	Submission late by more than 2 laboratories
		1	0.9-0.8	0.7-0.6	0.5

6. MAJOREQUIPMENT/INSTRUMENTSREQUIRED

Thismajorequipmentwithbroadspecificationsforthe PrOsisaguidetoprocurethem bythe administratorstoa userinuniformityofpracticeinallinstitutionsacrossthestate.

Sr. No.	Equipment/instrumentname with broad specification	Qty.
1.	Decimal stopwatch (Non fly back type)	02 pcs.
2.	Decimal stopwatch (Fly back type)	02 pcs.
3.	Playing cards	2 sets
4.	MS Pins 10mm diameter× 15mm length with tolerance of ± 0.01mm	100 pcs.
5.	Buttons of 6 different colors	100 of each
6.	Sampling rack with 1000 washers	1 set

7. AFFECTIVEDOMAINOUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of theabove COs and PrOs. More can be added to fulfill the development of this coursecompetency.

a. Workasaleader/teammember.

b. Followsafetypractices as per standard acts/rules.

c. Followethicalpractices.

d. Maintaintoolsandequipment.

e. Practiceenvironment-friendlymethodsandprocesses(Environmentrelated).

The ADOs are best developed through laboratory/field-based exercises. Moreover, the levelofachievementoftheADOs,accordingtoKrathwohl's'AffectiveDomainTaxonomy,'shouldgraduallyincreaseasplannedbelow:

I. 'ValuingLevel'in1st year

II. 'OrganizationLevel'in2nd year.

III. 'CharacterizationLevel'in3rd year.

8. UNDERPINNINGTHEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required,more such UOs could be included by the course teacher to focus on attaining COs andcompetency.

Unit	UnitOutcomes(UOs) (4to6UOsatdifferentlevels)	TopicsandSub-topics
Unit – I Plant Engineering and Safety	1.a Explain various types of plant layouts and plant maintenance. 1.b Explain importance of plant safety and regulations for industrial safety.	1.1 Plant: Selection of site of industry, Plant layout and it's three types. 1.2 Principles of a good layout, Techniques to improve Layout, Principles of Material handling equipment. 1.3 Plant maintenance, Importance,it's types; Breakdown, Preventive and Scheduled maintenance. 1.4 Plant safety: Importance, Accident; Causes and Cost of an Accident, Accident Proneness, Prevention of Accidents. 1.5 Industrial disputes, Settlement of Industrial disputes, Collective bargaining, Conciliation, Mediation, Arbitration. 1.6 Indian Factories Act 1948 and its provisions related to health, welfare and safety.
Unit– II Work Study	2.a Define work study, method study and work measurement. 2.b State the basic procedure of work study, method study and work measurement. 2.c Prepare in the standard formats the outline process chart, flow	2.1 Work study- Introduction, definition, techniques and role to enhance productivity.Basic procedure of method study. 2.2 Methods of recording data for method study using standard symbols, process charts and diagrams. 2.3 Preparation of operation (outline) process chart for given mechanical assembly having 6-8 components.

	process chart, flow diagrams, man machine chart and process plan for given data. 2.d Modify given process plan and flow diagram for improvements. 2.e State principles of motion economy. 2.f Analyze work content and calculate standard time in a given situation.	2.4 Preparation of flow process chart and flow diagram for given mechanical components having at least 6-8 major operations. 2.5 Given the process plan, operation process chart and flow diagram, develop questioning techniques in analyzing data for method study. Also develop and improve the method, based on analysis of given data. 2.6 Principles of motion economy applied in (a) use of human body, (b) design of work place layout (c) design of tools and equipment. 2.7 Man-machine chart. 2.8 Basic procedure of work measurement and equipments used in time study. 2.9 Job elements and their types. 2.10 Methods of measuring time cumulative and fly back timing. 2.11 Concept of rating & rating scale and calculation of basic time. 2.12 Calculation of standard time and work content. 2.13 Allowances-types, normal values and applications. 2.14 Concept of work sampling/ activity sampling.
Unit–III PPC and Quality Control	3.a Establish importance of process planning and controlwith types of production. 3.b Appreciate importance of quality control and inspection. 3.c Explain Statistical Quality Control (SQC) and control charts used for it. 3.d State the importance of OC curve and interpret OC curves in a given situation.	3.1 Production Planning and Control (PPC): Introduction, Major functions, Pre planning, Methods of forecasting. 3.2 Routing and Scheduling, Dispatching and Controlling, Concept of Critical Path Method (CPM). 3.3 Types of Production, Mass Production, Batch Production and Job Order Production, Characteristics. 3.4 Economic Batch Quantity (EBQ), Principles of Product and Process Planning, Make or Buy decision, Numerical problems. 3.5 Quality Control: Definition, Objectives, Types of Inspection: First piece, Floor and Centralized Inspection, Advantages and Disadvantages. 3.6 Statistical Quality Control (SQC), Types of Measurements, Method of Variables, Method of Attributes, Uses of X bar& R chart interpretations& examples. 3.7 Uses of p and c charts,interpretations& examples. Application of software tool for

		SQC like Minitab, MS Excel etc. 3.8 Operating Characteristics curve (O.C. curve), Sampling Inspection, Single and Double Sampling plan. 3.9 Concept of ISO 9001:2008 Quality ManagementSystem Registration/Certification procedure, Benefits of ISO to the organization.
Unit– IV Principles of Management	4.a Appreciate importance of management, it's principles and types of organization. 4.b Explain Modern Management Techniques and its importance in organization. 4.c Appreciate role of Human Resource Management (HRM) and importance of various training. 4.d Explain concept of Job Evaluation and Merit Rating. 4.e DescribeWages and types of wage payment.	4.1 Definition: Management, Administration,and Organization, F.W. Taylor's and Henry Fayol's Principles of Management. 4.2 Functions of Manager, Types of Organization: Line, Staff, Taylor's Pure functional types, Line and staff and committee type. 4.3 Directing, Leadership, Styles of Leadership, Qualities of a good leader, Motivation, Positive and Negative Motivation. 4.4 Modern Management Techniques: Just In Time; Total Quality Management (TQM). 4.5 Quality circle,zero defect concept, 5S Concept. 4.6 Personnel Management:Responsibility of HRM, Selection Procedure, Training of Workers, Apprentice Training. 4.7 On the Job training and Vestibule School Training, Job Evaluation and Merit Rating, Objectives and Importance. 4.8 Wages and Salary, Components of Wages, Wage Fixation, Type of Wage Payment: Halsey's 50% Plan, Rowan's Plan and Emerson's efficiency plan.

Unit–V **Recent trends**	5.a Explain six sigma and Reliability with their applications. 5.b Explain Sustainable Manufacturing and its dimensions. 5.c Appreciate importance of Product Life Cycle and Product Lifecycle Management (PLM).	5.1 Concept of six sigma and its applications. 5.2 Reliability, availability andmaintainability, distribution of failure and repair times,determination of MTBF and MTTR. 5.3 Sustainable Manufacturing: Concept of Triple bottom line, Environmental, Economic and Social Dimensions of Sustainability. 5.4 Product life cycle: New product introduction, early introduction, increased product life, Life cycle management tool. 5.5 Product Lifecycle Management (PLM): Importance, Implementation, Responsibility, Benefits to different managers, Components.

9. SUGGESTEDSPECIFICATIONTABLEFORQUESTIONPAPERDESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Plant Engineering and Safety	6	4	3	3	10
II	Work Study	14	7	10	7	24
III	PPC and Quality Control	9	3	4	7	14
IV	Principles of Management	8	4	4	4	12
V	Recent trends	5	3	7	-	10
Total		**42**	**21**	**28**	**21**	**70**

Legends:R=Remember,U=Understand,A=Applyandabove(RevisedBloom'staxonomy)

10. SUGGESTEDSTUDENTACTIVITIES

Sr. No.	Activity.
1.	During Industrial visit for other subjects, students should be made familiar with various types of management practices, safety rules and quality control tools used in the industry. They should be encouraged to write special reports on regarding these topics in the industries they visited.
2.	Visit nearby manufacturing unit and prepare report on SQC tools used and best management practices followed in the industries they visited.

11. SUGGESTEDSPECIALINSTRUCTIONALSTRATEGIES(ifany)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Sr. No.	Unit	UnitName	Strategies
1	I	Plant Engineering and Safety	Videos on topic and safety manuals / guidelines.
2	II	Work Study	Videos on work study, live discussion at workshop place, presentations.
3	III	PPC and Quality Control	Videos on QC, live cases during industrial visits, power point presentations, failure analysis with rejected live parts.
4	IV	Principles of Management	Videos on topics of principles of management, industrial visits, power point presentations.
5	V	Recent trends	Videos on trends and presentations.

12. SUGGESTEDMICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assignedat the beginning of the semester. The number of studentsin thegroupshould***notexceedthree.***

The micro-project could be industry application based, internet-based, workshop-based,laboratory-based, or field-based. Each micro-project should encompass at least COs with in integration of PrOs, UOs, and ADOs.The duration of the micro project should be about**4-5*(four tofive) student engagement hours*** during the course. The students ought to submit a micro-

projectbytheend ofthesemestertodeveloptheindustry-orientedCOs.

A representative list of micro-projects is given here. This has to match the competency and theCOs.Similar micro-projectscouldbeaddedbythe concernedcourseteacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projectsbased on student activities (chart/presentation/report/model/animation):

1. Case study on accident happened in any industry with root cause and remedies.
2. Prepare a display chart of OPC, FD, FPC & Man-machine chart (anyone chart).
3. Prepare a summary report of different software tools used for SQC.
4. Case study on Critical Path Method (CPM) for projects/tasks used in industry (like https://blacksmithint.com/understanding-critical-path-in-manufacturing/).
5. Application of TQM in any industry.
6. Case study on application of Quality circle, zero defect concept and 5S Concept in organization (anyone concept).
7. Make a PowerPoint presentation on anyonerecent trend appliedin industry relevant to subject.
8. Application of Industrial Engineering & Management techniques and tools in any service sector.

13. SUGGESTEDLEARNINGRESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Industrial Engineering & Management	S.C. Sharma, T. R. Banga	Khanna Book Publishing Co. (P) Ltd., New Delhi
2.	Industrial Engineering and Management	O.P. Khanna	Dhanpat Rai Publications (P) Ltd., New Delhi
3.	Method Study	-	National Productivity Councilhttps://npcindia.gov.in/NPC/Files/Publication/Other%20Publications/Method-Study-MG4.pdf
4.	Work Measurement	-	National Productivity Councilhttp://www.npcindia.org.in/wp-content/uploads/2017/04/Work-Measurement-MG5.pdf
5.	Statistical Quality Control	Eugene Grant, Richard Leavenworth	McGraw Hill Education (India) Private Limited, Noida
6.	Management: A Global, Innovative and	Heinz Weihrich,	McGraw Hill

	Entrepreneurial Perspective	Mark V. Cannice, Harold Koontz	Education (India) Private Limited, Noida
7.	Essentials of Management	Joseph L. Massie	Prentice Hall India Learning Private Limited, New Delhi
8.	Principles of Management	Premvir Kapoor	Khanna Publishing House, New Delhi

14. SOFTWARE/LEARNINGWEBSITES

1. https://www.minitab.com/en-us/products/minitab/free-trial/(Minitab Free Trial)
2. https://maitri.mahaonline.gov.in/pdf/factories-act-1948.pdf (Indian Factories Act 1948)
3. https://www.youtube.com/watch?v=qliO4B_ZQko (Plant Safety)
4. https://tinyurl.com/ycybfkuj(Work Study)
5. https://youtu.be/5V84h5PAjAQ?si=3mh9S5XE33ejFdLF (Method Study)
6. https://youtu.be/TlPJPJfstB8?si=sL4yqzsQqAfqfJSL (Time & Motion Study)
7. https://www.youtube.com/watch?v=0ufrez3JMIQ(Work Measurement & methods)
8. https://www.youtube.com/watch?v=1GjR6zySO04 (Standard time calculation)
9. https://www.youtube.com/watch?v=7y-Iom0RTO4 (Critical Path Method)
10. https://www.youtube.com/watch?v=dDzsFuOR-8o (Economic Batch Quantity)
11. https://www.youtube.com/watch?v=n8VeldCFea4 (O. C. Curve)
12. https://www.youtube.com/watch?v=ZaHiNsloTm0 (Acceptance Sampling)
13. https://www.youtube.com/watch?v=68rI_EP-c4w (Vestibule Training)
14. https://www.youtube.com/watch?v=4EDYfSl-fmc (Six Sigma)
15. https://www.youtube.com/watch?v=7YZaWarCrpQ(Sustainable Manufacturing)

15. PO-COMPETENCY-COMAPPING

SemesterVI	**Industrial Engineering and Management (4361901)**						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency &CourseOutcomes	Basic & Discipline-specificknowledge	ProblemAnalysis	Design/development ofsolutions	EngineeringTools,Experimentation&Testing	Engineering practices for society, sustainability & environment	ProjectManagement	Life-longLearning
Competency	• To take the right decisions to optimize resources utilization by improving productivity of Men, Materials, Machines, Money, Methods and Management effectively. • To eliminate unproductive activities under the control of the Management, Men and Design of Products and Processes.						
CO-1: Explain the different types of layouts and plant maintenance with safety.	3	-	-	-	-	-	2

CO-2: Analyze work content and calculate standard time in a given situation.	-	3	-	2	-	2	-
CO-3: Apply production planning and statistical quality control with its functions.	3	2	-	2	-	2	2
CO-4: Understand the basic principles, approaches and functions of management and identify concepts to specific situations.	2	2	2	-	-	-	-
CO-5: Appreciate the emerging trends in industrial engineering and management.	-	2	-	-	3	-	-

Legend:'3'forhigh, '2'formedium, '1'forlow,and '-'fornocorrelationofeachCOwithPO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU RESOURCE PERSONS)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. V. M.Vasaiya	B & B Institute of Technology, Vallabh Vidyanagar	9427386208	vmvasaiya@bbit.ac.in
2.	Prof. Altaf Nalbandh	Government Polytechnic, Porbandar	9904230786	altaf.nalbandh85@gmail.com

17. BOS RESOURCE PERSONS

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS Chairman & HOD Mechanical	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel, BOS Member & HOD Mechanical	B. & B. Institute of Technology, V. V. Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)

Semester-VI

Course Title: Computer-Aided Design / Computer-Aided Manufacturing

(Course Code: 4361902)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering	6Th semester

1. RATIONALE

Computers have become inevitable in today's era and find their application in various stages of product development. The course is intended to provide exposure to modeling techniques assembly in parts and CNC job preparation and their CNC program. It also includes topics on feature-based CAD modeling. This course intends to introduce students to computer use in the phases of product design viz. conceptualization, and modeling. A topic on geometric modeling, and graphical representation. In this context, it is of utmost importance to prepare, read, and interpret these drawings correctly to produce components and assemblies accurately and precisely. The industrial practices of modeling and designing are also important for the students to make them aware of modeling and designing practices, symbols, codes, norms, and standards generally used in industries. The manufacturing field has witnessed the recent development happening in CAD-CAM areas. CNC machines play a big role in the manufacturing field. An attempt has been made to focus on CNC machine tools, related programming, and their advanced features.

2. COMPETENCY

The course content should be taught and implemented to develop the different types of skills so that students can acquire the following competencies:

- **Development of 3D modeling, machine drawings/production drawings/assembly drawings, and their solid models using different types of 3D commands**. **Understanding the reference planes and axes, different constraints for preparation of 3d solid models, and assembly.**
- **Selection of required operating parameters, appropriate tools, tool holders, accessories, and consumables for manufacturing a given job on CNC.**
- **Manufacture methods of simple jobs using CNC part programming.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following Cos. At the end of the course, the student will be able to:

CO-1	To understand the basics of CAD solid and surface modeling methods.
CO-2	To create 3D models and assembly of 3D parts in CAD software.
CO-3	To demonstrate the working of a CNC machine.
CO-4	Develop the part program and simulation of the part program in a CNC Machine.
CO-5	To demonstrate interface software between CAD and CAM for auto part programming.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
03	00	02	04	30	70	25	25	150

**Theory CA having 30 marks has two components, i.e., the micro-project assessment, which will be done out of 10 marks to facilitate the integration of COs. The remaining 20 marks would be the average of marks of the 2 mid-semester exams to be taken during the semester to assess the cognitive domain's attainment.*

Legends: *L-Lecture; T— Tutorial/Teacher Guided Theory Practice; P -Practical; C — Credit, CA - Continuous Assessment; ESE -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES:

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some POs marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr No.	Practical Outcomes (PrOs)	Concerned Unit No.	Approx Hrs. Required
01	**3D Solid Modeling-I** Demonstrate various 3D Solid commands used in 3D creation, 3D Modify, and Pure primitives using datum planes/preference panes and datum axis/reference axis different types of constraints.	01 & 02	04
02	**3D Solid Modeling-II:** • Prepare a 3D solid model using any one parametric software (Creo, Unigraphics, CATIA, Solid Edge, Inventor, Solid Works, etc). • Assembly of the different modeling parts • Preparation of drawing sheet from 3D model/3D assembly.	03	06
03	**Demonstrate constructional features of CNC:** a. Demonstrate the CNC machines and their operations. b. Identify the major parts of CNC and draw a sketch. c. Write the specifications of CNC taken for demonstration.	04 & 05	04

	d. Importance of tool holders, and types of CNC tools. e. Tabulate sensors/feedback devices with type, specification, and purposes used on CNC taken for demonstration.		
04	**CNC turning part programming:** The teacher will assign part drawings. A minimum of five drawings having the following details are to be assigned. This includes parts- (i) Simple turning with steps, (ii) Turning with tapers, (iii) Turning with circular (concave/convex shape) interpolation, (iv) Turning using canned cycle - with threading or drilling or other and (v)Turning with use of canned cycle and subroutine. Students should do the following activities: a. Sketch of each part with dimensions. b. Prepare the CNC part program using G and M codes with ISO format. c. Show various zeros and tool paths on the part sketch with color codes and dimensions. d. Simulate the prepared part programs using available simulation software. e. Prepare the parts on CNC Machines.	06	04
05	**CNC machining center part programming:** The teacher will assign part drawings. A minimum of three drawings having the following details are to be assigned. This includes parts- (i) Simple contour milling (ii) Contour milling with (convex/concave) circular interpolation and (iii) contour milling with drilling/tapping. Students should do the following activities: a. Sketch of each part with dimensions. b. Preparing the CNC part program using G and M codes with ISO format. c. Show various zeros and tool paths on the part sketch with color codes and dimensions. d. Simulate the prepared part programs using available simulation software. e. Prepare the parts on CNC.	06	04
06	**Demonstrate the automated CNC program in Mater CAM /Inventor-CAM/Solid Works-**	06	06

	CAM/ Unigraphics or any CAD software with the Application of the CAM feature. • Selection of reference axis selection of models for automated CNC programs for the relevant type of CNC machines. • Simulation of automated CNC program with tool and tool holder selection, Tool compensation methods tool offset. • Demonstrate CAD / CAM integration in the above-mentioned CAM Software. • Demonstrate on CNC Lathe, or VMC for work holding, Tool compensation methods, and tool offset. • (Optional) Run the automated CNC program prepared from above mentioned CAD-CAM software in the CNC machine or CNC trainer.		
07	**Industrial Visit & and expert lecture** • Visit nearby industries having CNC machines. List and state important features of them with detailed specifications and names of manufacturers. • Arrange a lecture from an expert related to any CAD-CAM software, and recent trends in CAD-CAM.	ALL	-
		TOTAL HRS	28

Note:

- More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**
- The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed Practical Exercises of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Knowledge	20
2	Quality of Report/Sketch/Drawings/Jobs.	30
3	Participation	30
4	Punctuality	20
	Total	**100**

Sample rubrics Performance Indicators for the PrOs.

Criteria				
Knowledge	Students give the correct answers 90% or more	Students give the correct answers between 70-89%	Students give the correct answers between 50-69%	Students give the correct answers less than 50%
Quality of Report/Sketch/Drawing/Jobs.	1. Individual part is duplicated with 100% accuracy. 2. Accurate Assembly of parts. 3. Accurate and Neat Sketch. 4. Accurate Part Program. 5. Accurate Job.	1. Individual part is duplicated with up to 70 to 80% accuracy. 2. Improper Assembly of parts. 3. One or two mistakes in a sketch. 4. One or two mistakes in Part Program. 5. One or two mistakes in the job.	1. Individual part is duplicated with up to 50 to 60% accuracy. 2. Incomplete Assembly of parts. 3. More than 03 mistakes in the sketch. 4. More than 03 mistakes in Part Program. 5. More than 03 mistakes in the job.	1. Individual part is duplicated less than 50%. 2. Can't assemble parts. 3. In-Complete sketch. 4. Incomplete Part Program. 5. Incomplete Job.
Participation	Used time well in the lab and focused attention in the exercise	Used time mostly in lab focused attention on exercise	Used time moderate in the lab focused attention in the exercise	Participation is minimum
Punctuality	Submission on time	Submission late by 1 laboratory	Submission late by 2 laboratories	Submission late by more than 2 laboratories

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
01	**Cad Workstation with Software:** Suggested Workstation configuration: • Intel i3 (10th generation and above)/Intel i5(8th generation and above)/intel i7 (6th generation)/Ryzen 5 (5th generation and above)/ Ryzen 7 (4th generation and above). • 8GB or above DDR3/DDR4/DDR5 RAM • 500 GB SSD or NVME M.2 SSD • Internet. • Integrated or external UHD graphic card Software for CAD-CAM (Any One): • AutoCAD (Free educational version for educator/student is available*) • Autodesk Inventor Professional with CAM feature (Free educational version for educator/student is available*). • Unigraphics with CAM feature. • SolidWorks with CAM feature. • Mastercam.	01 & 02 & 06
02	CNC Lathe machine or CNC trainer and different types of CNC tools.	03 & 04
03	VMC Machine or VMC trainer and different types of CNC tools.	03 & 05
04	Vernier, Micrometer, Surface plate.	06

**Account in Autodesk website, documents, authority letter, transcript, I-card required*

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the Above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/ team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment-friendly methods and processes. (Environment-related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

I. 'Valuing Level' in 1st year.
II. 'Organization Level' in 2nd year.
III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY:

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs)	Topics & Sub-Topics
Unit -1 Introduction of CAD.	1a. Basic of CAD & its application.	1.1 CAD Definition, concept, and need. 1.2 CAD Process. 1.3 Functional Areas of CAD. 1.4 Applications of CAD. 1.5 Input / Output devices.
Unit-2 Geometric Modeling & 3D Modeling.	2a. Types of modeling.	2.1 Difference between 2D & 3D Models. 2.2 Wireframe, Surface & Solid Modeling. 2.3 Solid modeling methods like Constructive Solid Geometry, Pure primitives, and boundary Representation.
	2b. Feature base Modeling.	2.4 Feature-Based Modeling Concepts. 2.5 Parametric & non-Parametric Modeling concepts & its differences.
	2c. Introduction of 3D Commands.	2.6 AutoCAD 3D commands related to Pure primitives (BOX, CYLINDER, CONE, SPHERE, TORUS, PYRAMID, and WEDGE.) 2.7 3D Draw Commands (Extrude, Revolve, Sweep, Sweep blend (Loft), etc.) 2.8 Boolean Operations. 2.9 3D Modify & Editing Commands. 2.10 3D Viewing. 2.11 Importance of surface modeling. 2.12 AutoCAD surface modeling commands (EDGESURF, PLANESURF, RULESURF, REVSURF, TABSURF, 3DMESH, etc.).

Unit-3 3D Parametric Modeling and Assembly in CAD Software.	3a. Make a Solid model and assembly detail drawing using parametric software.	3.1 Introduction to parametric modeling software (Any one CATIA, Creo, Solid Works, Unigraphics, AutoCAD, Inventor/Solid Works, etc) 3.2 Understanding of 3D datum panes/ working planes / Reference planes, Axis and Constraints. 3.3 3D modeling using different 3D solid commands. 3.4 Assembly Modeling and creation of assembly and details drawing sheet for those parts. 3.5 Bill of Materials (BOM)
Unit 4 Introduction of CNC and CNC Machine Tools.	4a. Introduction of NC, CNC, and DNC. 4b. Introduction of CNC Machine tools.	4.1 CAM Concepts & definitions. 4.2 NC, CNC, & DNC concept, Feature & difference. 4.3 Advantages & Limitations & Application of CNC. 4.4 Selection Criteria of CNC Machines. 4.5 Types of CNC Tools and Tool Holders. 4.6 CNC machines: Types, classification, working and constructional features.
Unit 5 CNC machine components.	5a. Identify the role of the main components of CNC machines. 5b. Identify CNC axes.	5.1 CNC Machine building, structural details, CNC block diagram. 5.2 Spindle drives and axes drives on CNC machines. 5.3 Components of CNC machines - Types, sketch, working and importance of: • Different types of drives • Slideways. • Re-circulating ball screw. • Feedback devices (transducers, encoders). • Automatic tool changer (ATC). Automatic pallet changer (APC).

Unit 6 CNC part programming and recent trends.	6a. Interpret the ISO format of CNC part programming with used codes. 6b. Prepare part program by using applicable codes like G & M etc. 6c. Apply advanced CNC part programming features like a canned cycle, subroutine, etc. 6d. Describe the procedure for Setting various compensations on CNC. 6e.Recent trends in CNC Part programming.	6.1 Definition and importance of various positions like machine zero, home position, workpiece zero, and program zero. 6.2 CNC part programming: programming format and structure of the part program. 6.3 ISO G and M codes for turning and milling-meaning and applications of important codes. 6.4 Simple part programming for turning using ISO format having straight turning, taper turning (linear interpolation), and convex/concave turning (circular interpolation). 6.5 Simple part programming for milling using ISO format. 6.6 Importance, types, applications, and format for: • Canned cycles. • Subroutine. 6.7 CNC turning and milling part programming using canned cycles, and Subroutine. 6.8 Need and importance of various compensations: • Tool length compensation. • Pitch error compensation. • Tool radius compensation. • Tool offset. 6.9 Introduction of CAM software and application of automated part programming method & its feature scope.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
01	Introduction of CAD.	04	03	01	00	04
02	Geometric Modeling & 3D Modeling.	06	02	06	04	12
03	3D Parametric Modeling & CAD Database.	08	02	04	06	12
04	Introduction Of CNC Machine Tools.	04	04	06	00	10
05	Hardware & Drives & Control system.	10	06	04	02	12
06	CNC part programming and recent trends.	10	04	06	10	20
Total		42	21	27	22	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: *This specification table gives general guidelines to assist students in their learning, and to the teachers, for question paper design and teaching methodology to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U, and A) in the question paper may slightly vary from the above table.*

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity
01	Visit the design section of different industries and observe various hardware and Software, procedures, and standards they are following for designing a product.
02	Bring Actual mechanical assembly from industry/real life/scrap shop/garage/etc. Dismantle the same, measure dimensions, and prepare 3D parts.
03	Prepare a 3D model of a part from an orthographic drawing sheet and an isometric drawing from any machine design book and make assembly models of those different parts.
04	Prepare a 3D model using sheet metal features of CAD software (Inventor, Creo, Unigraphics, Solid Works, Solid Edge, etc.).
05	Give the information on free simulation software available on the website, download from its website, information about the installation of that software, and make a practice of part Programming.
06	Draw a simple sketch of a job and write the CNC part program using different CNC Codes according to ISO format.
07	Make simulation and automated CNC programs of the part created from student activity No 3 and 4 using tool setting, tool compensates workpiece zero, and machine zero.

	references in any CAD-CAM software (Master CAM, Inventor-CAM, Creo, Solid Works-CAM, etc).
08	Prepare a report on different errors generated during job making in different CNC Machines and identify & find solutions.
09	Prepare a report on different types of CNC controllers available in the market.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No	Unit	Strategies
01	I & II	a. Explain various configurations for CAD workstations and different peripherals regarding the processor, RAM, graphics, and hard drive. b. Demonstrate various Input/output devices and their connections and how to use them. c. Demonstrate the procedure of installing the CAD software on a computer system.
02	III	Bring actual industrial production drawings/machine drawings/assembly drawings and distribute them among a group of students for self-study and interpretation. Ask students to practice these drawings using CAD software.
03	IV & V	Videos, Presentation, Demonstration.
04	VI	Simulation software, actual practice on CNC machines, Demonstration.
05	(Optional)	Create or demonstrate the creation of an account on the Autodesk website. If possible then download the education version of AutoCAD, the education version of Inventor Professional with CAM, and the education version of Fusion 360. All these software are available on mobile platforms so the applicant/students can save their work on their account and get access on mobile through the cloud. So, students can get awareness of recent trends in CAD sectors.

12. SUGGESTED PROJECT LIST

Only **one micro project** will be given by the teacher to the students. The micro project should cover at least 2 COs which are integration of PrOs, UOs, and ADOs. Each student will have to submit a report related to their assigned micro project at the end of the semester.

The following is the suggested micro-projects list which should be matched with the competency and Cos.

- Any two Solid models of any components. Creation of an orthographic drawing sheet from those components with the dimensions.
- Only one Assembly of components. Creation of an orthographic drawing sheet from that assembly with the dimensions and part list.
- CNC part programming of any simple object with the use of CNC codes.
- Automated CNC program from 3D solid modeling part and CNC simulation in CAD-CAM software.

- Visit any Manufacturing industry and find out production parts and prepare detailed part and Assembly drawings.
- Visit the Automation industry and prepare specifications for CNC turning, CNC Milling, etc.
- Prepare Axis Designation model of CNC Turning, CNC Milling, etc.
- Prepare a report on different accessories used like Ball screws, Guideways, Slideways, ATC, APC, and Sensors used.
- Prepare a report on tool offset.
- Prepare a report tool compensation method.
- Prepare a report on different techniques used for work holding in different CNC Machines.
- Prepare a model on work zero, machine zero axis.
- Solve examples of identifying machining costs with the use of different CNC machines.
- Prepare a report on different types of CNC controllers available in the market.

13. SUGGESTED LEARNING RESOURCES

Sr No	Title of Book	Author	publication
01	Creo 2.0 for designer and engine designers	Sham Tickoo	Dream tech press
02	Designing with Creo Parametric 2.0	Dr. Michel J Rider	SDC Publications
03	Unigraphics for designers & engineers	Sham Tickoo	Dream tech press
04	Autodesk Inventor Professional 2022 for Designers	Sham Tickoo	Dream tech press
05	CNC Machines	Pabla B.S., Adithan M.	New Age International, New Delhi,2014(reprint)
06	CAD/CAM: computer-aided design and manufacturing	Groover Mikell P, Zimmered W Emory	Prentice Hall 2011
07	Computer Aided Manufacturing	Rao P N, Tiwari N K, Kundra T	Tata McGraw Hill 2014
08	CAD/CAM/CIM	P. Radhakrishnan, S. Subramaniyan & V. Raju	New Age International Pvt. Ltd., New Delhi, 3rd Edition

14. SOFTWARE/LEARNING WEBSITES

1. Autodesk AutoCAD (Educational network or stand-alone licensed latest Version).
2. Autodesk Inventor Professional with CAM feature or Creo (Pro-Engineer) or Solid Edge (Educational network or stand-alone licensed latest Version).
3. Unigraphics NX with CAM features.
4. Master CAM

Learning websites

CAD:

1. https://www.autodesk.com/education/edu-software/autocad
2. https://www.autodesk.in/campaigns/autocad-tutorials
3. https://www.autodesk.com/education/support
4. http://www.autocadmark.com/

5. http://www.autocadtutorials.net/

CAM:

1. https://www.autodesk.in/products/inventor/trial-intake
2. https://www.autodesk.in/products?page=2
3. http://www.nptel.ac.in
4. http://www.youtube.com/watch?v=M3eX2PKM1RI
5. http://www.youtube.com/watch?v=hJFLcvtiNQI

15. PO-COMPETENCY-CO MAPPING:

Semester V	**(Course Code:4361902)**						
	POs						
Competency and Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
	Basic and Discipline-specific knowledge	**Problem analysis**	**Design/ development of solutions**	**Engineering Tools, Experimentation, and Testing**	**Engineering Practices for society, sustainability, and environment**	**Project Management**	**Life-long learning**
CO-1 To understand the basics of CAD solid and surface modeling methods.	03	02	02	-	-	-	02
CO-2 To create 3D models and assembly of 3D parts in CAD software.	03	02	02	-	-	-	02
CO-3 To demonstrate the working of a CNC machine.	03	03	02	02	02		02
CO-4 Develop the part program and simulation of the part program in a CNC Machine.	03	03	02	02	02		02
CO-5 To demonstrate interface software between CAD and CAM for auto part programming.	03	02	01	02	02	-	02

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low, and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-VI

Course Title: Design of Machine Elements
(Course Code: 4361903)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering	6th Semester

1. RATIONALE

For production of machine parts and components it is required that specific shape and size of machine parts are determined and their drawings are prepared. We also have to select specific material for that product. This process is called as design. In designing a machine component it is necessary to have a good knowledge of many subjects such as Mathematics, Engineering Mechanics, Strength of Materials, Theory of Machines, Workshop Processes and Engineering Drawing. Students have learnt these subjects in previous semesters. This course curriculum provides the students' knowledge of design process, as well as familiarity with design of components subjected to various stresses and moments like direct stress, bending stress, twisting moment and combined stresses. In this course students will learn design of machine components/elements like cotter joint, knuckle joint, power screw, levers, helical and leaf springs, couplings, pressure vessels, bearings, etc.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

- **Design a simple machine element with appropriate material for given user defined boundary and loading conditions.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify various failures and its resisting areas of machine element.
CO-2	Make use of preferred number for standardization of element dimensions in given range.
CO-3	Design machine element subjected to Direct, Bending, Twisting and Combined load.
CO-4	Determine the safe dimensions of thin and thick cylinder pressure vessel.
CO-5	Calculate important characteristics of sliding and antifriction bearing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	**Preparatory Activity :** 1. Interpret and write various course related SI units and their conversions. 2. Write normal values of ultimate tensile strength, yield strength, density, modulus of elasticity and Poisson's ratio of commonly used materials. 3. List normal values of factor of safety for different situations. 4. Recall area, volume, section modulus, moment of inertia, radius of gyration, etc. for commonly used various section and shapes. 5. Draw orthographic projections symbols. 6. Draw symbols of threads, surface roughness, geometrical tolerances symbols, section lines, etc. 7. Recall by sketching the general systems for limits, fits and tolerances.	ALL	02
02	**Standardization using preferred number*** Teacher will provide required data for standardization of 1. Speed of shaft 2. Size of structural product like round bar, plate, sheet etc. 3. Weight of packages 4. Size of industrial design like electric motor, tractor, machine tool, crane 5. Size of machine parts like pulley, coupling 6. Size of cutting tool like drill, broach	I	02

	(minimum one example from each case)		
03	**Design of simple components subjected to direct load** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. Simple component 2. Riveted joint (Two to three example from each case decided by faculty)	II	02
04	**Design of simple components subjected to bending load*** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. Lever 2. Leaf spring (Two to three example from each case decided by faculty)	III	02
05	**Design of simple components subjected to twisting moment** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. Shaft 2. Key 3. Helical spring (Two to three example from each case decided by faculty)	IV	02
06	**Design of simple components subjected to eccentric load*** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. C-Clamp 2. Bracket 3. Column of drilling machine (Two to three example from each case decided by faculty)	V	02
07	**Design of Cotter joint*** Teacher will also assign material, load, factor of safety and other data for design of Cotter joint.	II	02
08	**Design of Knuckle joint*** Teacher will also assign material, load, factor of safety and other data for design of Knuckle joint.	II	02
09	**Design of Flange coupling*** Teacher will also assign material, load, factor of safety and other data for design of Flange coupling.	IV	02
10	**Production drawings of design assemblies:** 1. Cotter joint 2. Knuckle joint 3. Flange coupling Give desired geometrical and dimensional tolerance. Show dimensions calculated above at exercises number 7 to 9. (Prepare production drawing either manually or using software. Use A4 size paper only.)	II & IV	04
11	**Design of pressure vessel:*** 1. Thin cylinder 2. Spherical cylinder 3. Thick cylinder (Two to three example from each case decided by faculty)	VI	02

12	**Calculation of features/characteristics of Bearings*** Teacher will provide required data for calculation of different characteristic of bearing like bearing life, dynamic capacity, bearing characteristic number, coefficient of friction, bearing pressure, heat generation etc. for 1. Journal Bearing 2. Anti-friction Bearing (Three to four example from each case decided by faculty)	VII	04
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Preparatory activity (PrOs Number: 1)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Calculation type PrOs (PrOs Number: 2 to 9, 11 & 12)		
1	Recognition	20
2	Solution	30
3	Representation	20
4	Application	20
5	Punctuality	10
Total		**100**
Rating Scale for Production Drawing type PrOs (PrOs Number: 10)		
1	Drawing Layout, Planning & Scale	20
2	Dimensioning, Tolerances and Notations	30
3	Use of appropriate Line	20
4	Accuracy and Neatness/Drawing setting	20
5	Timely completion	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Criteria	Rating Scale for Preparatory activity				
	%	NEED IMPROVEMENT (1)	FAIR (2)	GOOD (3)	EXCELLENT (4)

Knowledge	30%	Student give the correct answers less than 50%.	Student give the correct answers between 50-69%.	Student give the correct answers between 70-89%.	Students give the correct answers 90% or more.
Quality of Report	30%	Several elements are missing (content in paragraph, labels, figures, tables).	A few required elements (labeling/ notations) are missing.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	Neat Handwriting, figure, and table. Complete labeling of figure and table.
Participation	20%	Participation is minimum.	Focused limited attention in the exercise.	Moderately focused attention on exercise.	Excellent focused attention in the exercise.
Punctuality	20%	Submission late by more than two laboratories.	Submission late by two laboratories.	Submission late by one laboratory.	Timely Submission.

Criteria	**Rating Scale for Calculation type PrOs**				
	%	**NEED IMPROVEMENT (1)**	**FAIR (2)**	**GOOD (3)**	**EXCELLENT (4)**
Recognition	20%	Little to no recognition of relevant information necessary to solve problem(s)	Somewhat recognizes relevant information to solve problem(s)	Mostly recognizes relevant information to solve problem(s)	Clearly recognizes of relevant information necessary to solve problem(s)
Solution	30%	Calculation is carried out step by step with more than 30% mathematical error and given data is not written properly	Calculation is carried out step by step with 30% mathematical error and given data is not written properly	Calculation is carried out step by step with 30% mathematical error or given data is not written properly	Calculation is carried out step by step with no mathematical error and given data is written properly
Representation	20%	Lacks ability to represent information in a variety of modes/forms	Somewhat able to represent information in a variety of modes/forms	Mostly able to represent information in a variety of modes/forms	Definitely able to represent information in a variety of modes/forms
Application	20%	Applies few to no concepts/principl es necessary to solve problem(s)	Applies some concepts/princi ples necessary to solve problem(s)	Applies most concepts/princip les necessary to solve problem(s)	Applies all concepts/princip les necessary to solve problem(s)

Punctuality	10%	Assignment work is submitted more than 4 days lately	Assignment work is submitted late within 2 to 4 days	Assignment work is submitted late within 2 days	Assignment work is submitted within time limit

Criteria	**Rating Scale for Manual Production Drawing type PrOs**				
	%	**NEED IMPROVEMENT (1)**	**FAIR (2)**	**GOOD (3)**	**EXCELLENT (4)**
Drawing Layout, Planning & Scale	20%	The drawing views provided are not sufficient, correct or appropriate and not drawn to the appropriate scale	50% of drawing views provided are sufficient, correct or appropriate and drawn to the appropriate scale	80% of drawing views provided are sufficient, correct appropriate and drawing is to the appropriate Scale.	All drawing with proper planning, layout and to the appropriate scale.
Dimensioning, Tolerances and Notations	30%	Drawing without proper Dimensioning, tolerances and notations.	50% of drawing dimensions, tolerances and notation are given Correctly.	80% of drawing dimensions, tolerances and notation are given Correctly.	All dimension, tolerances and notations are given in drawing.
Use of appropriate Line	20%	No rules were followed. Unable to set the line class. Did not use correct line type or weight	Inconsistent lines, dark and light line combination is not proper.	Two or three lines are not shown in proper type or shade.	Crisp, clear, consistent lines, Proper line type, proper light and dark combination of line.
Accuracy and Neatness for manual drawing / Drawing setting for software drawing	20%	There are many smudges and erasures or stray marks on the drawing sheet, which detract from the drawing and overall poor quality of drawing.	More than two smudge and erasures or stray marks on the drawing sheet, which detract from the drawing.	One or two smudge and erasures or stray marks on the drawing sheet, but they do not greatly detract from the drawing.	No smudge and almost no erasures or stray marks on the drawing.
		Not set drawing limit and dimension unit is not proper.	Minor error in drawing limits setting but do not select proper dimension unit.	Either Drawing limits do not set very well or do not select proper dimension unit.	Drawing limits set very well. Select proper dimension unit.
Timely completion	10%	Drawing work is completed late by more than 2 laboratories.	Drawing work is completed late by 2 laboratories.	Drawing work is completed late by 1 laboratory.	Drawing work is completed within time limit.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrOs. No.
1.	Assorted levers, Leaf Springs, shafts, keys, Helical Spring, C-clamps, frames, other machine components.	3,4,5,6
2.	Wooden models (with cut sections) of knuckle joint, cotter joint, flange coupling	7,8,9
3.	Assorted bearings	12
4.	Educational charts/models of different machine elements subjected to various stresses.	ALL

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction.	1.a List various factors to be considered for design process. 1.b Identify and select materials that can be used for design of machine elements. 1.c Explain loads, stresses, stress concentration factor and factor of safety.	1.1 General consideration and factors influencing the design of machine elements and design process. 1.2 Various materials used in manufacturing of machine elements and their properties. 1.3 Types of loads, types of stresses, concentration and factor of safety. 1.4 Standardization and preferred numbers, numeric examples on

	1.d List Types of loads, types of stresses 1.e Select standard items and preferred numbers for designing simple machine elements.	preferred numbers.
Unit– II Design of machine elements subjected to direct stresses.	2.a Describe the design process of simple elements like linkages, etc. 2.b Calculate resisting area of simple machine element subjected to direct independent stress. 2.c Explain the design of cotter joint and knuckle joint. 2.d Explain the design process of riveted joint and threaded fasteners.	2.1 Illustration of simple machine elements subjected to direct stresses-independently and identification of resisting areas (simple numeric examples). 2.2 Design of simple machine elements subjected to uni-axial direct stresses-independently. 2.3 Design procedure (with numeric examples), steps, identification of resisting areas and design of: i. Knuckle joint ii. Cotter joint. iii. Riveted joints.
Unit-III Design of machine elements subjected to bending stresses.	3.a State the fundamental bending equation. 3.b State modulus of various sections subjected to pure bending like levers, beams and axles. 3.c List types of levers. 3.d Design simple lever based on given input. 3.e Design leaf spring.	3.1 Principle of bending and its fundamental equation. 3.2 Modulus of various sections, example of pure bending like levers, beams, axle, etc. 3.3 Types of levers. 3.4 Design procedure (with numeric example) of levers including cross section of arms, bosses and pins. 3.5 Design procedure (with numeric example) of leaf spring.
Unit-IV Design of machine elements subjected to direct and twisting moments.	4.a State fundamental equation of twisting moment. 4.b List types of shafts with important features of each. 4.c List types of keys, couplings, spring & applications of each. 4.d Explain the design procedure of shafts, keys and couplings. 4.e Define helical spring terminology and its applications. 4.f Calculate numerical on	4.1 Fundamental equation of twisting moment with design procedure. 4.2 Types of shafts with important features of each. 4.3 Design of shafts (with numeric examples). 4.4 Types of keys, applications of each and design procedure (with numeric examples). 4.5 Types of couplings and applications. 4.6 Design of muff and flange couplings (with numeric examples). 4.7 Types of spring, terminology related to helical spring and applications of helical spring.

	the design procedure of machine elements subjected to twisting moment.	
Unit-V Design of machine elements subjected to direct and bending stresses.	5.a Define eccentric loading. 5.b Draw frame-clamp, Bracket, Column of drilling machine, etc. 5.c Design machine components subjected to eccentric loading.	5.1 Eccentric loading- i. Concept, ii. Illustrations like frame, C-clamp, Bracket, Column of drilling machine etc. iii. Design of machine element like C-Clamp, bracket, Column of drilling machine. (with numeric examples).
Unit-VI Design of pressure vessels.	6.a Define pressure vessels 6.b State types of pressure vessels with range of pressure. 6.c Design simple thick and thin cylinder pressure vessels. 6.d Design simple thin spherical shell.	6.1 Types and applications of pressure vessels used in industries. State Range of pressure also. 6.2 Design of thick and thin cylinders (with numeric examples). 6.3 Design of thin spherical shell (with numeric examples).
Unit-VII Selection procedure for bearings.	7.a Classify bearings. 7.b Explain designation of bearings. 7.c Select appropriate anti-friction bearings from manufacturer's catalogue. 7.d Calculate the load on the bearings.	7.1 Classification of bearings. 7.2 Bearing designation as per IS. 7.3 Antifriction bearings: types, advantages, applications. 7.4 Selection procedure of anti-friction bearings. 7.5 Calculation for anti-friction bearings: basic dynamic load, load rating, equivalent load, bearing life.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	08	3	7	4	14
II	Design of machine elements subjected to direct stresses	09	3	4	7	14
III	Design of machine elements subjected to bending stresses	05	0	0	7	7
IV	Design of machine elements subjected to direct and twisting moments.	08	4	3	7	14
V	Design of machine elements subjected to direct and bending stresses.	04	0	3	4	7
VI	Design of pressure vessels.	04	0	3	4	7

VII	Selection procedure for bearings.	04	4	3	0	7
Total		**42**	**14**	**23**	**33**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Download and present various presentations related to stresses in machine elements.
2.	Download and present various presentations related to failure of machine elements.
3.	Download and present various presentations related to design of machine elements.
4.	Prepare/Download a dynamic animation to illustrate the following: i. Knuckle joint. ii. Cotter joint. iii. Flange Coupling

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Introduction.	Power point presentations, live examples, demonstration of BIS on preferred numbers and standardizations,
II	Design of machine elements subjected to direct stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to various stresses, live demonstration of failed components,
III	Design of machine elements subjected to bending stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to bending, live demonstration of bending and induced stresses.
IV	Design of machine elements subjected to direct and twisting moments.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to twisting, live demonstration of twisting.
V	Design of machine elements subjected to direct and bending stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to direct and bending stresses.
VI	Design of pressure vessels.	Movies/ animations/ educational charts, videos, demonstration of live pressure vessels.
VII	Selection procedure for bearings.	Movies/ animations/ educational charts, videos, live demonstration of bearings, demonstration of BIS catalogues

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. The number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs with in integration of PrOs, UOs, and ADOs. Each student must maintain a dated work diary (Logbook) consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model):

1. Prepare model of simple mechanical element to show different types of stress induced in it.
2. Prepare a tabulated summary which shows the standard value of factor of safety based on types of load and types of material. Take reference of design data book.
3. Prepare a chart to represent different shapes like Round bar, Square bar, Steel flat, Different section like L, T, I and C and sizes of some structural members as per IS Code.
4. Prepare a chart to shows stress concentration acting on simple mechanical element.
5. Prepare a chart to represents all possible failure of cotter joints.
6. Prepare a chart to represents all possible failure of Knuckle joints.
7. Prepare a chart to represents all possible failure of flange coupling.
8. Collect different types of rivet.
9. Prepare model of different types of riveted joints. (like single riveted, double or triple riveted, lap joint or butt joint, single cover or double cover)
10. Prepare a demonstration model of the failure of Riveted Joint.
11. Prepare a chart to show the elements of screw thread.
12. Collect the mechanical elements or bolts to show different types of thread.
13. Prepare a tabulated summary to show moment of inertia and modulus of section for common sections.
14. Collect a semi elliptical leaf spring from scrap and prepare model to represents elements of leaf spring.
15. Collect the different types of keys used in industry.
16. Prepare model to represent failure of key.
17. Prepare chart/model to represent failure of thin cylinder.
18. Prepare chart to represent stress distribution in thick cylinder.
19. Prepare chart to represent construction of anti-friction bearing.
20. Prepare chart to represent different types of sliding contact bearing.
21. Prepare chart to represent different types of rolling contact bearing.
22. Take any real life problem (component) from day today life and design the same assuming the load and stresses for material.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication

1.	Machine Design	R.K.Jain	Khanna Publishers
2.	Machine Design	TVS Murthy and N.Shanmugam	Anuradha publications
3.	Machine Design	Pandya and Shah	Charotar Publishing House Pvt. Limited
4.	Machine Design	R.C.Patel and A.D.Pandya	Acharya Book Depot, 1959.
5.	Design of Machine Elements	Shigley	Tata McGraw-Hill Education
6.	Design Data Book	P.S.G. College of Technology, Coimbatore	P.S.G. Publication
7.	Design Data Book	K. Mahadevan & Balveera Reddy	S. Chand
8.	A Text book of Machine Design	R.S.Khurmi and J.K.Gupta	S. Chand
9.	Design of machine elements	V.B.Bhandari	McGraw-Hill

14. SOFTWARE/LLEARNING WEBSITES

1. Chapter: 1 Introduction.
   I. https://youtu.be/m9l1tVXyFp8
   II. https://youtu.be/jolY82CpmGo
   III. https://youtu.be/yH04FSBiCdk
2. Chapter: 2 Design of Machine elements subjected to direct stresses.
   I. https://youtu.be/OT6VcqvOoGY
   II. https://youtu.be/J9Aj17MAyLY
   III. https://youtu.be/C5ZPaCvoigw
3. Chapter: 3 Design of Machine elements subjected to Bending stresses.
   I. https://youtu.be/XSK4iupjbwY
   II. https://youtu.be/r04WynzyK-U
   III. https://youtu.be/E0hrPYAr8pA
4. Chapter: 4 Design of Machine elements subjected to direct and twisting moments.
   I. https://youtu.be/G0bShPqHn5c
   II. https://youtu.be/uGxfchLe-_I
   III. https://youtu.be/QfhIea6KzZA
   IV. https://youtu.be/46quOD7V-cQ
5. Chapter: 5 Design of Machine elements subjected to direct and bending stresses.
   I. https://youtu.be/E0hrPYAr8pA
   II. https://youtu.be/__py5xbKHGA

III. https://youtu.be/1oMjw1YIGwg

6. Chapter: 6 Design of Pressure vessels.
   I. https://youtu.be/hTL8JMmfSC0
   II. https://youtu.be/erW4HZ5I928
7. Chapter: 7 Selection Procedure for bearings.
   I. https://youtu.be/q4E9yaulqyc

15. PO-COMPETENCY-CO MAPPING

Semester V	Design of Machine Element (4351902)						
	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ developmentof solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Design a simple machine element with appropriate material for given user defined boundary and loading conditions.						
CO-1: Identify various failures and its resisting areas of machine element.	2	2	-	-	-	-	-
CO-2: Make use of preferred number for standardization of element dimensions in given range.	2	2	-	-	2	-	2
CO-3: Design machine element subjected to Direct, Bending, Twisting and Combined load.	2	3	3	2	2	-	3
CO-4: Determine the safe dimensions of thin and thick cylinder pressure vessel.	2	2	2	-	-	-	-
CO-5: Calculate important characteristics of sliding and antifriction bearing	2	2	2	-	-	-	-

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

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17. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-VI

Course Title: Mechanical Engineering Project-II
(Course Code: 4361904)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	6th Semester

1. RATIONALE

This course curriculum is in continuation with course code: 4351904, Mechanical Engineering Project-I. This course enables the students to exercise some of the knowledge and/or skills developed during the Diploma study; to solve at-least one of the selected problem; for which there may be number of approaches. This course include planning of the tasks which are to be completed within the time allocated, and in turn, helps to develop ability to plan, use, monitor and control resources sustainably, optimally and economically. Abilities like creativity, imitativeness and performance qualities are also developed in students. Leadership development and supervision skills are also integrated objectives of learning this course.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- Providing safer, qualitative and/or sustainable solution of the problem by optimal usage of the resources.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO	CO Statement
CO-1	Plan and execute group's work allocation.
CO-2	Manage for raw-materials, bought-out parts, out-sourcing and/or manufacturing.
CO-3	Manufacture / manage project parts, assemble the project and test its performance.
CO-4	Calculate project cost.
CO-5	Prepare Mechanical Engineering Project-II report and present the same.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	0	0	50	50	100

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA -Continuous Assessment; ESE-End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (COs). Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Pr. No.	Practical Outcomes (PrOs)	Approx. Hrs.
01	**Group's work allocation:** a. Refer group's project report selected for the course Mechanical Engineering Project-I and prepare group work allocation matrix for the entire term duration, as suggested in Annexure-I. b. Execute and update the said plan. Note: approximately equal work should be assigned per week, to each member for the entire term span.	04
02	**Schedule resources requirement:** a. Prepare various schedules of resources requirement like raw-materials, bought-out parts, and manufacturing facilities etc. and manage for the required resources.	04
03	**Manufacture and test the project:** a. Manufacture or manage for each project part. b. Assemble the project / product. c. Test its performance and maintain its record.	36
04	**Project cost Calculation:** a. Calculate the project cost. b. Prepare / update applicable documents as suggested in Exercise No. 4 of Mechanical Engineering Project-I	04
05	**Documentation and presentation:** a. Prepare a computerized project report as suggested in Exercise No.5 of Mechanical Engineering Project-I. Documentation of project report may includes following, in appropriate sequence.	08

Pr. No.	Practical Outcomes (PrOs)	Approx. Hrs.
	a. Title page- b. Certificate – c. Index. d. Preface/Acknowledgement. e. Brief description of the Project. f. Updated specifications, assembly and detail production drawings. g. Work allocation matrix. h. Specifications of bought out parts. i. Process charts as per format given in course Industrial engineering; if required. j. Specification and consumption of consumables. k. Report of inspection / tests carried out. l. Details of rework / rectifications carried out. m. Cost Calculation. n. Notes on troubleshooting. o. Notes on individual achievement of skills / experience /problems / solutions. p. References. q. Day to day logbook of individual student work. r. Presentation including moments at work-video/photographs in action. Note: 1. Each project group will present their work after completion of each exercise as per department's plan. 2. Projects may be showcased in Institutional/regional level events.	
Total (Hours)		56

Note:

a. Term work (hard copy) should also include experience logbook duly certified by workshop instructors (as applicable), Industry/Market/Field personnel (as applicable) and Guide / Mentor.

b. Term work has to be defended (along with term work of semester V and semester VI) by practical / oral examination to be conducted by external and internal examiners. Power point presentation is also to be included.

6. Sample rubrics Performance Indicators for the PrOs

Criteria	%	4	3	2	1
Logbook	10%	Always maintains proper order of meetings and assigned tasks	Consistently maintains proper order of meetings and assigned tasks	Sometimes maintains proper order of meetings and assigned tasks	Rarely maintains proper order of meetings and assigned tasks
Conclusion, Future Scope	10%	Conclusion derived appropriately	Conclusion derived but partial	Not relevant conclusion	No conclusion
Report write-up	10%	Always preparer basic category/section and summary	Consistently preparer basic category/section and summary	Sometime preparer basic category/section and summary	Rarely preparer basic category/section and summary
Oral Presentation	10%	Always discuss all contain with outline and methodology used	Consistently discuss all contain with outline and methodology used	Sometime discuss all contain with outline and methodology used	Rarely discuss all contain with outline and methodology used
Cost Calculation	10%	Always list parts used assembly and costing with competitive rates	Consistently list parts used assembly and costing with competitive rates	Sometime list parts used assembly and costing with competitive rates	Rarely list parts used assembly and costing with competitive rates
Work allocation	10%	Work Distribute Satisfactory & Corporate Team	60-79 % corporate to team	40-59 % corporate to team	Do not corporate to team
Part Manufacturing	15%	Contribute in part manufacturing	60-79 % Contribute in part manufacturing	40-59 % Contribute in part manufacturing	No Contribute in part manufacturing
Assembly	10%	Satisfactory assemble all part	60-79 % assemble all part	40-59 % assemble all part	Not assemble any part
Testing Result	15%	Satisfactory test the result	60-79 % test the result	40-59 % test the result	Not test any result

7. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

Sr. No.	Equipment Name	PrO. No.
1.	Basic manufacturing and inspection/test facilities as per individual project requirement	3
2.	Computer with word processor software	5

8. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes.(Environment Related)

9. PO-COMPETENCY-CO MAPPING

Semester VI	POs						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	**Apply systematic approach for problem identification and its selection; to provide qualitative, cost effective, sustainable solution for the selected problem.**						
Plan and execute group's work allocation.	3	-	-	2	-	3	3
Manage for raw-materials, bought-out parts, out-sourcing and/or manufacturing.	3	2	-	-	3	3	3
Manufacture / manage project parts, assemble the project and test its performance.	3	3	3	3	-	3	3
Calculate project cost.	2	-	-	2	-	2	2
Prepare Mechanical Engineering Project-II report and present the same.	2	-	-	2	-	-	2

Legend:'3' for high, '2' for medium, '1' for low, and '-'for no correlation each CO with PO.

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Jitendra P Parmar, Lecturer Mechanical Engineering	609 - C U Shah Polytechnic Surendranagar	9429942662	jpparmar66@gmail.com
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11. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. S. H. Sundarani, BOS Chairman & HOD Mechanical	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2	Dr. Rakesh D. Patel, BOS Member & HOD Mechanical	B. & B. Institute of Technology, V. V. Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in

ANNEXURE-I

SAMPLE WORK ALLOCATION MATRIX

Enrol.No: | | | | | | | | | | | | | **NAME :-**_____**GROUP:-**_____

Sr No	Short Description of Activity	Who Will Perform?	Planned Date		Actual Date		Who Has /Have Performed	Reason/s for Any delay; if any	Sign of Guide
			Start	End	Start	End			
1.	Preparing and maintaining logbook as per Annexure-V.								
2.	Finalization of assembly and detail drawings (This must be production drawings with suitable scale along with dimensions, tolerances, surface roughness symbols, heat treatment / other treatments required, material, quantity per assembly for components drawings, etc.								
3.	Preparing master schedule and work allocation matrix in group.								
4.	Preparation of bill of material.								
5.	Collecting data and specifications of available resources-mainly material and machineries / equipment / facilities and tools.								
6.	Make or Buy decision.								
7.	Preparing specifications of bought-out parts.								
8.	Preparation of process planning (sheets) for all components in standard format.								
9.	List, quantities and specifications of consumables.								
10.	Preparation of list of required tools cutting tools, jigs, fixtures, measuring instruments and other tools along with necessary specifications and sketches if required.								
11.	Identifying and locating required resources like material, machineries / equipments / facilities and								

Sr No	Short Description of Activity	Who Will Perform?	Planned Date		Actual Date		Who Has /Have Performed	Reason/s for Any delay; if any	Sign of Guide
			Start	End	Start	End			
	tools.								
12.	Preparing plant layout.								
13.	Manufacturing of components.								
	a. <name of component 1>								
	b. <name of component 2>								
	d. <name of component 3>								
	e. ..								
	n. <name of component n>								
14.	Details of inspection carried out.								
15.	Assembly.								
16.	Details of testing carried out.								
17.	Rework / rectification activities if required.								
18.	Costing.								
19.	Preparation of notes on troubleshooting.								
20.	Preparation of notes individually on a. Extent to which he/she has achieved learning outcomes. b. Own experience in executing project. c. He/ She has faced technical problems during execution of project and solutions found.								
21.	Preparation of list of references.								
22.	Preparation of project-II report.								
23.	Presentation.								

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)

Semester-VI

Course Title: Power Plant Engineering

(Course Code: 4361905)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	6th Semester

1. RATIONALE

Availability of power is the one key area where most of the Indian industry is facing problems. In India, even today, short fall of power generation is about 30 percent. Fuel supply and distribution is also an area where country is still developing smooth lines of supply. Since power and energy is required by every sector of economy, the growth in this sector is must if Indian economy grows in any sector. Many of the job opportunity in private as well as public sector are therefore waiting for students in this field. Hence, this course attempts to provide them basic knowledge of the technologies available at plant level and would also acquaint them with the latest technological advances taking place in this sector.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Apply knowledge of mechanical engineering related to power generation systems, their control and economics in different type of power plants for their operation and maintenance.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Outline factors affecting the power plants by analyzing its economy.
CO-2	Interpret layout of coal-based power plant and its components.
CO-3	Identify elements and their functions of Diesel, gas turbine, nuclear and hydro power plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

5. SUGGESTED PRACTICAL EXERCISES

Following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Demonstrate various energy conversion Systems in different types of power plants. *	I	04
02	Calculate the cost of power for given data of power station. *	II	02
03	Calculate the Tariff of electric energy for (i) domestic (urban) usage, (ii) Tariff for electric energy, (iii) Industrial usages, and (iv) agriculture usage from given data.	II	04
04	Demonstrate various circuits of modern coal-based thermal power plants. *	II	04
05	Demonstrate various high-pressure boilers. *	II	04
06	Demonstrate coil fired boiler furnaces.	II	02
07	Demonstrate major components of the Diesel power plant. *	III	02
08	Demonstrate major components of nuclear power plants. *	IV	02
09	Demonstrate CANDU nuclear reactor. *	IV	02
10	Demonstrate major components of hydroelectric power plant. *	V	02
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Third-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required,

which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1, 4, 5, 6, 7, 8, 9 & 10)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Calculation/ performance type PrOs (PrOs Number: 2 & 3)		
1	Knowledge	20
2	Procedure follows	15
3	Observation Skill	20
4	Analysis	10
5	Quality of Report	20
6	Punctuality	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 1, 4, 5, 6, 7, 8, 9 & 10)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.
Experimentation/performance type PrOs (PrOs Number: 2 & 3)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or	Student give the correct answers	Student give the correct answers	Student give the correct answers less

		more.	between 70-89%.	between 50-69%.	than 50%.
Procedure follows	15%	Students follow all the procedures with precaution in a logical order.	Students follow all the procedures with some precautions in a logical order.	Students follow all the procedures without precaution in a logical order.	Students follow all the procedures without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Analysis	10%	Student understand the data and analyze correctly the obtained test results.	Student understand most of the data and analyze the obtained test results with help or support.	Student need help to understand some of the data and also in analyzing the obtained test results.	Student always need help to understand the data and also in analyzing the obtained test results.
Quality of Report	20%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables , use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them bythe administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Model of coal-based thermal power plant (including all circuits).	II
2.	Models of high-pressure boilers: - Lamont boiler - Benson boiler - Loffler boiler - Velox boiler	II
3.	Models of boiler furnaces.	II

4.	Model of Diesel power plant.	III
5.	Model of gas turbine power plant.	III
6.	Model of cogeneration and combined cycle power plant.	III
7.	Model of nuclear power plant.	IV
8.	Models of nuclear reactors: - Pressurized water reactor - Boiling water reactor - CANDU reactor	IV
9.	Model of hydroelectric power plant.	V

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices.

d. Maintain models and equipment.

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Introduction to Power Plant	1.a Describe power plants with Indian energy scenario. 1.b Explain various terminology used in plant economy 1.c Calculate the cost of power, rate of return, rate of interest and tariff for power generation.	1.1 Concept 1.2 Energy Scenario in India 1.3 Energy conversion steps in various power plants 1.4 Types of power plants 1.5 Terminology of plant economy - Peak load - Baseload - Load factor - Load curve - Load duration curve - Diversity factor

		1.6 Cost of power - Fixed cost - Operational cost 1.7 Rate of return and rate of interest 1.8 Tariff for electric energy 1.9 National grid 1.10 Simple numerical
Unit– II Modern Coal-based Power Plants	2.a Analyze the Rankine cycle and its efficiency improvement methods. 2.b Describe various circuits of modern coal-based power plants. 2.c Explain various, boilers, boiler furnaces, fuel supply systems, and governing systems of coal-based power plants.	2.1 Rankine cycle - Simple cycle and analysis - Actual cycle 2.2 Efficiency Improvement Methods - Reheating - Regeneration 2.3 Layout of modern thermal power plant 2.4 Various Circuits - Coal and ash handling - Air and gas - Feed water and steam - Condenser and cooling water - Steam turbine lubrication 2.5 High-pressure boilers - Lamont boiler - Benson boiler - Loffler boiler - Velox boiler 2.6 Boiler Furnaces 2.7 Pulverized fuel supply system 2.8 Electrostatic precipitator (ESP) 2.9 Governing system 2.10 Simple numerical
Unit-III Diesel and Cogeneration Power Plant	3.a Describe the concept of Diesel power plant. 3.b List the essential elements and various systems of Diesel and gas turbine power plants. 3.c Explain the working of cogeneration and combine cycle power plant.	3.1 Diesel engine power plant - Applications - Merits and De-merits 3.2 Layout of Diesel engine power plant 3.3 Various systems of Diesel engine power plant 3.4 Comparison of diesel and gas turbine power plant 3.5 Auxiliary systems of gas turbine power plant 3.6 Cogeneration and combined cycle power plant 3.7 Simple numerical
Unit– IV Nuclear Power Plant	4.a Describe the nuclear physics. 4.b Identify major components of nuclear reactors, and explain the working of nuclear reactors. 4.c Choose the waste disposal methods, particularly for	4.1 Fundaments of nuclear physics - Fusion and fission - Chain reaction - Nuclear fuel 4.2 Nuclear reactor - Major Components 4.3 Construction and working of

	nuclear waste.	- Pressurized water reactor - Boiling water reactor - CANDU reactor 4.4 Nuclear waste and disposal 4.5 Site selection 4.6 Nuclear power scenario in India
Unit–V Hydro Power Plant	5.1 Describe hydroelectric power plant. 5.2 Identify the major components of hydro power plants.	5.1 Concept and purpose 5.2 Major elements 5.3 Classifications 5.4 Site selection

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Power Plant	10	3	7	7	17
II	Modern Coal-based Power Plants	14	7	7	7	21
III	Diesel and Cogeneration Power Plant	08	3	4	7	14
IV	Nuclear Power Plant	06	7	4	0	11
V	Hydro Power Plant	04	3	4	0	7
Total		**42**	**23**	**26**	**21**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Collect data of new installed power plants (type, capacity, place etc) in last 10 years.
2.	Collect data for tariff for different types of consumer and explain it.
3.	Explain possible impact on environment for different types of power plant.
4.	Explain possible impact on economy for different types of power plant.
5.	Explain various circuits of thermal power plant from given layout of power plant.
6.	Collect data of diesel generating sets installed at nearby place.
7.	Find scope of municipal waste as a fuel in suitable power plant.
8.	Explain scope of micro hydel power plant in your state.
9.	Enlist coal-based thermal power plant specifications which is available nearby.

10.	Prepare a comparative analysis of high pressure boilers, super critical and sub critical boilers.
11.	Identify type of defect/ failure in high pressure boilers.
12.	Visit any coal-based/ Diesel engine/gas turbine/nuclear power plant.
13.	Prepare property table for different types of fuel/energy which is useful for power generation.
14.	Undertake 2 to 5 days of training in any power plant.
15.	Prepare a presentation on various control systems for modern power plant.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Introduction to Power Plant	o Real-life examples, demonstration of natural systems, movies /animations /chart /tables /models. o Numericals, Massive Open Online Courses (MOOCs).
II	Modern Coal-based Power Plants	
III	Diesel and Cogeneration Power Plant	
IV	Nuclear Power Plant	
V	Hydro Power Plant	

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned at the beginning of the semester. The number of students ınthe group should ***not exceed three.***

The micro-project could be literature survey based, data collection and its interpretation for existing power plant, site survey for new power plant, finding load curve of given area/ institute, finding peak load and peak hours of given area/ institute, internet-based, workshop-based, or field-based. Each micro-project should encompass at least COs with in integration of PrOs, UOs, and ADOs. The duration of the micro project should be about **4-5** ***(four to five) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model/animation):

1. Prepare a demonstration model of coal-based thermal power plant on wooden board.
2. Prepare a demonstration model of Diesel engine power plant on wooden board.
3. Prepare a demonstration model of gas turbine power plant on wooden board.
4. Prepare a demonstration model of nuclear power plant on wooden board.
5. Prepare a demonstration model of hydroelectric power plant on wooden board.
6. Prepare a display chart of different coal-based thermal power plant circuits.

7. Prepare a display chart of different types of high pressure boilers.
8. Prepare a display chart of different types of nuclear reactors.
9. Make a PowerPoint presentation on Indian energy scenario.
10. Prepare a tabulated summary of the coal-based thermal power plants installed in a Gujarat. (Summary includes capacity, location, types of boilers, fuel, furnace, coal handling system, ash handling system, etc).
11. Prepare a tabulated summary of the gas turbine power plants installed in a Gujarat. (Summary includes capacity, location, types of combustion chamber, type of compressor, fuel, etc).
12. Prepare a tabulated summary of the nuclear power plants installed in a Gujarat. (Summary includes capacity, location, types of reactors, fuel, waste disposal method, cooling system, etc).
13. Prepare a tabulated summary of the hydroelectric power plants installed in a Gujarat. (Summary includes capacity, location, types turbine, reservoir height, draft system, etc).
14. Prepare a chart of possible major and minor fault and remedies of high-pressure boiler.
15. Make a PowerPoint presentation on the latest trends in nuclear power plant.
16. Make a PowerPoint presentation on the latest industry trends in gas turbines.
17. Carry out a comparative study of coal-based thermal power plant, Diesel engine power plant, gas turbine power plant, nuclear power plant and hydroelectric power plant based.
18. Carry out a comparative analysis pollution impact due to coal-based thermal power plant, Diesel engine power plant, gas turbine power plant, nuclear power plant and hydroelectric power plant.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Power Plant Engineering	P K Nag	Tata Mc Graw Hill
2.	Power Plant Engineering	Domkundwar	Dhanpat Rai & Co. Limited
3.	Power Plant Engineering	Dr. P. C. Sharma	S. K. Kataria & Sons
4.	Power Plant Engineering	R. K. Rajput	Laxmi Publications
5.	Power Plant Engineering	Black & Veatch	Springer Publication
6.	Power Station Engineering and Economy	Bernhardt G A Sarotzki, William A Vopat	Tata Mc Graw Hill

14. SOFTWARE/LEARNING WEBSITES

1. http://nptel.ac.in/courses/112105051/
2. https://www.nrc.gov/reactors.html
3. https://www.energy.gov/eere/water/types-hydropower-plants
4. https://www.ntpc.co.in/
5. https://powermin.gov.in/

15. PO-COMPETENCY-CO MAPPING

Semester V	Power Plant Engineering (4361905)						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ developmentof	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability &	Project Management	Life-longLearning
Competency	Apply knowledge of mechanical engineering related to power generation systems, their control and economics in different type of power plants for their operation and maintenance						
CO-1: Outline factors affecting the power plants by analyzing its economy.	3	3	2	-	2	-	2
CO-2: Interpret layout of coal-based power plant and its components.	3	-	3	-	2	-	-
CO-3: Identify elements and their functions of Diesel, gas turbine, nuclear and hydro power plant.	3	-	-	-	2	-	-

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU RESOURCE PERSONS)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. (Dr.) Rakesh Bumataria	Government Polytechnic, Porbandar	9924402808	rakesh.bumataria@gmail.com
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17. BOS RESOURCE PERSONS

Sr. No.	Name and Designation	Institute	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-VI

Course Title: Robotics and Industrial Automation
(Course Code: 4361906)

Diploma programmer in which this course is offered	Semester in which offered
Diploma Mechanical Engineering	6th Semester

1. RATIONALE

In near future, robots will be used widely in the fields of manufacturing, medicine, search and rescue, service, and entertainment. So, it is very much important to teach robotics as the synergistic integration of mechanics, electronics, controls and computer science. This subject is intended to make students aware with basics of robot sensors, controls, transformations along with essential kinematics and dynamics, robot programming language and Industrial automation system & Industry 4.0.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Able to select types of robots, its end effectors and sensor.
- Able to understand concept of robot kinematics.
- Able to calculate the robot position and orientation.
- Able to understand various industrial automation system & Industry 4.0.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

CO1	Classify types of robots and identify its subsystems.
CO2	Select an actuator, its gripper/s and sensor for a robot based on given application
CO3	Calculate robot position and orientation.
CO4	Identification of robot programming language.
CO5	Explain Industrial automation system & Industry 4.0

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	70	30	25	25	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	**Demonstration:** Students would: a. Demonstrate working of following: i. Robot-anyone. b. Sketch following. i. Configuration sketch of robot demonstrated.	1	2 Hrs
2	**Demonstration:** Students would: a. Demonstrate working of following: i. Sensors-each one from unit IV. b. Sketch following. i. Working sketch of sensors demonstrated.	4	2 Hrs
3	Demonstrate various types of grippers used in robotics.	2	4 Hrs
4	Demonstrate block diagram of actuator system.	2	4 Hrs
5	Prepare a report/Case study on various types of motors used in robotics	2	2 Hrs
6	Prepare a report/Case study on classification of robots based on coordinate system and Conversion of coordinates form one system to other.	3	2 Hrs
7	Calculate position of a given point in Cartesian coordinate system.	3	2 Hrs
8	Develop a program of Robert in any available software (like V-REP, RoboDK etc.) for given activity.	5	4 Hrs
9	Prepare a report/Case study on Industrial Automation and process control system.	6	2 Hrs
10	Prepare a report/Case study on Industry 4.0	6	2 Hrs
11	Industrial visit ,report and presentation: Students would: Visit any one advanced manufacturing system/CAD-CAM/ Robotics/Additive manufacturing based industry/Centre of excellence/Exhibition and prepare brief report.	1 to 6	2 Hrs

Note: *More* ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name	Broad Specifications	PrO. No.
1	Any available software (like V-REP, RoboDK etc.)	Robot programming and simulation software	8
2	Robotic arm	6 axis robotic arm	1,
3	Sensors, Grippers and Actuators	Various sensors, grippers and actuators	2,3,4

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member for Micro project.
b) Follow safety practices and procedure in Lab.
c) Realize the importance of engineering for societal development.
d) Develop gradually the engineering mindset in day-to-day observation.

8. UNDERPINNING THEORY:

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-I Introduction to Robotics	1a. Understand evolution of robotics over time. 1b. Define robot. 1c. Explain advantages and disadvantages of robots. 1d. Explain terminology of robot 1e. Explain components the component of robot. 1f. Classification of robots based on coordinate system they use, power source they use, control method used by them and programming method. 1g.Explain safety measures to be followed while working with and around robots.	1.1: Brief History of robotics. 1.2: Definition of a ROBOT 1.3: Laws of robotics. 1.4: Advantages and Disadvantages of robots 1.5: Component of an Industrial Robot 1.6: Robot Terminology 1.7: Robotic Joints 1.8: Classification of Robots 1.8.1 : Based on Coordinate Systems 1.8.2 : Based on Power Source 1.8.3 : Based on Method of Control 1.8.4 : Based on programming Method 1.9: Industrial Applications of Robot. 1.10: Safety practices with robots
Unit-II Actuators and Grippers	2a. Explain robotic actuators and its components. 2b. Classify robotics actuators and explain their working. 2c. Explain factors affecting selection of actuators. 2d. Explain robotic grippers. 2e. Classify robotic grippers.	2.1: Introduction to robotic actuators: 2.1.1: Block Diagram of an actuator system 2.1.2: Subsystems of actuator system: 2.1.2.1: Power supply, 2.1.2.2: Power amplifier, 2.1.2.3: Servomotor, and 2.1.2.4: Transmission system. 2.2: Classification of actuators: 2.2.1: Pneumatic actuators, 2.2.2: Hydraulic actuators, 2.2.3: Electric actuators: 2.2.3.1: DC motor. 2.2.3.2: AC motor. 2.2.3.3: Induction motor. 2.2.3.4: Stepper motors. 2.2.3.5: Linear actuators. 2.3: Factors affecting selection of actuators. 2.4: Introduction to Grippers. 2.5: Classification of grippers: 2.5.1: Mechanical grippers. 2.5.2: Magnetic grippers. 2.5.3: Vacuum grippers.

	2f. Explain factors affecting design and selection of grippers.	2.5.4: Adhesive grippers. 2.5.5: Tools as grippers. 2.6: Factors affecting design and Selection of grippers.
Unit-III Robot Kinematics	3a. Introduction to kinematics. 3b. types of links in kinematics. 3c. Explain kinematic constrains. 3d. Explain types of joints used in robots. 3e. Explain Chain in kinematics. 3f. Explain and calculate Degree of freedom for given body. 3g. Explain and calculate position and orientation of rigid body in space. 3h. Identification of position of a point and vector in given coordinate system.	3.1: What is kinematics? 3.2: Types of kinematic links: 3.2.1: Rigid link. 3.2.2: Flexible link. 3.2.3: Floating link. 3.3: Kinematic pair/constrains. 3.3.1: Types of constrains 3.3.2: Classification of kinematic pairs. 3.4: Common types of robotic joints 3.5: Kinematic chain: 3.5.1: Closed chain mechanism. 3.5.2: Open chain mechanism. 3.6: Degree of freedom (DOF) 3.7: Position and orientation of rigid body in space. 3.7.1: Configuration space 3.7.2: Coordinate systems 3.7.2.1: Cartesian coordinate system 3.7.2.2: Cylindrical coordinate system 3.7.2.3: Spherical Coordinate system 3.8: Representation of points and vectors in coordinate systems.
Unit-IV Robotic Sensors	4a. Categorize various robotic sensors 4b. List various Internal and External sensors used in Robotic Application 4c. List various Contact and Non-Contact sensors used in Robotic Application 4d. Describe the general working principles of given sensor 4e. Explain Construction and Working of given Robotic sensor with neat sketch 4f. Discuss some applications of given sensor	4.1: Types of Sensors in Robots 4.1.1: Internal Sensors 4.1.2: External Sensors 4.1.3: Contact sensors 4.1.4: Non-contact sensors 4.2: Position and Displacement Sensor 4.2.1: Potentiometers 4.2.2: Optical Encoders 4.2.2.1: Absolute 4.2.2.2: Incremental 4.2.2.3: LVDT 4.3: Touch or Tactile Sensor 4.3.1: Binary Sensor 4.3.2: Analog Sensor 4.4: Proximity Sensor 4.4.1: Contact Proximity 4.4.2: Non-Contact Proximity 4.4.3: Optical 4.4.4: Ultrasonic 4.4.5: Eddy Current 4.4.6: Inductive 4.4.7: Hall Effective 4.4.8: Capacitive 4.5: Procedure to choose right sensor for particular Application

	4g. Write procedure to choose right sensor for particular Application	
Unit-V Robot Programming	4a. Describe the requirement of robot language 4a. Explain languages and its structure used for robot programming. 4b. Explain methods used for programming a robot.	5.0: Introduction 5.1: Requirement for robot language 5.2: Structure of robot language 5.3: Different Robot languages 5.4: Robot Programming Techniques: 5.4.1: Manual Programming Method 5.4.2: Walk through Programming method 5.4.3: Teach pendant or lead through programming method 5.4.4: Off-line programming method
Unit-VI Industrial Automation	6a. List advantages and limitations of Automation 6b. Explain application of Automation 6c. List elements of automation 6d. Differentiate Mechanization vs Automation 6e. Explain types of Automation. 6f. Explain assembly automation equipment. 6g. Explain Automated Guided Vehicles. 6h. Explain Automated Storage system. 6h.Explain Flexible Manufacturing System. 6i.Describe various components of Flexible Manufacturing System. 6i. Explain Importance of Group technology 6j. Determine part family of given parts based on part design	6.1: Introduction 6.2: Advantages and Limitations of Automation 6.3: Application of Automation 6.4: Elements of Automation 6.5: Mechanization vs Automation 6.6: Types of Automation 6.6.1: Fixed (or Hard) Automation 6.6.2: Programmable Automation 6.6.3: Flexible (or soft) Automation 6.7: Assembly automation equipment: 6.7.1: Material handling System 6.7.1.1: Classification of Material handling system 6.7.2: Transportation System : 6.7.2.1: Transfer Systems 6.7.2.2: Transfer Machines 6.7.2.3: Transfer Devices 6.7.3: Feed System 6.7.3.1: Introduction 6.7.3.2: Characteristics of Feeder 6.7.3.3: Types of Feeders 6.7.5: Automated Guided Vehicles (AGV's) 6.7.6: Automated Storage Systems : 6.7.6.1: Introduction 6.7.6.2: Automated storage/ Retrieval Systems 6.8: Flexible Manufacturing System (FMS) 6.8.1: Introduction 6.8.2: Flexible Manufacturing Cell and FMS 6.8.3: Components of FMS 6.8.4: Requirement of FMS 6.8.5: Advantages and limitations of FMS 6.9: Group Technology 6.9.1: Introduction 6.9.2: Advantages and limitations of Group Technology 6.9.3: Part Families 6.9.4: Formation and establishment of component family

	attribute and part manufacturing attribute. 6j. Explain Computer Aided Process Planning 6k. Explain Computer integrated Manufacturing 6l. Industry 4.0	6.9.5: Collection of production data 6.10: Computer Aided Process planning system 6.11: Computer Integrated Manufacturing (CIM) 6.12: Industry 4.0

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory marks			
			R Level	U Level	A Level	Total Marks
1	Introduction to Robotics	4	2	4	0	06
2	Actuators and Grippers	8	5	5	4	14
3	Robot Kinematics	8	6	4	4	14
4	Robotic Sensors	8	6	4	4	14
5	Robot Programming	6	2	3	3	08
6	Industrial Automation	8	6	6	2	14
	Total	**42**	**27**	**26**	**17**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare models of 2 DOF and 3 DOF robotic arms.
b) Give seminar on drones and its controls.
c) Undertake a market survey of different types of robots used in industries.
d) Give seminar on advancement in robotics with development of AI.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:

a) Inspire Student to read books on development and evolution of robotics, instruct them to take notes in form of summary
b) Prepare a short note on applications of robot in defense industry.
c) Guide students to make presentation on various applications of robotics in medical field in small groups.
d) List out various programming languages used in robotics along with their advantages and limitations.
e) Make a model for 3D Cartesian coordinate system and explain calculation of position of point, vector and plane in it.

12. SUGGESTED PROJECT LIST

The micro-project could be industry application based, internet-based, workshop based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit a micro-project by the end of the semester to develop the industry oriented COs. A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1) *Prepare a model of 2DOF robotic arm.*
2) *Prepare a model of 3DOF robotic arm.*
3) *Prepare a model of pick and place robot.*
4) *Prepare a model for demonstration of hydraulics.*
5) *Prepare a model for demonstration of Gripper mechanism.*
6) *Prepare a model for demonstration of rigid links.*
7) *Prepare a model for demonstration of flexible links.*
8) *Prepare a model for demonstration of floating links.*
9) *Prepare model for demonstration on flexible Manufacturing System.*
10) *Prepare a model using robotic sensors.*

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Robotics and Industrial Automation	R.K.Rajput	S.Chand and Company ISBN (13): 978-8121929974 ISBN (10): 8121929970
2	Industrial Automation and Robotics	A.K.Gupta S.K.Arora	University of Science Press (An imprint of Laxmi Publication Private Limited) ISBN: 978-1-938549-30-4
3	Introduction to robotics	Prof. Subair kumar Shah	McGraw Hill Education (India) Private Limited ISBN (13): 978-93-3290-280-0 ISBN (10): 93-3290-280-1
4	Robotics Simplified	Dr. Jisu Elsa Jacob Manjunath N	BPB Publications India ISBN: 978-93-91030-26-1
5	Fundamentals of Robotics	Prof. Dilip Kumar Pratihar	Narosa Publication House Pvt. Ltd., New Delhi, ISBN (13): 978-8184875775 ISBN (10): 8184875770
6	Fundamentals of Robot Technology	D J Todd	Kogan Page Ltd 120 Pentonville Road, London Nl 9JN ISBN-13: 978-94-011-6770-3 e- ISBN-13: 978-94-011-6768-0

14. SOFTWARE/LEARNING WEBSITES

Various link of free demo robotics software

1. https://downloads.intelitek.com/PLTW/ROBOCELL/
2. https://intelitek.com/
3. https://convergent-it.com/robot-programming-demo/
4. https://cyberbotics.com/
5. https://www.robocamp.eu/en/lessons/demo/
6. https://instrumentationtools.com/download-free-robotics-software/
7. https://www.kuka.com/en-in/products/robotics-systems/software/simulation-planning-optimization/kuka_sim

15. PO-COMPETENCY-CO MAPPING:

Semester VI	Robotics and Industrial Automation (Course Code:4361906)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Classify types of robots and identify its subsystems.	3	2	-	-	-	-	2
Select an actuator, its gripper/s and sensor for a robot based on given application	3	2	2	2	-	-	2
Calculate robot position and orientation.	3	3	3	3	-	-	3
Identification of robot programming language.	3	2	3	3	2	-	3
Explain Industrial automation system.	3	2	2	-	-	2	3

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr.Priykant A. Vaghela	G.P.Dahod	9427950895	pavaghela1979@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)

Semester-VI

Course Title: Fabrication Technology

(Course Code: 4361907)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	6th Semester

1. RATIONALE

This course focuses on fabrication of different types process plant equipment used in various refineries, chemical, petro-chemical, solid-liquid-gas handling industries. This course would help students how to interpret design drawings, code & standards used in fabrication industry. Student also acquainted with use of code & standards to various to prepare engineering documents. This course also provides opportunity for hands on practice for student to develop skill for process equipment fabrication with use of necessary desired safety norms.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency.

- ✓ Plan, prepare engineering documents, implement and supervise equipment fabrication with reference to fabrication code – standards, using appropriate methods – procedures along with safety norms.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Interpret term fabrication and weldability.
CO-2	Calculate the material requirements on basis of drawing interpretation.
CO-3	Apply suitable fabrication procedures for equipment manufacturing.
CO-4	Suggest testing & inspection procedures for pre-during-after fabrication work.
CO-5	Select suitable surface finishing and coating method for fabricated equipment.
CO-6	Plan process equipment erection & commissioning at site.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No. /COs	Approx. Hrs. Required
01	**STUDY OF GENERAL ENGINEERING DRAWINGS & DESIGNATION OF PHYSICAL ENGINEERING ITEMS** PART-I Study any two drawing from following list. a. Process Plant General Arrangement Drawing (GAD) b. Process plant process and instrumentation drawing (P&ID) c. Process Flow Diagram (PFD) d. Detail and Assembly Drawing (D&AD) e. Route sheet OR Operation sheet f. Structural Detail drawing g. Shop Lay out drawing PART-II Find out the designation appeared on various items used in equipment fabrication from following list (any three). a. Spiral wound gasket b. Scooter tyre and Car tyre c. Welding electrode and welding rods d. Piping e. Flanges f. Grinding wheels g. Gas bottles (acetylene, oxygen, LPG)	I & II / CO-1 & CO-2	02
02	**DRAWING STUDY : BILL OF MATERIAL** Prepare bill of material from Pressure vessel equipment detail drawing. **OR** Prepare bill of material from Shell tube type heat exchanger equipment detail drawing.	II / CO-2	02
03	**DRAWING STUDY : WELDING JOINT** Draw actual welding joint from location of weld symbol shown in pressure vessel drawing. **OR** Draw actual welding joint from location of weld symbol shown in Heat Exchanger drawing.	II / CO-2	02
04	**DRAWING STUDY : RAW MATERIAL REQUIREMENT CALULATION** Find out required raw material requirement like shell plate blank, dished end, end plate, skirt shell and related other parts, from pressure vessel drawing. **OR** Find out required raw material requirement like Tube sheet plate blank, end plate, HE main shell, HE channel shell, dish end supporting shell, baffles, tie rods, tubes from shell & tube type HE drawing.	II / CO-2	02
05	**DRAWING STUDY : DISH END BLANK DIA CALCULATION** Calculate dish end blank diameter for following type. a. Torispherical type dish end b. Ellipsoidal type dish end c. Hemispherical type dish end	II / CO-2	02

06	**DRAWING STUDY : NOZZLE SCHEDULE** Prepare Nozzle schedule with Location chart from pressure vessel drawing (different type of pipes / type of pipe size and type of flanges / flange size) **OR** Prepare Nozzle schedule with Location chart from HE drawing (different type of pipes / type of pipe size and type of flanges / flange size)	II / CO-2	02
07	**DRAWING STUDY : PIPING ISOMETRICS** Find out following points from piping isometrics drawing. a. Find Start and End point co-ordinates from drawing. b. Find different type of fittings used with size from drawing. c. Calculate Different type of pipes and type of pipe size from drawing. d. Calculate erection work in inch-meter e. Calculate welding work in inch-dia from drawing.	II / CO-2	02
08	**STUDY OF ENGINEERING DOCUMENTATION - I** Prepare WPS and WPQ document for CS material pressure vessel **OR** shell & Tube type Heat Exchanger. (Take required data from ASME / AWS code)	II / CO-2	02
09	**STUDY OF ENGINEERING DOCUMENTATION - II** Prepare SWP and WTP document for typical pressure vessel **OR** shell & Tube type Heat Exchanger.	II / CO-2	02
10	**PRACTICE OF FABRICATION PROCEDURES** Practice (Whichever is possible in institute) (group of 5-6 students / minimum one demonstration per batch) a. TWO shell making by rolling process and LONG SEAM tack welding b. Measure ovality and rectify ovality by turn buckle type spiders. c. Measure peak in- peak out and rectify by triangular wedges. d. Two shell CIRC SEAM tack welding e. Shell Alignment at 0-90-180-270 degree angles (By L shape and string method). f. Measure practically dia. and circ. Of vessel shell and compare with theoretical equation. g. Reference line (vertical VRL by plumb and horizontal HRL by spirit level) marking on shell. h. Calculate arc length from zero degree VRL and Calculate height from HRL for nozzle orientation marking on shell. i. Erect pressure vessel OR install centrifugal pump at site.	II, III & VI / CO-2, CO-3, CO-6	02
11	**FABRICATION OF SMALL WELD JOB** Prepare JOB of 5 mm thick x 200 mm length x 80 mm width two plates 60 degree 'V' included angle WEP weld joint with SMAW process. (group of 5-6 students / minimum one job per batch)	III / CO-3	02
12	**NON DESTRUCTIVE TESTING OF SMALL WELD JOB** Test the weld job by Liquid Penetrant Testing method and discuss the results. (group of 5-6 students / minimum one LPT testing per batch)	IV / CO-4	02
13	**FINISHING & COATING OF SMALL WELD JOB** Finish weld job by hand grinding process and apply color coating on job. (group of 5-6 students / minimum one finishing & coating per batch)	V / CO-5	02
14	**MINI PROJECT** Prepare any one fabricated item from following list (group of 5-6 students / minimum one item per batch). Note: Corse teacher may	I TO VI / CO-1 to CO-6	02

	select other than this list also, as per Institute convenience. 1. Podium 2. Shelf rake 3. Stool 4. Table with drawers 5. Bench-desk 6. Window greel 7. Door greel 8. Camera tripod 9. Mike stand 10. Display board stand 11. Performance Stage 12. Banner stand 13. Tipoi 14. Long height table 15. Welding Work table 16. Chair 17. Zulla 18. Cycle stand 19. Cycle scooter car parking shade 20. Storage tank		
Total (Hours)		**ALL UNITS ALL COs**	**28**

Note:

More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

Sample rubrics Performance Indicators for the PrOs

PRACTICAL CA RUBRICS

Fabrication Technology (Total marks = 50) (For Practical 1 to 9)							MAX 5 MARKS
No	**Marking Criteria**		**Poor (2 Marks)**	**Good (3 Marks)**	**Very Good (4 Marks)**	**Excellent (5 Marks)**	**OBTAINED**
1	**Regularity Level – 10 marks**	Punctual in work Reporting	Work reporting very less.	Partially punctual in work reporting.	Punctual in work reporting.	Punctual in work reporting and takes initiatives.	
		Discipline during lab work	undisciplined during lab work	Disciplined during lab work.	Very disciplined during lab work.	Very disciplined and strictly follow lab work norms.	
2	**Understanding Level – 15 marks**	Draw job drawing.	Draw but not perfect.	Draws with scale, but appearance is fair and not perfect nomenclature	Draws with scale, drawing appearance is good, nomenclature partially.	Draw with scale, excellent nomenclature and drawing appearance is very good.	
		Interpret the drawing and its Specification.	Cannot interpret.	Interpret partially and cannot answer.	Can Interpret but cannot answer with technical justification.	Interpret drawing and its specification with giving proper answer with technical justification.	
		Ability to calculate.	Cannot calculate.	Can Partially calculate.	Can calculate easily.	Can calculate and confident about calculation.	
3	**Assigned work skills Level – 15 marks**	Write practical	Partially Written practical & poor work	Practical writing work is moderate level and some work copied.	Practical work doing by self, but appearance wise moderate level	Excellent in Practical writing work and doing work by self.	
		Ability to prepare specifications	Not able to prepare, only copied.	Can prepare the specification partially.	Can prepare specification but not confident about specification.	Excellent in preparation of specification and very much confident about their work with justification.	
		Submission of assigned work & report	Not submit or partially submit.	Submit but not perfect.	Submit within time limit but can't give answers about job operations.	Submit within time limit and can give Right Answer with technical justification	
4	**Documentation and Presentation skill level – 10 marks**	Appearance & Maintenance of Document.	Copied and Unmaintained file or document, submitting incomplete file	Complete file but Poor appearance with multiple correction, Submission after final date.	Timely submission & Prepared document with Partial Correction	Finely Prepared document or Presentation along with all data within time limit.	
		Answers the experiment related questions.	Cannot present.	Improper presentation.	Well present, can answer, cannot give perfect justification of answer.	Well present and giving answer with proper technical justification.	
						Total marks out of 50	
						SIGN OF BATCH TEACHER	

PRACTICAL CA RUBRICS							
Fabrication Technology (Total marks = 50) (For Practical 10 to 14)							MAX 5 MARKS
Sr. No.	OUT OF		Poor (2 Marks)	Good (3 Marks)	Very Good (4 Marks)	Excellent (5 Marks)	OBTAINED
1	Regularity Level – 10 marks	Punctual in work Reporting	Work reporting very less.	Partially punctual in work reporting.	Punctual in work reporting.	Punctual in work reporting and takes initiatives.	
		Discipline during lab work	undisciplined during lab work	Disciplined during lab work.	Very disciplined during lab work.	Very disciplined and strictly follow safety norms during lab work.	
2	Understanding Level – 15 marks	Draw job drawing.	Draw but not perfect.	Draws with scale, but appearance is fair and not perfect nomenclature.	Draws with scale, drawing appearance is good, nomenclature partially.	Draw with scale, excellent nomenclature and drawing appearance is very good.	
		Interpret the drawing and its Specification.	Cannot interpret.	Interpret partially and cannot answer.	Can Interpret but cannot answer with technical justification.	Interpret drawing and its specification with giving proper answer with technical justification.	
		Ability to calculate job material requirement.	Cannot calculate.	Can Partially calculate.	Can calculate easily.	Can calculate and confident about calculation.	
3	Job work skills Level – 15 marks	Follows the safety measures during job work.	Not follows.	Partially follows	Follows safety measures for human but not aware about work place safety.	Follows strictly safety measure and aware about all types of safety measures.	
		Preparation of job work	Not prepare or partially prepare.	Prepare but not as per size.	Prepare within tolerance limit, appearance is fair.	Prepare job within tolerance limit and excellent in appearance.	
		Submission of job work & report	not submit or partially submit.	Submit but not perfect.	Submit within time limit but cannot give answers about job operations.	Submit within time limit and can give Right Answer with technical justification	
4	Documentation and Presentation skill level – 10 marks	Appearance & Maintenance of Document.	Copied and Unmaintained file or document, submitting incomplete file	Complete file but Poor appearance with multiple correction, Submission after final date.	Timely submission & Prepared document with Partial Correction	Finely Prepared document or Presentation along with all data within time limit.	
		Answers the experiment related questions.	Cannot present.	Improper presentation.	Well present, can answer, cannot give perfect justification of answer.	Well present and giving answer with proper technical justification.	
						Total marks out of 50	
						SIGN OF BATCH TEACHER	

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	specification
1.	Welding power source rectifier	➢ AC input 220 volts, single phase, 50 Hz ➢ DC output 10-30 volt, 70-250Amp. ➢ Output wattage (1 to 5 kW).
2.	Portable Plate rolling machine	➢ Three high rolling machine with 0.5 meter length with max. Plate thickness capacity up to 10mm. ➢ 3-phase induction motor with 5kW capacity. ➢ Suitable reduction gear box.
3.	Gas cutting set	➢ Acetylene and oxygen gas cylinder. ➢ Pressure regulator and gas flow measuring device. ➢ Cutting torch with back fire arrester. ➢ Various nozzle tip set (2 to 6 mm).
4.	Hand grinder	➢ Disc Diameter 100 millimeter; 4 Inch ➢ machine with 670W brush motor ➢ Rated input power 660 W ➢ No-load speed 12,000 rpm ➢ dimensions (width) 77 mm ➢ Tool dimensions (length) 263 mm ➢ Tool dimensions (height) 95 mm ➢ Weight 1,5 kg
5.	Power hacksaw machine	➢ Cutting Blade Size 14 Inch ➢ Power Consumption HP ➢ Type Of Saw Hydraulic

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction (CO-1)	1a. List the factors affecting weldability. 1b. Explain importance of weldability.	1.1 Term fabrication 1.2 Need and scope of Fabrication technology 1.3 Weldability of materials 1.4 Term manufacturing and fabrication 1.5 List different code & standards (with full forms) used in fabrication & erection of equipment / piping. 1.6 Major national and international fabrication companies 1.7 Major national and international third party inspection agencies 1.8 General Designation used for various engineering items. ➢ Spiral wound gasket ➢ Vehicle Tyre ➢ Welding electrode and welding rods ➢ Piping ➢ Flanges ➢ Grinding wheels
Unit– II Drawing Interpretation (CO-2)	2a. Interpret manufacturing/ welding drawings. 2b. Prepare bill of materials, parts list and quantity. 2c. Explain procedure for weld edge preparation. 2d. Develop WPS, WPQ, WTP and SWP documents. 2e. Interpret different terms of code.	2.1 Types of drawing ➢ Process Plant General Arrangement Drawing (GAD) ➢ Process plant process and instrumentation drawing (P&ID) ➢ Process Flow Diagram (PFD) ➢ Detail and Assembly Drawing (D&AD) ➢ Route sheet OR Operation sheet ➢ Structural Detail drawing ➢ Shop Lay out drawing ➢ Equipment detail drawing ➢ Piping isometrics drawing ➢ Welding detail drawing 2.2 Fabrication documentation preparation from drawing ➢ Shop Weld Plan (SWP) ➢ Weld Test Plan (WTP) ➢ Welding Procedure Specification & Procedure Qualification Record (WPS/PQR) ➢ Welder Performance Qualification & Welder Qualification Record (WPQ/WQR) 2.3 Raw material requirement calculation from drawing ➢ Plate calculation ➢ Piping , tube and fittings calculation ➢ Nozzle (flange and pipe/tube) calculation ➢ Dish end plate blank dia. calculation ➢ Weld consumable requirement calculation

		➢ Structural items angle, I section, T section, C section, square solid/hollow bar, hexagonal solid/hollow bar, triangle solid/hollow bar calculation ➢ Lifting lug, support, impingement plate, reinforcement pad, dished end, limpet coil, tube sheet calculation ➢ Piping erection calculation in inch-meter and piping welding calculation in inch-dia. 2.4 Welding detailing preparation from drawing ➢ Weld Joint (WJ) nomenclature of groove and fillet weld ➢ Weld Edge preparation (WEP) nomenclature ➢ Weld joint (WJ) and WJ symbol ➢ Weld Edge preparation (WEP) and WEP symbol ➢ Weld Location of Elements and its symbol ➢ Weld pass and Weld Layers ➢ Welding position ➢ Welding technique (forward and backward) ➢ Welding electrode designation (SMAW and GTAW electrode) ➢ Welding weaving patterns 2.5 Introduction to Code and standards used for fabrication ➢ ASME section 2A, 2B, 2C, 2D, section 5, section 8 div.1, 8 div.2, 8 div.3, section-9. ➢ AWS vol. 1,2,3,4,5 ➢ ASTM, TEMA, EJMA, Piping standard B 31.1 and B31.3
Unit-III Fabrication Processes (CO-3)	3a. Use equipment/ machineries for edge preparation. 3b. Select preheating, post heating and PWHT method. 3c. Explain different methods of relieving thermal stresses. 3d. Set different arc welding parameters. 3e. Explain various fabrication procedures. 3f. Calculate Ovality, shell plate orientation and arc length. 3g. Identify fabrication stages for equipment to be fabricated.	3.1 Welding Process requirements ➢ Arc Welding parameters setting (Voltage, Current, welding speed, consumable feed and arc length) ➢ Gas welding parameters setting (gas pressure, gas flow, type of nozzle and optimized nozzle number) ➢ Preheating before starting welding ➢ Interpass during welding ➢ Post heating after welding ➢ Preheat, Interpass and post heat temperature measuring by thermal sticks ➢ PWHT for thermal stress relieving 3.2 Fabrication procedures ➢ Plate Edge bending for rolling ➢ Plate rolling ➢ Weld edge preparation ➢ Plate marking for shell, dished end, tube sheet, RF pad etc. ➢ Plate cutting by gas cutting and plasma cutting ➢ Shell alignment by string and laser technology ➢ Nozzle Orientation marking on shell ➢ Reference line marking on shell by dumpy level ➢ Ovality measurement of shell and it's rectification by spiders.

	3h. Describe safety norms to be followed during fabrication	➢ Profile checking by template (peak in / peak out) ➢ Circularity measurement by swing arm method. ➢ Offset rectification by wedge. ➢ Strip cladding and overlay ➢ Limpet coil marking on shell ➢ shell to shell /dish end Long seam setup ➢ shell to shell /dish end circ. seam setup ➢ method used to control thermal distortion ➢ dish end manufacturing technique 3.3 Fabrication steps for with equipment function, name of parts, ➢ pressure vessel / storage vessel ➢ shell and tube type heat exchanger ➢ piping spools / multi-tier piping arrangement ➢ industrial shed / electrical power transmission tower 3.4 safety norms for, ➢ work at heights ➢ before, during and after welding work ➢ PPEs for welding work ➢ work safety equipment
Unit-IV Inspection and Testing (CO-4)	4a. Distinguish weld defects and thermal distortion. 4b. Identify factors affecting weld quality. 4c. Explain testing and inspection procedures. 4d. Suggest process parameters for DT,NDT and special type of testing procedures.	4.1 general terms regarding weld quality ➢ weld quality ➢ Weld defects ➢ stages of inspection ➢ types of inspection ➢ types of testing ➢ difference between inspection and testing ➢ failure analysis 4.2 destructive testing (procedure as per ASTM / ASME sec. v and Acceptance criteria as per ASME sec. viii div.1) ➢ tensile testing ➢ compressive testing ➢ impact testing ➢ hardness testing ➢ weld bend testing ➢ fracture toughness testing 4.3 nondestructive testing (procedure as per ASTM / ASME sec. v and Acceptance criteria as per ASME sec. viii div.1) ➢ LPT ➢ MPT ➢ UT ➢ RT ➢ ECT 4.4 Special type of testing for equipment / piping operation ➢ Hydro test of pressure vessel ➢ Hydro test of piping spools ➢ Pneumatic test ➢ Helium Leak test 4.5 Running inspection methods ➢ visual inspection by eye contact

		➢ visual inspection by smell ➢ visual inspection by hand touch ➢ visual inspection by earing
Unit-V Surface preparation, Finishing and Coating Methods (CO-5)	5a. Explain surface preparation, finishing and coating methods. 5b.Measure thickness coating layers. 5c. suggest appropriate coating method for mechanical equipment.	5.1 Surface preparation methods ➢ sand blasting / ball blasting ➢ surface grinding 5.2 surface finishing methods ➢ emery papering ➢ wire brushing ➢ buffing wheel machining ➢ acetone / kerosene /petrol /diesel cleaning 5.3 surface color coating methods ➢ brush application ➢ roller application ➢ cotton application ➢ spray application 5.4 coating film thickness measurement techniques ➢ dry film thickness ➢ wet film thickness
Unit-VI Installation, erection and commissioning of process equipment (CO-6)	6a. Describe steps for erection, installation and commissioning of various fabricated equipment. 6b. Suggest steps for erection, installation and commissioning for given equipment.	6.1 term installation, erection and commissioning 6.2 difference between installation and erection 6.3 installation of centrifugal pump and valves at site 6.4 erection of vessel at site 6.5 erection and mechanical clearance of piping spools at site 6.6 commissioning of process plant

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	04	4	3	0	07
II	Drawing Interpretation	10	5	6	6	17
III	Fabrication processes	10	5	5	6	16
IV	Inspection and Testing	10	3	6	7	16
V	Surface preparation, Finishing and Coating Methods	04	1	4	2	07
VI	Installation, erection and commissioning of process equipment	04	2	3	2	07
Total		**42**	**20**	**27**	**23**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

MST SYLLABUS / MICRO PROJET CUM TOPIC DISTRIBUTION

DESCRIPTION	L1	L2	L3
MST-1 SYLLABUS (20 MARKS)	UNIT-1 (CO-1) & UNIT-2.1, 2.2 (CO-2)	UNIT- 3.1, 3.2 (CO-3)	UNIT- 4.1, 4.2 (CO-4)
MST-2 SYLLABUS (20 MARKS)	UNIT - 2.3, 2.4, 2.5 (CO-2)	UNIT-6 (CO-6) & UNIT-3.3, 3.4 (CO-3)	UNIT-5 (CO-5) & UNIT-4.3, 4.4, 4.5 (CO-4)
MICRO PROJECT (10 MARKS)	Student can prepare any such type of PPT PRESENTATION, ANIMATION VIDEO OF PROCESS EQUIPMENT, PREPARTION OF DEMONSTRATION CHARTS, SOLUTION OF INDUSTRY DEFINED PROBLEM, etc. assigned by Theory teacher.		

NOTEs :

1. **The Best of two MST result Marks, may be counted as Theory CA.**
2. **The MST exam can be conducted as descriptive paper, as MCQ paper with Physical OMR sheet, as MCQ quiz ONLINE google forms in any manner.**
3. **The MST syllabus / Micro project shown here is just as example, The institute is fully empowered to do changes, but the changes should be in term starting and the change instructions to be pass on students well in advance.**

10. SUGGESTED STUDENT ACTIVITIES

ENGINEERING QUIZ (OFFLINE / ONLINE / BLANDED MODE)

MCQ quiz from given fabrication drawing.

Physical copy of drawing and answering in Physical OMR sheet. (FULLY OFFLINE MODE)

OR

Online drawing and answering in Online google forms. (FULLY ONLINE MODE)

OR

Physical copy of drawing and answering in Online google forms. (BLANDED MODE)

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Introduction.	Lecture on fabrication technology and its uses.
II	Drawing Interpretation	Use drawings from various fabrication industries related to equipment fabrication, structural fabrication, piping isometrics etc. and explain to students, movies, industrial visits.
III	Fabrication processes	Use video/animations available on internet related to various fabrication processes, industrial visits, demonstration.
IV	Inspection and Testing	Use various inspection and testing related presentations from various websites, movies, actual demonstration, and industrial visits.
V	Surface preparation, Finishing and Coating Methods	Use charts and posters to show the surface preparation, finishing and coating activity, movies, industrial visits, demonstration.
VI	Installation, erection and commissioning of process equipment	Show operational manuals for installation, erecting and commissioning procedures for equipment and visit industry site where actual installation, erection and commissioning activities ongoing.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. The number of students in the group should ***not exceed three.***

The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

***PPT PRESENTATION** Prepare PPT on assigned topic by teacher AND Present on behalf of another Division/batch students/teachers.

***ANIMATION VIDEO OF PROCESS EQUIPMENT**

Prepare animation on assigned topic by teacher AND publish on department knowledge website / youtube channel.

***PREPARTION OF DEMONSTRATION CHARTS**

Prepare charts on assigned topic by teacher AND display in annual exhibition.

***INDUSTRY DEFINED PROBLEM**

Take any real industry problem related to fabrication and suggest probable solutions.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Welding technology	Khanna,O.P	Dhanpat Rai Publications, New Delhi
2	Welding engineering and technology	Parmar, R.S.	Khanna Publishers, New Delhi
3	Modern arc welding Technology	Nadkarni, S.V.	Advani oerlikon, Mumbai
4	Structural steel fabrication and erection	Saxena, S.K.; Asthana, R.B.	Somaiya Publishers, New Delhi
5	Metal cutting science and production technology	Jain, K.C.; Agrawal L.N.	Khanna Publishers, New Delhi
6	Manufacturing processes (Foundry, Forming and Welding)	Rao P.N.	Mc GRAW HILL
7	Metal Fabrication Technology	Shyamal Mukharjee	PHI
8	Fabrication processes	Sudhir Gadhi	Nexus Stories publication, Surat
9	Fabrication Technology at a glance	Sudhir Gadhi	Nexus Stories publication, Surat

14. SOFTWARE/LEARNING WEBSITES

i. https://www.engineering.osu.edu
ii. www.aws.org
iii. www.careersinwelding.com
iv. www.weldingalloys.com
v. www.adorweldingacademy.com
vi. www.themanufacturinginstitute.org
vii. www.asme.org
viii. www.weldingdesign.com
ix. www.engineeringtoolbox.com
x. www.asnt.org
xi. www.twi-global.com

Unit	Unit Title	LEARNING VIDEOs
I	Introduction.	Concept of weldability https://youtu.be/4UHqL7zxVQs?si=11Qzjfe1822rnnT_ types of electrode https://youtu.be/24UHx0dhv-Y?si=c_P7TvPzrYJ0ISvU PRESSURE VESSEL FABRICATION https://youtu.be/Xnje2Iq6sRI?si=Pt4WnIfZoWW7GFPz
II	Drawing Interpretation	READING OF PRESSURE VESSEL DRAWING https://youtu.be/-t2FYGaH5IQ?si=mgTwXi0iwOoi3A5W READING OF P & ID DRAWING https://youtu.be/2VLpV1dpUho?si=0OQJ2vtT6z2QNd8V READING OF P & ID DRAWING https://youtu.be/lBJnU1MJAts?si=i4kOFCOd8T9jLtnF READING OF PFD https://youtu.be/AIjl_eTWyFY?si=vHumHSL8yEyVFCll DIFFERENCE BETWEEN PFD AND P&ID https://youtu.be/xVQs3aAA1KY?si=0NpEhery8PS0ywEM DIFFERENT TYPE OF VALVES https://youtu.be/ZAB6LezNJJA?si=KJVNy8UVw2CqJ2wv
III	Fabrication processes	NOZZLE ORIENTATION MARKING ON SHELL https://youtu.be/fNahADYpItM?si=8hRHbF2ZSh_ysgIW NOZZLE SETUP ON DISH END https://youtu.be/xWOWsZvdHSc?si=ec8QTKlKpI9ig6zk NOZZLE SETUP ON PRESSURE VESSEL https://youtu.be/W1eohCV1kuM?si=rFb-MYqX4YwRLAYY LIMPET COIL MARKING https://youtu.be/KbhbyoWVyLk?si=Pcpu76kWLc5sbEs7 PLATE ROLLING https://youtu.be/50DfkV9Y4Dk?si=Hy098E82LfDdLfSh SHELL MAKING FROM PLATE https://youtu.be/r9d37h-xaaw?si=2M0SB6ZjgPI3Zo6g dish end manufaccturing https://youtu.be/xFjdnBKoXzI?si=t8wuW0uUirkHuCgj steel structure weight calculation https://youtu.be/yI_7B6XEu9o?si=GVPh0qXRL_6fuSg4
IV	Inspection and Testing	LPT https://youtu.be/bHTRmTQDZzg?si=E2MWlTxpKmlg_-hl MPT https://youtu.be/sfjK1GZ2W9A?si=_GS7tpM4VSjgc7nB UT https://youtu.be/0SK250WUuNs?si=BMgZXDaEL_esaMKL RT https://youtu.be/2RwV4AOmM4o?si=W2-Bj5b8RBpRe7_f Eddy current testing (ECT) https://youtu.be/3fnVjLjDCUw?si=c7xA8t2U8OqAPZU9 hydro test of heat exchager https://youtu.be/ph3oOGABIG4?si=cHqm7m8ZQRN7whz2 Helium leak testing https://youtu.be/3PLN0K_tTCk?si=QT0tIk572D7KCfCg
V	Surface preparation, Finishing	Sand blasting

	and Coating Methods	https://youtu.be/NBzNCB_HZlE?si=UA63Iw_4MTYeHyMQ surface preparation of vessel https://youtu.be/VMZXn2PHXaM?si=UMI2Ooa713i5Bk87 epoxy oating of structure https://youtube.com/shorts/IZQH-3N9bmI?si=8cqqj-2ybH6r70FF
VI	Installation, erection and commissioning of process equipment	Pressure vessel equipment erection https://youtu.be/bk0gygJR19E?si=QPbq1quR9_80RN0k Pressure vessel equipment erection https://youtu.be/zFB1-84Olfw?si=8Zwop-ZR8kjDFI8S erection of steel struccture https://youtu.be/PorCp4mslcI?si=QLE_K5lAsR7V8tkc erection of pumps https://youtu.be/CDj3HgPD5I8?si=U3n6oyB8JSy3HK9h https://youtu.be/uw0T1bp4MbQ?si=8xeaQsUoPWYNNqLK https://youtu.be/uw0T1bp4MbQ?si=W0hqkrwKKDN0MDU-

15. PO-COMPETENCY-CO MAPPING

Semester VI	FABRICATION TECHNOLOGY						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Plan, prepare engineering documents, implement and supervise equipment fabrication with reference to fabrication code – standards, using appropriate methods – procedures along with safety norms.						
CO-1 : Interpret term fabrication and weldability.	3	-	-	-	-	-	1
CO-2 : Calculate the material requirements on basis of drawing interpretation.	2	3	3	-	-	2	2
CO-3 : Apply suitable fabrication procedures for equipment manufacturing.	2	1	3	-	2	2	-
CO-4 : Suggest testing & inspection procedures for pre-during-after fabrication work.	3	2	-	3	2	1	2
CO-5: Select suitable surface finishing and coating method for fabricated equipment.	2	-	-	1	3	1	3
CO-6 : Plan process equipment erection & commissioning at site.	2	-	2	1	1	2	1

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO.

16. Suggested GTU External exam Question Paper format

MAIN QUE. NO.	SUB QUE. NO.	QUESTION	Marks	CO (Course Outcome)	Cognitive Level (As per Revised Bloom's Taxonomy)
Q.1	**(a)**	UNIT-1 INTRODUCTION	**03**	**CO-1**	**R/U/A**
પ્રશ્ન.1	**(**અ)		૦૩		
	(b)	UNIT-1 INTRODUCTION	**04**	**CO-1**	**R/U/A**
	(બ)		૦૪		
	(c)	MIXED QUESTION FROM UNIT-2. UNIT-3. UNIT-4	**07**	**CO-2,3,4**	**R/U/A**
	(ક)		૦૭		
		OR			
	(c)	MIXED QUESTION FROM UNIT-2. UNIT-3. UNIT-4	**07**	**CO-2,3,4**	**R/U/A**
	(ક)		૦૭		
Q.2	**(a)**	UNIT-2 DRAWING INTERPRETATION	**03**	**CO-2**	**R/U/A**
પ્રશ્ન.2	(**અ)**		**૦૩**		
	(b)	UNIT-2 DRAWING INTERPRETATION	**04**	**CO-2**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-2 DRAWING INTERPRETATION	**07**	**CO-2**	**R/U/A**
	(ક)		૦૭		
		OR			
Q.2	**(a)**	UNIT-2 DRAWING INTERPRETATION	**03**	**CO-2**	**R/U/A**
પ્રશ્ન.**2**	**(**અ)		૦૩		
	(b)	UNIT-2 DRAWING INTERPRETATION	**04**	**CO-2**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-2 DRAWING INTERPRETATION	**07**	**CO-2**	**R/U/A**
	(ક)		૦૭		
Q. 3	**(a)**	UNIT-3 FABRICATION PROCESSES	**03**	**CO-3**	**R/U/A**
પ્રશ્ન.**3**	**(**અ)		૦૩		
	(b)	UNIT-3 FABRICATION PROCESSES	**04**	**CO-3**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-3 FABRICATION PROCESSES	**07**	**CO-3**	**R/U/A**
	(ક)		૦૭		
		OR			
Q. 3	**(a)**	UNIT-3 FABRICATION PROCESSES	**03**	**CO-3**	**R/U/A**
પ્રશ્ન.**3**	**(**અ)		૦૩		
	(b)	UNIT-3 FABRICATION PROCESSES	**04**	**CO-3**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-3 FABRICATION PROCESSES	**07**	**CO-3**	**R/U/A**
	(ક)		૦૭		

Q. 4	**(a)**	UNIT-4 INSPECTION AND TESTING	**03**	**CO-4**	**R/U/A**
પ્રશ્ન.4	(અ)		૦૩		
	(b)	UNIT-4 INSPECTION AND TESTING	**04**	**CO-4**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-4 INSPECTION AND TESTING	**07**	**CO-4**	**R/U/A**
	(ક)		૦૭		
		OR			
Q. 4	**(a)**	UNIT-4 INSPECTION AND TESTING	**03**	**CO-4**	**R/U/A**
પ્રશ્ન.4	(અ)		૦૩		
	(b)	UNIT-4 INSPECTION AND TESTING	**04**	**CO-4**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-4 INSPECTION AND TESTING	**07**	**CO-4**	**R/U/A**
	(ક)		૦૭		
Q.5	**(a)**	UNIT-5 SURFACE PREPARATION, FINISHING, COATING	**03**	**CO-5**	**R/U/A**
પ્રશ્ન.5	(અ)		૦૩		
	(b)	UNIT-5 SURFACE PREPARATION, FINISHING, COATING	**04**	**CO-5**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-6 INSTALLATION, ERECTION, COMISSIONING	**07**	**CO-6**	**R/U/A**
	(ક)		૦૭		
		OR			
Q.5	**(a)**	UNIT-6 INSTALLATION, ERECTION, COMISSIONING	**03**	**CO-6**	**R/U/A**
પ્રશ્ન.5	(અ)		૦૩		
	(b)	UNIT-6 INSTALLATION, ERECTION, COMISSIONING	**04**	**CO-5**	**R/U/A**
	(બ)		૦૪		
	(c)	UNIT-5 SURFACE PREPARATION, FINISHING, COATING	**07**	**CO-5**	**R/U/A**
	(ક)		૦૭		

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
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18. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-VI
Course Title: THERMAL SYSTEM AND ENERGY EFFICIENCY
(Course Code: 4361908)

Diploma programmer in which this course is offered	Semester in which offered
MECHANICAL ENGINEERING	6th Semester

1. RATIONALE

Thermal systems play a pivotal role in the industrial sector, and their effective operation and maintenance are crucial for achieving economic energy use and environmental conservation. Without proper oversight, managing energy efficiently while minimizing environmental impact becomes challenging. This course is designed to impart foundational knowledge and skills related to the principles, types, and functioning of thermal systems, including boilers, heat exchangers, furnaces, HVAC, and other high-energy consumption devices. By studying this course, students will gain insights enabling them to make informed decisions about the design and specifications of these energy-intensive devices. This, in turn, contributes to energy savings, resulting in lower production costs and reduced environmental impact. Consequently, this course serves as a cornerstone for aspiring thermal engineers.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Operate and maintain thermal systems for energy efficiency**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

CO1	Acquire the concept of energy conservation and improve efficiencies of various thermal systems.
CO2	Suggest remedies to improve boiler efficiency after computing the boiler performance and analyzing the effect of parameters
CO3	Evaluate the performance of various furnaces by adopting energy efficiency measures
CO4	Determine the performance of heat exchangers and air compressors based on operating conditions
CO5	Assessment of Energy Performance of HVAC systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)					
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE(Th)	CA(Th)	CA(Pr)	ESE(Pr)	
03	00	02	04	70	30	25	25	150

5. SUGGESTED PRACTICAL EXERCISES:

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: *Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes related to affective domain****. Thus over all development of* ***Programme Outcomes (as given in a common list at the beginning of curriculum document for this programme****) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical Exercises (PrOs)	Approx Hours. required
1	I	**Preparatory activity:** a. Visit laboratory/ workshop and identify various thermal systems such as heat exchangers, boilers, furnaces, air compressors, pump, motors, etc. Write down technical specifications of the same along with manufactures. b. Compare price of various fuels on common parameter. c. Interpret terms and equations of data sheets provided with the curriculum.	04
2	II	**Case study of Boiler (based on real life example):** a. Calculate losses in the **boiler** using given data by direct and indirect method. b. Prepare sankey diagram. c. Prepare heat balance sheet. d. List various instrumentation required to measure the required	06

3	III	**Case study of Furnace (based on real life example):** a. Calculate losses in the **furnace** using given data by direct and indirect method. b. Prepare sankey diagram. c. Prepare heat balance sheet. d. List various instrumentation required to measure the required	04
4	IV	**Case study of Heat Exchangers (based on real life example):** a. Calculate efficiency and over all heat transfer coefficient of **heat exchanger** based on given data. Use LMTD methods. b. List various instrumentation required to measure the required data. **OR** a. Write technical specifications of any **heat exchanger** available in vicinity. b. Determine its performance based on the technical data available. Tabulate the observation. c. List the parameters which lead to energy losses in heat exchangers. Also show the effect of such parameters. d. Recommend your suggestions for energy saving in heat exchangers.	04
5	V	**Case study of Air Conditioning (based on real life example):** a. Calculate **air conditioning** load of given class room or laboratory (Class teacher need to give values related to calculation such as U, TETD, shading coefficient, Allowance for lighting, SHGF, standard electric equipment load, etc. required data - Refer BEE guide books if necessary) b. List various instrumentation required to measure the required data.	06
6	V	**Case study of Refrigerator (based on real life example):** a. Calculate load of domestic **refrigerator /other suitable refrigeration equipment**. Use standard data sheets.(Class teacher need to provide necessary data to students for the calculation- Refer BEE guide books if necessary) b. Calculate Fan / Blower Efficiency	04

Notes:

a. It is compulsory to provide real life data for calculation purpose to students. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.
b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc..

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1)		
1	Knowledge	30
2	Quality of Report	20
3	Observation Skills	15
4	Participation	15
5	Punctuality	20
Total		100

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 2, 3, 4, 5, 6, 7)		
1	Knowledge	20
2	Quality of Report	15
3	Observation Skills	15
4	Analysis	20
5	Participation	15
6	Punctuality	15
Total		100

Sample Rubrics Performance Indicators for the PrOs

For all PrOs					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	**For all**	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	**For all**	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tabl es, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Observation Skill	**For all**	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise.	Participation is minimum

Participation	**For all**	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	**For all**	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.
Analysis	**For all**	Student understand the data and analyze correctly the obtained test results.	Student understand most of the data and analyze the obtained test results with help or support.	Student need help to understand some of the data and also in analyzing the obtained test results.	Student always need help to understand the data and also in analyzing the obtained test results.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	Boilers/ furnaces/ air compressor system/ heat exchangers/ HVAC/ Refrigeration, Pump, Motors, Lighting, etc. available within institute OR nearby area and industries	1 to 6

7. AFFECTIVE DOMAIN OUTCOMES

Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of ***Course Outcomes related to affective domain****. Thus over all development of* ***Programme Outcomes (as given in a common list at the beginning of curriculum document for this programme****) would be assured.*

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.
b. Follow safety practices.
c. Follow ethical practices.
d. Maintain tools and equipment.
e. Practice environment-friendly methods and processes. (Environment related)

8. UNDERPINNING THEORY: (Refer attached data sheet also. Data sheet is allowed for students in examination hall).

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Major Unit Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. **Basic Concepts of Energy Conservations and Thermal Systems**	1a. Importance of Energy Conservation 1b. Explain Energy conservation in Domestic appliances 1c. Describe basic concepts of energy savings in various thermal systems 1d. Role of Energy Audit	1.1 Energy conservation and its importance. 1.2 Energy Conservation in Domestic Applications: - Refrigerator & Air-Conditioning - Water heater (Electric/Gas), Pressure Cooker - Light & Fan - Washing machine, Oven, Television 1.3 Introduction to Energy Conservation Act 2001 and schemes of Bureau of Energy Efficiency under EA-2001. 1.4 Introduction of energy efficiency in various thermal systems such as steam generation, heat exchanger, HVAC (Heating, Ventilating and Air Conditioning), refrigeration system, air compressor, pumps, etc. 1.5 Introduction to energy audit and walk through audit for energy.
Unit – II. **Steam Generation & Steam Distribution System**	2a. Determine performance of boilers by direct and indirect method. 2b. Analyze effect of energy efficiency parameters on performance of boiler. 2c. Describe energy saving measures in steam distribution system.	2.1 Performance evaluation of typical boiler system (Attached data sheet is allowed in exams): i. Indirect method. ii. Direct method. 2.2 Energy efficiency measures in boiler system. 2.3 Introduction and understanding of steam distribution system. 2.4 Steam traps-working principal, operation and need of: i. Float and thermostatic. ii. Thermodynamic. iii. Inverted bucket. iv. Thermostatic with thermal element (Bellow or bi-metallic strip). 2.5 Energy saving in steam distribution systems.

Unit – III **Furnaces**	3a. Describe concept of furnaces. 3b. Determine the performance of heat treatment furnaces. 3c. Derive energy efficiency parameters.	3.1 General structure of furnace, working of general furnace and its applications. 3.2 Factors affecting furnace efficiency. 3.3 Performance evaluation of typical heat treatment furnace system (Attached data sheets are allowed in exams). i. Indirect method. ii. Direct Method. 3.4 General fuel economy/ Energy efficiency measures in furnace systems.
Unit – IV **Heat Exchangers and Air Compressor.**	4a. Concept of LMTD in Heat Exchanger 4b. Determine performance of Heat exchangers 4c. Describe energy saving measures in Heat exchangers & air compressor.	4.1 Energy savings measures in general in a heat exchanger 4.2 Concept of LMTD and its calculation without derivation for parallel and cross flow type heat exchangers. 4.3 Performance evaluation of heat exchangers based on LMTD (Attached data sheets are allowed in exams). ~~4.4~~ Air compressor: Understanding of free air delivery and energy saving measures in compressed air system 4.5 Field testing of compressor by nozzle and by pump up method (Attached data sheets are allowed in exams).
Unit – V **HVAC systems.**	5a. Use concept of HVAC and refrigeration system. 5b. Assessment of Energy Performance of HVAC System	5.1 Concept of HVAC and refrigeration system. 5.2 Energy Performance assessment of HVAC System - Concept of Tons of refrigeration (TR), Net Refrigerating Capacity, kW/ton rating, Coefficient of Performance (COP), Energy Efficiency Ratio (EER) - Calculations of COP, EER & kW/Ton - Heat load evaluation based on enthalpy difference by using psychrometric chart. Simple Numerical on it. 5.3 Simple Load calculation for

		refrigeration/ air conditioning systems such as class room or laboratory or conference/seminar hall, etc. to understand the methods and procedure with the help of data sheet. 5.4 Energy efficiency measures in refrigeration/ air conditioning systems. 5.5 Energy Performance Assessment of Fans and Blowers - Determination of Fan Pressure, Power Input & Fan Efficiency - Factors affecting the Performance of Fans/Blowers

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN: NA

Table for details of hours distribution is as follows for the given units.

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic Concepts of Energy Conservations and Thermal Systems.	08	04	04	02	10
II	Steam Generation & Steam Distribution	10	02	05	11	18
III	Furnaces.	06	02	02	06	10
IV	Heat Exchangers and Air Compressors.	08	02	03	09	14
V	HVAC systems.	10	04	04	10	18
	Total	42	14	18	38	70

Legends: R = Remember U= Understand; A= Apply and above levels (Bloom's revised taxonomy).

Notes:

a. This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.
b. Duration of End Semester Examination (Theory) is 3 hours.
c. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.
d. Use of enclosed data sheets are to be allowed to student during examination (They should be provided by the examining agency).

10. SUGGESTED STUDENT ACTIVITIES:

Sr. No.	Unit	Unit Name	Activities and Strategies
1	I	Basic Concepts of Energy Conservations and Thermal Systems.	Demonstration of systems, movies, industrial visits, on-hand practice on available thermal systems.
2	II	Steam Generation & Steam Distribution	Standard data of boiler room and other auxiliaries from real life example, Industrial visits, movies.
3	III	Furnaces.	Standard data of furnace room and other auxiliaries from real life example, Industrial visits, movies.
4	IV	Heat exchangers and air compressors.	Standard data of any heat exchanger from thermal plant and air compressor room as well as air compressor system, Industrial visits, and movies.
5	V	HVAC systems.	Standard data of load calculation to compare with the calculated load calculations, industrial visits, demonstration of plants having HVAC systems.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Walk through audits must be carried out with understanding and knowledge sharing where expert in the field can be invited who have degree of energy manager or energy auditor or other field experts.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. The number of students in the group should not exceed five. Each student must maintain a dated work diary (Logbook) consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **4-5** ***(four to five) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

Walk through audit for thermal equipments available in thermal laboratory or walk through audit of mechanical department including class rooms and laboratories or conference/seminar hall of the institute.

(Students should understand basics of audit and prepare report related to actual observations. They must suggest measures for energy conservation based on the audit carried out in the department.)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	A Text book of Thermal	R S Khurmi& J.K. Gupta	S Chand & Co.
2.	Refrigeration and air conditioning	Arora & Domkundwar	Khanna publication

3.	Guide book for NCE for EM & EA (Vol I to IV)	--	Bureau of Energy Efficiency
4.	The Efficient Use of Energy	The Rt Hon Tony Benn, MP	BSI, 2 Park street, London

14. SOFTWARE/LEARNING WEBSITES

a. http://nptel.ac.in/courses/112101005/downloads/Module_4_Lecture_7_final.p df
b. http://btech.mit.asia/downloads/svlomte/HT2011.pdf
c. http://powermin.nic.in/acts_notification/pdf/ecact2001.pdf
d. www.energymanagertraining.com (register for free guide book downloads)
e. http://www.ureda.uk.gov.in/upload/downloads/Download-7.pdf
f. http://www.fao.org/docrep/t0269e/t0269e05.htm
g. http://energy.gov/eere/government-energy-management
h. http://www.sari

15. PO-COMPETENCY-CO MAPPING:

Semester VI	**Mechanical Engineering TS&EE (Course Code:4361908)**						
	POs						
Competency & Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
	Basic & Discipline specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	**Identify various energy sources availability; analyze performance of boiler, furnace, heat exchanger and compressor. Calculate variety of refrigeration and air-conditioning loads.**						
CO1- Acquire the concept of energy conservation and improve efficiencies of various thermal systems.	2	-	-	-		-	2
CO2- Suggest remedies to improve boiler efficiency after computing the boiler performance and	2	3	2	1	2	-	2

analyzing the effect of parameters							
CO3- Evaluate the performance of various furnaces by adopting energy efficiency measures	2	3	2	1	2	-	2
CO4- Determine the performance of heat exchangers and air compressors based on operating conditions	2	3	2	1	2	-	2
CO5- Assessment of Energy Performance of HVAC systems	2	3	2	-	2	-	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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17. BOS Resource Persons

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3.	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

THERMAL SYSTEMS AND ENERGY EFFICIENCY

(Code: 4361908)

[Allowed in examination hall]

Diploma Programme in which this course is offere	Semester in which offered
Mechanical Engineering	6th Semester

DATA SHEET IS ALLOWED IN EXAMINATIONS:

1. **BOILERS:**

Direct method:

$$Boiler\ Efficiency(\eta) = (Heat\ output / Heat\ input) \times 100$$

$$Boiler\ Efficiency(\eta) = \frac{M \times (h_g - h_f)}{mf \times GCV} \times 100$$

where, M = Quantity of steam generated per hour in kg/ hr
mf = Quantity of fuel used per hour in kg/ hr
GCV = Gross calorific value of fuel (kCal/ kg of fuel)
h_g = Enthalpy of saturated steam in kCal/ kg of steam
h_f = Enthalpy of feed water in kCal/ kg of water
Temperatures are in degree centigrade and pressure in kg/ cm^2

Indirect Method:

Conversion of proximate analysis into ultimate analysis,

$$\%C = 0.97C + 0.7(VM + 0.1A) - M(0.6 - 0.01M)$$
$$\%H = 0.036C + 0.086(VM - 0.1A) - 0.0035M^2(1 - 0.02M)$$
$$\%N_2 = 2.10 - 0.020VM$$

Where, %C = % of fixed carbon
A = % of ash
VM = % of volatile matter
M = % of moisture in general notations.

Theoretical air required for combustion:

$$\text{Theoretical air required for combustion} = [11.6\text{C} + \{34.8(\text{H}_2 - \frac{O_2}{8})\} + 4.35S]/100\ kg/kg\ of\ fuel$$

$$\%Excess\ air\ supplied\ (EA) = \frac{O_2\%}{21 - O_2\%} \times 100 = \frac{7900[(CO_2\%)_t - (CO_2\%)_a}{(CO_2\%)_a[100 - (CO_2\%)_t]} \rightarrow From\ flue\ gas\ analysis$$

$$(CO_2\%)_t = Theoretical\ CO_2 = \frac{Moles\ of\ C}{Moles\ of\ N_2 + Moles\ of\ C}$$

$$(CO_2\%)_a = Actual\ CO_2\%\ measured\ in\ flue\ gas$$

$$Moles\ of\ N_2 = \frac{Wt\ of\ N_2\ in\ theoretical\ air}{Mol.wt\ of\ N_2} + \frac{Wt\ of\ N_2\ in\ fuel}{Mol.wt\ of\ N_2}$$

$$Moles\ of\ C = \frac{Wt\ of\ C\ in\ fuel}{Molecular\ Wt\ of\ C}$$

$$Actual\ mass\ of\ air\ supplied\ /\ kg\ of\ fuel\ (AAS) = [1 + \frac{EA}{100}] \times theoretical\ air$$

$$Total\ mass\ of\ dry\ flue\ gas = (C \times \frac{44}{12}) + (AAS \times \frac{77}{100}) + [(AAS - Theoretical\ Air) \times \frac{23}{100}] + (S \times \frac{64}{32}) + N_2$$

OR $\text{Total mass of dry flue gas} = \text{Total AAS} + 1$

$$\%Loss\ due\ to\ dry\ flue\ gas = L_1 = \frac{m_d \times Cp \times (T_f - T_a)}{GCV\ of\ fuel} \times 100$$

Cp=0.23 kCal/kg Degree C

Where, m_d = Mass of dry flue gas in kg/ kg of fuel
= Combustion product from fuel: CO_2+SO_2+N_2 in fuel+N_2 in actual mass of air supplied+O_2 in flue gas(H_2O/water vapour in the flue gas should not be considered)
Cp = Specific heat of flue gas in kCal/ kg degree C
Tf = Flue gas temperature in degree C
Ta = Ambient temperature in degree C

$$\%Heat\ loss\ due\ to\ evaporation\ of\ water\ formed\ due\ to\ H_2\ in\ fuel = L_2 = \frac{9H_2[584 + Cp(T_f - T_a)]}{GCV\ of\ fuel} \times 100$$

Cp=0.45 kCal/kg Degree C

$$\%Heat\ loss\ due\ to\ moisture\ present\ in\ fuel = L_3 = \frac{M[584 + Cp(T_f - T_a)]}{GCV\ of\ fuel} \times 100$$

$$\%Heat\ loss\ due\ to\ moisture\ present\ in\ air = L_4 = \frac{AAS \times Humidity\ factor \times Cp(T_f - T_a) \times 100}{GCV\ of\ fuel}$$

where (for L_3 to L_4), H_2 = kg of hydrogen present in fuel on 1 kg basis
Cp = Specific heat of superheated steam in kCal/ kg degree C
T_f = Flue gas temperature in C
T_a = Ambient temperature in C
584 = Latent heat corresponding to partial pressure of water vapour
M = kg moisture in fuel on 1 kg basis
AAS = Actual mass of air supplied per kg of fuel
Humidity factor = kg of water/ kg of dry air

DBT (Degree C)	WBT degree C	Relative Humidity	Kg water per kg of dry air(Humidity Factor)
20	20	100	0.016
20	14	50	0.008
30	22	50	0.014
40	30	50	0.024

$$\%Heat\ loss\ due\ to\ incomplete\ combustion = L_5 = \frac{\%CO \times C}{\%CO + \%CO_2} \times \frac{5744}{GCV\ of\ fuel} \times 100$$

Where, L5 = %Heat loss due to partial conversion of C to CO
CO = Volume of CO in flue gas leaving economiser %
CO_2 = Actual volume of CO_2 in flue gas%
C = Carbon content kg/ kg of fuel

OR

When CO is obtained in ppm during the flue gas analysis
CO formation(Mco) = CO(in ppm)*M_f*28*10^{-6}
M_f = Fuel consumption in kg/ hr
L_5 = Mco*5744

$$\%Heat\ loss\ due\ to\ radiation\ \&\ convection = L_6 = 0.548[(\frac{T_s}{55.55})^4 - (\frac{T_a}{55.55})^4]$$
$$+[1.957 \times (T_s - T_a)^{1.25} \times \sqrt{[\frac{(196.85V_m + 68.9)}{68.9}]}$$

Where, L_6 = Radiation loss in W/m^2
V_m = Wind velocity in m/s
T_s = Surface tmperature (K)
T_a = Ambient temperature (K)

$$\%Heat\ loss\ due\ to\ unburnt\ in\ fly\ ash = L_7 = \frac{Total\ fly\ ash\ collected\ per\ kg\ of\ fuel\ burnt \times GCV\ of\ fly\ ash \times 100}{GCV\ of\ fuel}$$

$$\%Heat\ loss\ due\ to\ unburnt\ in\ bottom\ ash = L_8 = \frac{Total\ bottom\ ash\ collected\ per\ kg\ of\ fuel\ burnt \times GCV\ of\ bottom\ ash \times 100}{GCV\ of\ fuel}$$

Boiler Efficiency in % η = 100 -(Addition of %L_1 to %L_8)

2. Furnace:

Specific energy consumption = Quantity of fuel or energy consumed/ quantity of material processed.

Direct Method:

$$Thermal\ efficiency of\ furnace = \frac{\text{Heat in stock (material) in kCal}}{\text{Heat in fuel in kCal}} \times 100$$

$$Heat\ imparted\ to\ stock\ Q = mCp(t_2 - t_1)$$

Where, Q = Quantity of heat in kCal

m = Mass of material in kg

Cp = Mean Specific Heat in kCal/ kg degree C

t_2 = Final temperature desired in degree C

t_1 = Initial temperature of the charge before it enters the furnace in degree C

Indirect Method:

Calculation of air quantity and specific fuel consumption:

$$\text{Theoretical air required for combustion} = [11.6C + \{34.8(H_2 - \frac{O_2}{8})\} + 4.35S]/100\ kg/kg\ of\ fuel$$

$$Excess\ air\ supplied\ (EA) = \frac{O_2\%}{21 - O_2\%} \times 100$$

$$Actual\ mass\ of\ air\ supplied\ /\ kg\ of\ fuel\ (AAS) = [1 + \frac{EA}{100}] \times theoretical\ air$$

$$Total\ mass\ of\ dry\ flue\ gas = Mass\ of\ C + Mass\ of\ N_2\ in\ fuel + Mass\ of\ SO_2 + Mass\ of\ N_2\ in\ Combustion\ air\ supplied + Mass\ of\ O_2\ in\ flue\ gas$$

or

$$= (C \times \frac{44}{12}) + (AAS \times \frac{77}{100}) + [(AAS - Theoretical\ Air) \times \frac{23}{100}] + (S \times \frac{64}{32}) + N_2$$

$$OR\ \ Total\ mass\ of\ dry\ flue\ gas = Total\ AAS + 1$$

Above values can be taken from proximate or ultimate analysis of fuel.

Specific fuel consumption(F) = Amount of fuel consumed in kg per hour/ amount of billet in tonne per hour

Heat input calculation for furnace heat balance sheet (one tonne basis):

Heat Input = Combustion heat of fuel Q_1+ Sensible heat of fuel Q_2

= (fuel consumption per tonne of billet*GCV)+ (fuel consumption per tonneof billet*Cp of fuel*Temperature difference of flue gas to atmosphere)

= $Q_1 + Q_2$inkCal per tonne of billet.

Heat out to furnace calculation for heat balance sheet (on one tonne basis):

$$Heat\ carried\ away\ by\ 1 tonne\ of\ billet = Q_3 = 1000 kg/tonne \times Cp(T_o - T_i)$$

Where, To = Temperature of billet at outlet of furnace in degree C

Ti = Temperature of atmosphere at outlet

Cp = Specific heat of billets in lCal/ kg/degree C

Sensible heat loss in flue gases:

$$Heat\ loss\ in\ flue\ gas = Q_4 = Sensible\ heat\ loss = m \times Cp_{fg} \times (T_1 - T_a)$$

Where, m = Amount of fuel consumped per tonne of billet in kg/ tonne of billet.

C_{pg} = Specific heat of flue gas ~ 0.24 kCal/ kg/degree C

T_1 = Temperature of flue gas in degree C

Ta = Temperature of atmosphere at base in degree C

Assumption: 1 kg of oil require 14 kg of air to burn fully.

$$Heat\ loss\ due\ to\ formation\ of\ water\ formed\ due\ in\ fuel = Q_5 = \frac{F \times (M + 9H_2)[584 + Cp_{\sup.heat\ wat}(T_1 - T_a)]}{GCV\ of\ fuel} \times 100$$

Where, $Cp_{super\ heated\ water}$ = Specific heat of superheated water vapour in kCal/ kg/degree C

$$Heat\ loss\ due\ to\ moisture\ in\ combustion\ air = Q_6 = F \times AAS \times Humidity\ of\ air \times Cp_{\sup\ heat\ wat}(T_1 - T_a)$$

$$Heat\ loss\ due\ to\ partial\ combustion\ of\ \ to\ CO = Q_7 = \frac{F \times \%CO \times C}{\%CO + \%CO_2} \times 5654$$

Amount of heat loss from furnace body and other sections Q_7

= heat loss from furnace body ceiling q1 + heat loss from furnace side wall q2+ bottom q3 +heat loss from flue gas duct between furnace exit and air pre heater q4

$$q1 = (h \times \Delta T^{1.25} \times A_i) + (4.88 \times \varepsilon \times [(\frac{T_w}{100})^4 - (\frac{T_a}{100})^4] \times A_i)$$

Where,
- h = Natural convective heat transfer rate for ceiling in kCal/ m^2 h degree C
- Tw = External temperature of ceiling in degree C
- Ta = Room temperature in degree C
- Δt = Tw- Ta
- Ai = Ceiling surface area in m^2
- ε = emissivity of furnace body surface

$$q2 = (h \times \Delta T^{1.25} \times A_i) + (4.88 \times \varepsilon \times [(\frac{T_w}{100})^4 - (\frac{T_a}{100})^4] \times A_i)$$

Where,
- h = Natural convective heat transfer rate for side wall in kCal/ m^2 h degree C
- Tw = External temperature of side wall in degree C
- Ta = Room temperature in degree C
- Δt = Tw- Ta
- Ai = side wall surface area in m^2
- ε = emissivity of furnace body surface

q3 = Bottom: But as bottom surface area is not exposed to the atmosphere, here it is ignored.

$$q4 = (h \times \frac{\Delta T}{D^{1.25}}^{1.25} \times A_i) + (4.88 \times \varepsilon \times [(\frac{T_w}{100})^4 - (\frac{T_a}{100})^4] \times A_i)$$

Where, h = Natural convective heat transfer rate for duct in kCal/ m^2 h degree C
Tw = External temperature of flue gas duct in degree C
Ta = Room temperature in degree C
Δt = Tw- Ta
Ai = external flue gas duct in m^2
ε = emissivity of furnace body surface
D = Outside diameter of flue gas duct

Q_8 = q1+ q2+ q3+ q4 kCal per hour/ Amount of billet (t/ hr)

$$Radiation\,heat\,loss\,through\ furnace\,opening = Q_9 = hr \times A \times \varphi \times 4.88[(\frac{T_f}{100})^4 - (\frac{T_0}{100})^4]/t$$

Where, hr = Open time during the period of heat balancing
Tf = Furnace temperature in degree C
To = base temperature in degree C
A = Area of opening in m^2
φ = Co efficient based on the profile of the furnace opening
= Dia. of shortest side/ wall thickness
t = Amount of billet in ton/ hour

Q10 = Other types of unaccounted heat losses like heat carried away by the cooling water in flue damper and furnace excess door, Radiation from furnace bottom, Heat accumulated by refractory, Instrumental error or any other errors etc.

$Q_{heat\ balance}$: (Q_1+Q_2) = $(Q_3+Q_4+Q_5+Q_6+Q_7+Q_8+Q_9+Q_{10})$

3. Heat Exchanger

Over all heat transfer co efficient:

$$Q = UA \times LMTD$$

Where, Q = Heat transfer in kCal/ hr
U = Overall heat transfer co efficient in kCal/ hr/ m^2/ degree C
A = Heat transfer area in m2
LMTD = Logarithmic Mean Temperature difference in degree C

$$\varepsilon = Heat\ exchanger\ effectiveness = \frac{Actual\ heat\ transfer\ rate\ in\ kCal/hr}{Max.\ possible\ heat\ transfer\ rate\ in\ kCal/hr} = \frac{Q}{Q_{\max}} = \frac{Q}{C_{\min} \times \Delta T_{\max}}$$

Where, Cmin = Lower of two fluid heat capacities in kCal/ hr degree C
ΔTmax = Max. temp. difference from terminal stream temperature. in degree C

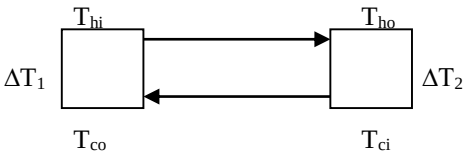
$$Heat\ duty\ of\ hot\ fluid = Q_h = W \times C_{ph} \times (T_{hi} - T_{ho})$$
$$Heat\ duty\ of\ cold\ fluid = Q_c = w \times C_{pc} \times (T_{co} - T_{ci})$$

Where, C_{ph}&C_{pc} = Specific heat of hot and cold fluid respectively in kCal/ kg Degree K
$T_{hi/\ ho}$&$T_{co/ci}$ = Temperature at inlet (i) and outlet (o) of hot and cold fluids respectively in degree C
W, w = Hot and cold fluid flow respectively.

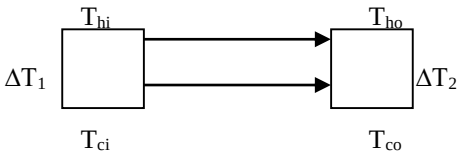
$$\text{Heat duty of heat exchanger } Q = \text{Sensible heat } q_s + \text{Latent heat } q_l$$
$$q_s = W \times C_{ph} \times (T_{hi} - T_{ho}) / 3600 = w \times C_{pc} \times (T_{co} - T_{ci}) / 3600 \ldots\ldots in\ kW$$
$$q_l = W \times \lambda_h / 3600 = w \times \lambda_c / 3600 \ldots. in\ kW$$

Where, λ_h&λ_c = Latent heat of condensation for hot fluid and latent heat of vaporization for cold fluid in kJ/ kg

$$\text{Hot fluid pressure drop} = \Delta P_h = P_i - P_o$$
$$\text{Hot fluid temperature range} = \Delta T_h = T_{hi} - T_{ho}$$
$$\text{Cold fluid pressure drop} = \Delta P_c = P_i - P_o$$
$$\text{Cold fluid temperature range} = \Delta T_c = T_{co} - T_{ci}$$



Counter flow heat exchanger



Parallel flow heat exchanger

$$LMTD \text{ for counter flow} = \frac{(T_{hi} - T_{co}) - (T_{ho} - T_{ci})}{\ln[(T_{hi} - T_{co})/(T_{ho} - T_{ci})]}$$
$$LMTD \text{ for parallel flow} = \frac{(T_{hi} - T_{ci}) - (T_{ho} - T_{co})}{\ln[(T_{hi} - T_{ci})/(T_{ho} - T_{co})]}$$

LMTD correction factor F: (where two dimensionless numbers R and S are to be used as below)

$$R = \frac{T_a - T_b}{t_b - t_a} \qquad P = \frac{t_b - t_a}{T_a - t_a}$$

Where, T_a&T_b = Inlet and outlet temperature of shell side fluid
t_a&t_b = Inlet and outlet temperature of tube side fluid

For R≠1, compute as following:

$$\alpha = \left[\frac{1 - RP}{1 - P}\right]^{\frac{1}{N}} \quad \& \quad S = \frac{\alpha - 1}{\alpha - R} \quad \& \quad F = \frac{\sqrt{R^2 + 1}\ln\left(\frac{1 - RS}{1 - S}\right)}{(1 - R)\ln\left[\frac{2 - S(R + 1 - \sqrt{R^2 + 1})}{2 - S(R + 1 + \sqrt{R^2 + 1})}\right]}$$

For R=1, compute as following:

$$S = \frac{P}{N-(N-1)P} \quad \& \quad F = \frac{S\sqrt{2}}{(1-S)\ln\left[\frac{2-S(2-\sqrt{2})}{2-S(2+\sqrt{2})}\right]}$$

Where, N = No of shell side passes
S & α = Parameters used to calculate LMTD correction factors

Corrected LMTD	=	F*LMTD
Overall heat transfer co efficient U	=	Q / (A* Corrected LMTD)

4. Air Compressor and free air delivery:

Load unload test of compressor for compressed air system leakage:

$$\%Leakage = \frac{Time\ for load in \min utes}{Time\ for load + Time\ for unload in \min utes} \times 100$$

$$System\ leakage\ quantity = \frac{Time\ for load in \min utes}{Time\ for load + Time\ for unload in \min utes} \times Comp.capacity\ in\ m^3/\min$$

Free air delivery by nozzle method:

$$Q_{free} = c \times \pi \times \frac{d^2}{4} \times \frac{T_a}{P_a}\left[\frac{2(P_{bn}-P_n)(P_{bn}\times R)}{T_{bn}}\right]^{1/2}$$

Where, Q_{free} = Free air delivery in m^3/ sec
c = Flow constant to be specified
d = diameter of nozzle in m
T_a = Absolute inlet temperature in degree K
P_a = Absolute inlet pressure in kg/ cm^2
P_{bn} = Absolute pressure before nozzle in kg/ cm^2
P_{bn}-P_n = Difference of pressure across nozzle in kg/ cm^2
R = Gas constant for air and is taken as 287.10 J/ kg K
T_{bn} = Absolute temperature before nozzle in degree K

Isothermal efficiency = Isothermal Power/ Actual measured input power

Isothermal Power = $PV\log_e r$/ 36.7

Where, P = Absolute inlet pressure in kg/ cm^2
V = Free air delivery in m^3/ hr
r = pressure ratio P_d/P
P_d = Delivery Pressure m^3/ hr

Volumetric Efficiency = [Free air delivery (in m^3/ min) / Compressor displacement (in m^3/ hr)]*100
= [Free air delivery (in m^3/ min)/ (0.785*D^2*L*N*X*n)

Where, D = Cylinder bore in m
V = Free air delivery in m^3/ hr
L = Stroke length in m
N = RPM of compressor or speed in RPM
x = Single or double acting compressor cylinder

n = Nos. of cylinder in compressor

Specific power consumption at rated discharge pressure = Power consumption in kW/ Free air delivered m^3/ hr

5. Refrigeration and air conditioning Load Calculations: (Use standard Refrigeration Tables for values of different factors)

a. External roof and walls (sensible):

$$Q = UA[(TETD_P \times F_C) + (TETD_A \times F_R)]$$

Where, U = Overall heat transfer co efficient for roof walls in W/m^2 degree K
A = Area of wall in m^2
TETD = Total Equivalent Temperature Difference, Time Integrated peak and average respectively
F = Convective and radiative factor respectively for walls

b. Glass Conduction (sensible):

$$Q = UA\Delta T$$

Where, U = Overall heat transfer co efficient for glass in W/m^2 degree K
A = Area of glass in m^2
ΔT = Outside and inside temperature difference in degree C.

Glass Solar load (sensible):

$$Q = A[SC\{(F_C \times SHGF_P) + (F_R \times SHGF_A)\}]$$

Where, A = Glass Area m^2
SHGF = Solar heat gain factor for peak and average
SC = Shading co efficient
F = Convective and radiative factor respectively for glass

c. Ceiling/ Roof/ Floor/ Partition sensible (not exposed):

$$Q = UA\Delta T$$

Where, U = Overall heat transfer co efficient for Ceiling/ Roof/ Floor/ Partition in W/m^2 degree K
A = Area of Ceiling/ Roof/ Floor/ Partition in m^2
ΔT = Outside and inside temperature difference in degree C.

d. People Or Occupants (sensible and latent):

$$Q_s = No\ of\ occupants\ in\ space \times Sensible\ heat\ gain\ \ factor\ per\ occupant$$
$$Q_s = No\ of\ occupants\ in\ space \times Latent\ heat\ gain\ \ factor\ per\ occupant$$

e. Lights (sensible):

$$Q = Input \times Allowance \times Use$$

Where, Input = Input rating from electrical plants or lighting fixture data
Allowance = Usage of tube lights ~1.2
Use = Actual wattage in use/ installed wattage and to be decided based on application.

f. Motors and other load (sensible):

$$Q = Power of motor \times Load\ factor \times Use\ factor$$

Where, Power of motor = Name plate details of motor
Load factor = Depends on relative placement of motor and load
Use factor = Generally taken as 1 if not specified.

g. Appliances (sensible):

$$Q_s = No\ appliances\ in\ space \times Sensible\ heat\ factor$$
$$Q_s = No\ of\ appliances\ in\ space \times Latent\ heat\ factor$$

h. Ventilation and Infiltration (sensible):

$$Q_s = 20.43 \times Q_m (t_o - t_i) W$$
$$Q_L = 49.1 \times Q_m (W_o - W_i) W$$

Where, Qm = Outside air in m^3/ min infiltration or ventilation which ever is more.
t = Outside and inside temperature difference respcetively in degree K.
W = Humidity ratio difference of outside and inside in gms/ kg

i. Ventilation and Infiltration (latent):

$$Infiltration\ for\ room = HLWG / 60$$
$$Door\ \text{inf}\ iltration = door\ opening \times Factor / 60$$

Where, H = Room height in m.
W = Room width in m
L = Room Length in m
G = Factor for infiltration

6. Fan & Blower Efficiency:

Determination of Flow

Once the cross-sectional area of the duct is measured, the flow can be calculated as follows:

$$\text{Flow, } (m^3/s) = \text{Area } (m^2) \times \text{Velocity (m/s)}$$

$$\text{Volume(flow)} = A \times C_p \times \frac{\sqrt{2 \times 9.81 \times \Delta p \times \gamma}}{\gamma}$$

Power Measurement:

$$P = \sqrt{3} \times V \times I \times \cos\Phi$$

$$\textit{Power Input to fan shaft} = \textit{Power input to the motor} * \eta \textit{ of motor at the corresponding loading} * \textit{transmission system } \eta$$

$$\textit{Fan efficiency} = \frac{\textit{Volume in } m^3/\text{sec} * \textit{total pressure in mmWC}}{102 * \textit{power input to fan shaft in kW}}$$

CAD/CAM

1st Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-I

Course Title: Mechanical Drawing and Drafting
(Course Code: 1316501)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering (CAD CAM)	First

1. RATIONALE

Mechanical drawing and drafting is a way of communication for engineers. It is a graphical language that essential for communicating design ideas and technical information to engineers in industry and other professionals throughout the design process. The purpose of a mechanical drawing and drafting is to clearly and accurately capture all geometric features of a product or component so that a manufacturer or engineer can produce the required item. This course aims at development of fundamental understanding and application of drawing and drafting so as to develop the ability to prepare, read and interpret drawings correctly and make aware of drafting practices, symbols, codes, norms and standards generally used in industries. It covers knowledge & application of drawing instruments & also familiarizes the learner about codified symbols and principles of technical drawing as per BIS (Bureau of Indian Standards) and ASME (American Society of Mechanical Engineers) standards.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Draw various mechanical component using codes, norms and standards.**
- **Interpret basic engineering drawings for various planning, manufacturing activities and inspection.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Use scales, drawing standards and drafting instruments as per BIS codes.
b) Construct engineering curves as per given dimensions.
c) Draw orthographic and sectional orthographic views from isometric views of simple objects and vice versa.
d) Apply Geometric Dimensioning and Tolerancing (GD&T) to machine parts in a manner that complies with the ASME Y14.5-2009 standard.
e) Prepare assembly and detail drawing of various mechanical components.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. These PrOs need to be attained to achieve COs.

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Use of Drawing Instruments:** Draw following as per I.S. 1a. Draw different types of lines. 1b. Draw simple drawing using various dimensioning systems. 1c. Illustrate dimensioning of circle, arc, angle, square bar, hexagonal bar, cylinder & sphere through figures. 1d. Draw 1st and 3rd angle orthographic projection symbols. 1e. Draw a typical Title block. 1f. Draw simple objects using reduced and enlarged scales.	I & II	06
2	**Engineering Curves (Conic Sections):** 2a. Construct ellipse using concentric circle method, four center method, arc of circle method, rectangle method, oblong method and eccentricity method. (four problems) 2b. Construct parabola using rectangular method, parallelogram method, tangent method and eccentricity method. (two problems) 2c. Construct hyperbola using rectangular method, oblique method and eccentricity method. (two problems)	III	06
3	**Surface Development:** Draw development of surface - 8 problems	IV	06
4	**Orthographic Projections and sectional views:** Draw Orthographic projections and sectional views of different objects (three views of each object) (Four problems one view of each problem must be sectional view).	V	08
5	**Isometric Projections:**	VI	08

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Draw isometric drawing from given orthographic views. (8 problems). 4 problems should be L, I, T and C sections.		
6	**Details:** Draw the details of all parts for the assembly assigned and sketched as student activity. (One problem)	IX	8
7	**Assembly:** Draw the assembly of all parts assigned by faculty. This includes minimum one sectional view and also prepare BOM. (One problem)	IX	8
8	**Production Drawing:** Draw the production drawing of simple machine components assigned by faculty. This includes Geometric & Dimensional Tolerances (GD&T), Surface Roughness Symbols, Open Dimensional Tolerances, Notes, etc., (One problem)	VIII	6
9	**Mechanical Symbols (Prepare only in sketch book)** *Draw following symbols & its interpretation:* Drafting Symbols (Machining, threading, dowels, pins, ribs, bearings, heat treatment conditions, surface conditions, assembly notes), Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementary symbols), Piping Symbols (Pipe line symbol as per passing fluid, air, gas, water etc. and Piping fitting symbols.)	VII	-
	Total		**56**

Note

i. *Note: The teacher should demonstrate –*
   - *Use of drawing instruments.*
   - *Planning and layout of drawing sheet as per IS code.*
   - *Scaling technique.*

ii. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

iii. *Teachers should encourage students for optimum use of drawing sheet space. Further, instruct them to use both sides of a drawing sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.*

iv. *First angle orthographic projection and IS codes (Engineering Drawing Practices for School and Colleges SP 46:2003) should be followed wherever applicable.*

v. *The dimensions of line, axes, distances, angle, side of polygon, diameter, etc. must be varied for each student in batch so that each student will have same problems, but with different dimensions.*

vi. *The sketchbook should contain data related to all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.*
vii. *A hand out containing applicable standards from IS codes including title block as per IS standard should be given to each student by concerned teacher.*
viii. *For 25 marks Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to prepare drawings.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr.	Sample Performance Indicators for the PrOs	Weightage %
1	Drawing planning, layout and scale (for optimum use of drawing sheet)	20
2	Use of appropriate instruments, lines, dimensioning & annotations	30
3	Accuracy and Neatness of drawing	15
4	Timely submission of completed drawing sheet	15
5	Answering viva voce questions	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practicals in all institutions across the state.

Sr.	Equipment Name with Broad Specifications	PrO. No.
1	Drawing instruments for class room teaching (Large Size).	1 to 9
2	Models of various objects	3,4,5,6,7
3	Drawing Board (B2) & Mini Drafter.	All
4	Other Instruments: T-Square, Set square (45˚ and 30˚-60˚), Roller Scale, Protector, Drawing Compass, Dividers, Drawing Pencils (Clutch Pencil with H & 2H Lead), Lead Box (H & 2H – 0.5 or 0.7 mm) Circle Master, French Curves, Stencils (8-6-4 mm, All in One), Eraser, Drawing sheets, Drawing Pins/Clips, Sheet Container and Drawing instrument box.	All
5	Set of various drawings being used by industries/developed by experienced teachers.	6,7,8
6	Interactive board with LCD overhead projector	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices
c) Follow ethical practices.

d) Maintain cleanliness
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Engineering Drawing Aids, Planning Layout and Scaling of Drawing**	1a. Use of drawing instruments effectively. 1b. Follow and apply standard practice as per B.I.S. for planning and layout. 1c. Choose appropriate scale factor for the drawing as per the given situation.	1.1 Drawing instruments and materials. • Instruments-types, specifications, method to use them and applications. • Pencils-grades, papers-grades, applications, types of points and applications. • Other materials-types and applications. 1.2 I.S. cods for planning and layout.
Unit – II **Lines, Lettering and Dimensioning**	2a. Write annotations on the given drawing where ever necessary. 2b. Choose appropriate line and dimensioning style for given entity.	2.1 Different types of lines. 2.2 Lettering. 2.3 Dimensioning methods. • Aligned and unidirectional • Unilateral with chain, parallel, progressive and combined dimensioning.
Unit-III **Engineering Curves**	3a. Draw engineering curves with proficiency as per given dimensions.	3.1 Conic sections. a) Concept and understanding of focus, directrix, vertex and eccentricity and drawing of conic sections. b) Using various methods, understand construction and application of : • Ellipse • Parabola • Hyperbola

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-IV **Development of Surface**	Develop the lateral surface of given Solid.	4.1 Types and dimensional specifications of solids (prism, pyramid, cylinder and cone) (only initial position of solid without any inclination with HP and VP). 4.2 Introduction to cutting planes / section planes, positions of the cutting plane (HCP, VCP, PCP, AVP &AIP) w.r.t solids. (no need to draw sectional view) 4.3 Development of surfaces of solids - Prism and pyramid - Cylinder & Cone
Unit-V **Orthographic Projection and sectional views**	5a. Draw the orthographic views of objects containing lines, circles and arc geometry. 5b. Interpret given orthographic views to imagine the shape of the component. 5c. Draw sectional orthographic views of an object. 5d. Interpretation of sectional orthographic views.	5.1 Types of projections-orthographic, perspective, isometric and oblique: concept and applications. 5.2 Various term associated with orthographic projections. • Theory of projection. • Methods of projection. • Orthographic projection. • Planes of projection. 5.3 Need of sections, section lines &cutting plane, rules for sectioning and section lines 5.4 Types and application of sections- full, half, revolved, removed, partial, off-set, aligned, etc. 5.5 Conversion of simple pictorial views into Orthographic and sectional views. Illustrative problems on orthographic projection. 5.6 B.I.S. code of practice.
Unit-VI **Isometric Projection**	Draw the isometric view from orthographic views of object/s containing lines, circles, arcs and slant surfaces.	6.1 Isometric axis, lines and planes. 6.2 Isometric scales, isometric projection and isometric drawing. 6.3 Simple shapes like L-section, I-section, T-section, C-section, etc. 6.5 Illustrative problems limited to objects Containing lines, circles and arcs shape only.
Unit-VII **Mechanical Drafting Symbols**	Use & interpret mechanical drafting symbols.	7.1 Machining symbol, Roughness symbol, Grade Number, Roughness value 7.2 Drafting and Geometric symbol, Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementary symbols.) 7.3 Piping Symbols (Pipe line symbol as per passing fluid, air, gas, water etc. and Piping fitting symbols.)

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		7.4 Demonstration of above symbol in production drawing.
Unit-VIII **System of Geometric Dimensioning and Tolerancing (GD&T)**	Use & interpret Geometric & Dimensioning Tolerances (GD&T) in production drawing.	8.1 Difference between dimensional tolerance & geometric tolerance. Limits & Fits–Introduction, need & applications. 8.2 Abbreviations & designations for shaft, holes and grades, determinations of deviation, limit, tolerance and fits, shaft basis and hole basis system & selection of shaft & hole pair as per standard tolerance of grades. 8.3 Selection of appropriate shaft / hole for a given condition, calculation of tolerances & deviations for a fit according to application of mating parts. 8.4 Geometric Tolerances – Introduction, symbols, representation, meaning of each element of tolerance frame and application in industrial drawing. *(Faculty should demonstrate & discuss moderate production drawing for better understanding of topic)*
Unit-IX **Details & Assembly**	9a. Prepare and interpret detail and assembly drawing. 9b. Workout bill of material (BOM) from a given drawing.	9.1 Importance and difference of these drawings. 9.2 Detail drawing from given assembly. 9.3 Assembly drawings from given details and prepare BOM.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Engineering drawing aids, planning, layout and scaling of drawing**	**00**	**04**	**00**	**02**	**06**
II	**Lines, lettering and dimensioning**	**00**	**02**	**02**	**00**	**04**
III	**Engineering curves**	**06**	**02**	**00**	**04**	**06**
IV	**Development of Surfaces**	**06**	**00**	**02**	**06**	**08**
V	**Orthographic projections and sectional views**	**08**	**00**	**02**	**08**	**10**
VI	**Isometric projections**	**08**	**00**	**02**	**08**	**10**
VII	**Mechanical symbols**	**04**	**04**	**04**	**00**	**08**
VIII	**System of Geometric Dimensioning and Tolerancing (GD&T)**	**04**	**00**	**04**	**04**	**08**
IX	**Details & assembly**	**06**	**02**	**00**	**08**	**10**
	Total	**42**	**14**	**16**	**40**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Solve all problems for all sheets number 1 to 8 in sketch book (with complete data and dimensions).
b) Take two simple objects in your vicinity and sketch 3D isometric of them. Also draw 2D orthographic projections of them (all views). Try to clearly and accurately capture all the geometric features present in the selected objects.
c) Take a visit of manufacturing industry and prepare production drawing of simple part manufactured by that industry.
d) List out different weld joints carried out in fabrication industry.
e) Download soft copy of technical drawing of any engineering products. Read and interpret this drawing (e.g. connecting rod, piston, pulley etc.).
f) Explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each batch student.
g) Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes

committed by them. Student will also guide the students for correcting the mistakes, if any.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students for using BIS "SP 46:2003", ASME Y14.3-2003 & ASME Y14.5-2009 standard.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Make a poster presentation on exploded view of mechanical components.
b) Take a simple assembly of 3 to 4 parts and prepare its assembly and detail drawing.
c) Model Making: Students should build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap.
d) World of work connect: Students should collect Production drawings from nearby workshops/industries and try to
   - redraw types of lines used
   - redraw lettering styles used
   - list ASME code referred
   - list the symbols/annotations/dimensioning used

- list the type of scales used. Compare the size of component on drawing sheet with actual component.
- Redraw the 2D entities

13. SUGGESTED LEARNING RESOURCES

Sr.	Title of Book	Author	Publication with place, year & ISBN
1	Engineering Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014. ISBN : 9789380358963
2	Engineering Drawing	M.B. Shah, B.C. Rana	Pearsons. 2009 ISBN: 9788131759714
3	SP 46-2003	-	Bureau of Indian Standards; Old Delhi, 2003 ISBN-10: 8170610192
4	Textbook of Engineering Drawing	P.J. Shah	S.Chand, New Delhi. 2013 ISBN : 9788121941822
5	Textbook of Engineering Drawing	R K Dhawan	S.Chand, New Delhi. 2013 ISBN : 9789352837373
6	Machine Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014 ISBN-13: 9789385039232
7	Machine Drawing	P.J. Shah	S.Chand; New Delhi, 2013 ISBN-13: 9788121929660
8	Geometric Dimensioning & Tolerancing for Mechanical Design	Gene R. Cogorno	McGraw Hill; Noida,2011 ISBN-13: 9780071772129
9	Westermann Tables for the Metal Trade	Jutz Hermann	New Age International Pvt. Ltd.; Hyderabad, 2018 ISBN-13: 9788122417302
10	BIS IS 696 - 1972 BIS 919 (Part 1 and 2): 1993	-	-

14. SOFTWARE/LEARNING WEBSITES

Unit	Software/Learning Websites	
1.1	Drawing equipments, instruments and materials	https://youtu.be/MT1T31GtGpg
2.1	Types of lines, systems of dimensioning, scale	https://youtu.be/nUD4SBtu0GA
3.1	Conic sections : Ellipse	https://youtu.be/hG38kPDN2fU
	Ellipse by Four center method	https://youtu.be/YX_vqD83uhI
	Draw Parabola	https://youtu.be/dn3-9N_lzEo
	Draw Hyperbola	https://youtu.be/QEpS0QBwoas
	Directrics method to draw conic curves	https://youtu.be/aBk_DSToBbI
4.1	Development of surfaces Part 1	https://youtu.be/EVTrZ-ApC7g
4.2	Development of surfaces Part 2	https://youtu.be/a5C_VPEkUtI
5.1	Orthographic projections	https://youtu.be/55mR97uzjys
5.4	Sectional views	https://youtu.be/5bkG-LTb6-s

6	Isometric view from orthographic views	https://youtu.be/trJQIvatIpI
7.1	Mechanical drafting symbols	https://youtu.be/KdeeZeKO7ko
7.2	Drafting, geometric and welding symbol	https://youtu.be/H4koN4WSRSM
7.3	Piping symbols	https://youtu.be/euySmmCnzpA
1 to 9	https://nptel.ac.in/courses/112/103/112103019/ https://nptel.ac.in/courses/112/105/112105294/ https://www.youtube.com/c/MechanicalEnggSubjectsGTU/playlists https://youtube.com/playlist?list=PL5Rqb_WO7qVy2-6FluBrQcJh__rXvyOxe https://youtube.com/playlist?list=PL5Rqb_WO7qVxzROfyk2EusQDokGkLXVax	
Study following QR codes:		

15. PO-COMPETENCY-CO MAPPING

Semester I	Mechanical Drawing and Drafting (Course Code: 1316501)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency							
Course Outcomes CO 1)Use scales, drawing standards and drafting instruments as per BIS codes.	3	-	2	3	-	-	2
CO 2)Construct engineering curves as per given dimensions.	3	-	3	2	2	-	2
CO 3)Draw orthographic and sectional orthographic views from isometric views of simple objects and vice versa.	3	2	3	2	2	2	2
CO 4)Apply Geometric Dimensioning and Tolerancing techniques to machine parts in a manner that complys with the ASME Y14.5-2009 standard.	2	3	2	3	2	2	3

CO 5) Prepare assembly and detail drawing of various mechanical components.	2	2	2	2	2	-	2

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. H. R. Sapramer Head of Mech. Dept.	Dr. J. N. Mehta Polytechnic, Amreli	9426587197	merhamir@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I– Semester

CourseTitle: **Mathematics**
(Course Code: 4300001)

Diploma program in which this course is offered	Semester in which offered
Automobile Engineering, Architecture Assistantship, Biomedical Engineering, Ceramic, Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics &Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Marine Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Electronics Engineering, Printing Technology, Textile Designing, Textile Manufacturing Technology, Textile Processing Technology, Computer Science & Engineering (All branches)	First

1. RATIONALE

This course of Mathematics is being introduced as a foundation which will help students in developing competency and the requisite course outcomes in most of the Diploma Engineering programs. Components of Mathematics like Algebra, Geometry, Calculus, Computer computation work as a tool to describe physical phenomena and to evaluate the merit of different possible solutions. This course is an attempt to initiate the multi-dimensional logical thinking and reasoning capabilities. It will help the students to apply the basic principles of Mathematics to solve related technology problems. The course will give the students an insight to apply and analyse the Engineering problems scientifically based on the subject of Trigonometry, Differential Calculus and Basic elements of algebra and coordinate geometry to give a comprehensive coverage at an introductory level.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

Solve broad-based technology problems using the principles of mathematics.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Interpret the function graphically, numerically and analytically**.**

b) Demonstrate the ability to algebraically analyse basic functions used in Trigonometry.

c) Demonstrate the ability to Crack engineering related problems based on concepts of Vectors**.**

d) Solve basic engineering problems under given conditions of straight lines and circle.

e) Demonstrate the ability to analyze and illustrate the Functions using the concept of Limit.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	1	-	4	30*	70	-	-	100

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES (During Tutorial Hours)

The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve the Cos.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Solve given problems of Determinant up to order 3*3.	I	1
2	Use Open source mathematical software to demonstrate the graphs of given functions with its geometrical interpretation.	I	1
3	Use Open source mathematical software to display given logarithmic functions showing basic laws.	I	1
4	Solve the given examples based on conversion of units of Angles explaining the allied angles.	II	1
5	Crack given problems based on the concept of Compound Angles, Multiple and Submultiples angles.	II	1
6	Plot the graph of sine and cosine functions with help of Open source mathematical software and justify problems related to sum and factor formulae.	II	1
7	Use the concepts of Algebra to Solve given engineering related problems based on Magnitude of a vector.	III	1
8	Apply the concept of Dot Product to solve given engineering	III	1

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	related problems.		
9	Explain the physical significance of the Cross Product and apply the concept to solve given engineering related problems.	III	1
10	Apply the concept of various forms of line, slope, intercept to solve simple problems.	IV	1
11	Use the concepts of equations of Parallel lines and Perpendicular lines to solve specified problems.	IV	1
12	Use the concept of Tangent and Normal to solve related engineering problems.	IV	1
13	Explain Limit of a function graphically and solve the specified problems.	V	1
14	Apply the Standard Formulae of Limit and crack the specified problems.	V	1
	Total		**14**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	Geometric Thinking: Comprehend geometric concepts to prove theorems by applying apt results to solve well defined Engineering problems.	
1.	Experiment with transformations in the plane.	30
2.	Define trigonometric ratios and solve problems involving right triangles.	30
3.	Apply theorems about circles.	40
Total		**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	Algebraic Thinking: Create, interpret, use, and analyze expressions, equations, and inequalities in a variety of contexts.	
1.	Represent, interpret, and solve variable expressions, equations, and inequalities.	60
2.	Write expressions in equivalent forms to solve problems.	40
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	Computer System & LCD Projector	2,3,6,10,13
2	Scientific Calculator (Display type: Natural Display Algebraic input logic: Natural V.P.A.M. Significand function: 10+2.	1,5,10

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Determinant and Function**	1a. Solve simple problems of Determinant up to order 3*3. 1b. Explain graphically the given functions. 1c. Solve simple problems using concepts of Logarithms	1.1 Determinant and its value up to 3rd order (Without properties) 1.2 Function and simple examples. 1.3 Logarithm as a function 1.4 Laws of Logarithm and related Simple examples
Unit– II **Trigonometry**	2a. Apply the concept of Compound angle, Allied angle, and Multiple angles to solve the given simple engineering problem(s) 2b. Explain the concept of Sub-Multiple and solve related problem(s). 2c. Invoke the concept of Sum and Factor formulae to solve the given simple problem(s) 2d. Investigate given simple problems using inverse Trigonometric functions.	2.1 Units of Angles (degree and radian) 2.2 Trigonometric Functions 2.3 Allied & Compound Angles, Multiple –Submultiples angles 2.4 Graph of Sine and Cosine, 2.5 Periodic Trigonometric function 2.6 Sum and factor formulae 2.7 Inverse Trigonometric function
Unit– III **Vectors**	3a. Apply the concept of algebraic operations of Vectors to solve given simple engineering problem(s) 3b. Apply the concept of Scalar and Vector product to solve specified simple problem(s) 3c. Solve problems of work done and moment of force using the concept of Vectors.	3.1 Vector, Addition, Subtraction, Magnitude and direction. 3.2 Scalar and Vector Product and it's properties 3.3 Angle between two Vectors 3.4 Applications of Scalar and Vector Product (Work Done and Moment of Force)
Unit– IV **Coordinate Geometry**	4a. Employ the equation of straight line to solve given simple problems. 4b. Apply the concept of slope and its consequences to	4.1 Straight line (Two-point form) and slope of straight line 4.2 Slope point form, Intercept form, General form of line 4.3 Condition of parallel and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	solve the given problems. 4c. Find the angle between two lines using the concept of Parallel and Perpendicular lines. 4d. Apply the concept of equation of circle with center and radius to solve the given problems. 4e. Solve problems related to general equation of circle based on tangent and normal.	perpendicular lines 4.4 Equations of Parallel lines and Perpendicular lines to the given lines 4.5 Angle between two lines. 4.6 Equation of circle with center and Radius. 4.7 General equation of circle. 4.8 Tangent and normal to a circle.
Unit– V **Limit**	5a. Analyse the characteristic of functions using the concept of Limit. 5b. Solve the given problems using standard formulae of Limit	5.1 Limit of a Function. 5.2 Standard formulae of Limit and related simple examples.

***Note**: The Unit Outcomes (UOs) need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Determinant and Function	9	4	7	5	16
II	Trigonometry	12	4	5	5	14
III	Vectors	7	4	6	4	14
IV	Coordinate Geometry	8	4	5	5	14
V	Limit	6	3	4	5	12
Total		42	**19**	**27**	**24**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

***Note**: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Identify engineering problems based on real world problems relevant to content of the unit and solve these problems in the light of free tutorials available on the internet.
b) Explore the opportunity to visit Science city, ISRO or nearby Science centres.
c) Explore the opportunity to visit Mathematics Lab Virtually.
d) Prepare charts showing formulas of multiple and sub multiple trigonometric functions.
e) Use Graphing calculator to plot the graph of functions showing Engineering applications.
f) Collect set of problems based on concept of limit with real world applications and make a presentation.
g) Communicate mathematical thinking coherently and clearly to other students, peers, and others.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L" in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Explore the possibility for understanding the Biosphere through Mathematics
g) Guide students for using data manuals.

12.SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more

COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course.The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Draw graphs of given Functions like $2x-1, x^2, \sin x, \cos x$ etc and verify using suitable Open-source software like GeoGebra, DPLOT and GRAPH.
b) Prepare the Charts of formulae for limit, Vector, Trigonometry, Co-ordinate Geometry, and Logarithm.
c) Prepare the cardboard models based on Mathematical concepts.
d) Draw various lines, circles using GeoGebra software.
e) Prepare projects on height and distance using Trigonometry.
f) Use PHET website for simulation of Vector Algebra.
g) Prepare a presentation/seminar on any relevant topic of interdisciplinary nature.
h) Prepare a write up on the Historical path of Calculus.
i) Prepare models of graphical representation for the existence of limits of given functions.
j) Prepare charts showing formulas of multiple and sub multiple trigonometric functions and its usefulness.
k) Formulate models to describe mathematical relationships and analyze data.

13.SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Mathematics (Third edition).	Croft, Anthony	Pearson Education, New Delhi, 2014. ISBN 978-81-317-2605-1
2	A Text Book of Vector Analysis	Narayan Shanti and Mittal P.K	S. Chand Publication, ISBN 978-8121922432
3	Calculus and Analytic Geometry	G. B. Thomas, R. L. Finney	Addison Wesley, 9th Edition, 1995. ISBN 978-8174906168
4	Understanding Engineering Mathematics	John Bird	Routledge; 1st edition ISBN 978-0415662840
5	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5

14.SUGGESTED LEARNING WEBSITES

a. https://www.youtube.com/channel/UCLJVrQyPYsseCf78QWCDsvA/featured
(YouTube Channel of DTEGUJ)
b. https://www.geogebra.org/?lang=en
c. https://phet.colorado.edu/
d. www.dplot.com/ - DPlot
e. www.wolfram.com/mathematica/
f. https://www.khanacademy.org/
g. www.easycalculation.com
i. www.scilab.org/ - SCI Lab
j. https://cnx.org/contents/cCXsMC7-@3.2:rOtjgdjI@5/Trigonometry
k. https://www.embibe.com/exams/real-life-applications-of-trigonometry
l. https://opentextbc.ca/calculusv1openstax/chapter/the-limit-of-a-function
m.https://www.accessengineeringlibrary.com/?implicit-login=true

15.PO-COMPETENCY-CO MAPPING

Semester I	Mathematics (Course Code: 4300001)						
	POs and PSOs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency ***Solve broad-based technology problems using the principles of mathematics.***	3	2	1	-	-	-	1
Course Outcomes CO a) Interpret the function graphically, numerically and analytically.	3	2	1	-	-	-	-
CO b) Demonstrate the ability to algebraically analyze basic functions used in Trigonometry.	3	1	1	-	-	-	1
CO c) Demonstrate the ability to Crack engineering related problems based on concepts of Vectors.	3	1	1	-	-	-	1
CO d) Solve basic engineering problems under given conditions of straight lines and circle.	3	1	-	-	-	-	-
CO e) Demonstrate the ability to analyze and illustrate the Function using the concept of Limit.	3	-	-	-	-	-	-

Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. N. R. Pandya I/C Principal (Retired) Head of Department	Government Polytechnic, Kheda	9099097990	nrpandyagp@gmail.com

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3	Mr. P. N. Joshi Sr. Lecturer	A.V.P.T.I, Rajkot	9924844699	pnj2004@rediffmail.com
4	Dr. J. S. Prajapati Sr. Lecturer	R.C.T.I, Ahmedabad	9426469752	jsprajapati26@gmail.com
5	Dr. Sachin J. Gajjar Lecturer	Government Polytechnic, Gandhinagar	9925362754	gjr.sachin@gmail.com
6	Dr. Nirav H. Shah Lecturer	Government Polytechnic, Jamnagar	9327632570	Nirav.hs@gmail.com

NITTTR Resource Person

S. No.	Name and Designation	Department	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I– Semester

Course Title: **COMMUNICATION SKILLS IN ENGLISH**
(Course Code: 4300002)

Diploma programme in which this course is offered	Semester in which offered
ALL BRANCHES	FIRST

1. RATIONALE

Language is the most commonly used medium of self-expression in all spheres of human life – personal, social and professional. English language has become a dire need to deal successfully in the globalized and competitive market. Competency in English is need of the hour, not only for Indian industry, but also worldwide, where diploma engineers have the employable opportunity. Therefore, the basic English skills- listening, speaking, reading and writing have become almost mandatory for employability. This course intends to make the students to develop comprehension skills, improve vocabulary, use proper grammar, acquire writing skills, correspond with others and enhance skills in spoken English. Further, it is expected that each polytechnic will provide conducive environment for acquiring proficiency in communication skills among the students through English language.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use reading, writing, speaking, listening skills to communicate effectively in English**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

- Use strategies to minimise barriers of effective communication.
- Construct grammatically correct sentences.
- Develop reading and listening skills in terms of fluency and comprehensibility.
- Compose different types of written communication.
- Communicate orally in a given situation with a purpose.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	-	2	3	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be

taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.		Approx. Hrs. required
1	Make correct sentences using tenses.	II	Any two	02
2	Compose Syntactical statements in written and Oral Communication (especially Formal Communication).	II		02
3	Make meaningful sentences using confusing words..	II		02
4	Develop listening skills through listening to recorded lectures, poems, interviews and speeches.	III		02*
5	Use antonyms and synonyms effectively in oral and written forms.	III, IV		02*
6	Use grammatically correct sentence	IV		01
7	Communicate ideas effectively and fluently in oral and written communication.	IV, V		02*
8	Apply idioms and one word substitute effectively in oral and written forms of communication.	IV, V		01
9	Articulate vowels, consonants and diphthongs correctly.	V		02*
10	Syllable and Syllable Stress	V		02
11	Speak with appropriate intonation, voice modulation, pitch, speed and volume.	V		02
12	Participate in conversations (GD /meetings etc.)	V		02*
13	Deliver the presentation effectively in the class.	V		02*
14	Communicate effectively through verbal and non-verbal means of communication.	V		02*
15	Practice online exercises for listening and reading comprehension.	V		02*
16	Perform role play and mock interview	V		02
	Total			**28**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Oral Communication

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S. No.	Sample Performance Indicators for the PrOs (Oral communication)	Weightage in %
1	Pronunciation	20
2	Use of language (simple or decorated language)	20
3	Syntax (Sub-Verb Agreement, types of sentences, Modals etc.)	20
4	Use of appropriate Vocabulary	15
5	Fluency (Ease and speed of the flow of speech)	15
6	Audibility	10
Total		**100**

Written Communication

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S.No.	Sample Performance Indicators for the PrOs (Written communication)	Weightage in %
1	Content(ideas expressed)	25
2	Use of language (Organisation of the content)	20
3	Grammar • Syntax (Sub-Verb Agreement) • Diction (choice and use of words) • Control of the basic grammatical patterns	20
4	Style • Choice of sentence structures • Use of appropriate sentence structures	20
5	Mechanics (Use of punctuations, Capitalization, paragraphing, italicizing)	15
Total		**100**

Listening skills

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S.No.	Sample Performance Indicators for the PrOs (Listening skills)	Weightage in %
1	Enthusiasm for patient listening	15
2	Attentive listening	20
3	After listening, each student has to summarize • Accuracy of facts and figures. • Description of places and situations.	40
4	Para- phrasing of the listened texts.	25
Total		**100**

Reading Skills

Each student performance will be evaluated on the basis of the sample Performance Indicators given below:

S.No.	Sample Performance Indicators for the PrOs (Reading Skills)	Weightage in %
1	Reading correctly with clarity	30
2	Correct pronunciation	20
3	Comprehension of a vocabulary and deriving meaning of information	15
4	Reading speed	20
5	Drawing correct conclusion and valid inference	15
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer systems windows 7 or above with internet connectivity	All
2	Headphones with speakers	All
3	LCD Projector	All
4	Language lab software	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work well as a leader/a team member.
b) Follow ethics
c) Demonstrate human concern.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy'

should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	**Speaking Skills**	
Unit 1 **Theory of Communi-cation**	1a. Define the theory of communication 1b. State different types of communication. 1c. Explain barriers in communication	1d. Communicate effectively	**1.1** Concept of effective communication and communication skills **1.2** Basic communication model(S+M+C+R+F) **1.3** Types of communication **1.4** Barriers of effective communication
Unit 2 **Grammar**	2a. Identify different parts of speech and their usage in the sentence.	2f. Choose appropriate parts of speech for day to day communication.	**2.1 Parts of Speech** Noun, Pronoun, Verb, Adjective, Adverb and Interjection- Meaning and Examples (Recapitulation) Prepositions- In, into, On, At, for, Since, between, among, to, towards Connectors - If, Unless, Otherwise, Because, Therefore, Who, Which, Where, When, Why.
	2b. Apply correct verbs in the given sentence	2g. Use grammatically correct sentence in day to day communication	**2.2 Tenses** **2.2.1 Present Tense** (Simple, Continuous, Perfect, Perfect Continuous) **2.2.2 Past Tense** (Simple, Continuous, Perfect) **2.2.3 Future Tense** (Simple)
	2c. Use appropriate Modal Auxiliaries in a given expression.	2h. Choose appropriate Modals in situations where different modes of expressions are used.	**2.3 Modal Auxiliaries** (Can, Could, May, Might, Shall, Should, Will, Would, Must, Have to, Ought to)

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	**Speaking Skills**	
	2d. Choose the correct verb for the given subject.	2i. Use the correct verb depending on the subject in a sentence.	**2.4 Subject- Verb Agreement**
	2e. Identify basic sentence patterns of English and form sentences in correct word order.	2j. Use correct word order in their speech.	**2.5 Basic Sentence Patterns of English** (Explanation of S, V,O,A,C) S-Subject, V-Verb, O-Object, A-Adverbial and C- Complement Four Basic Sentence Patterns • S+V • S+V+O • S+V+A • S+V+C
Unit 3 **Prose and Poetry**	3a. Realise the central idea of the literary piece. 3b. Formulate sentences using new words. 3c. Enrich vocabulary through reading. 3d. Write short as well as long answers to questions. 3e. Express ideas in English in written form effectively	3f. Explain the content of the passage/story in the class. 3g. Ask appropriate questions as well to answer them. 3h. Follow oral instructions and interpret them to others. 3i. Present topics effectively and clearly. 3j. Use dictionary, thesaurus and other reference books. 3k. Describe an object or product. 3l. Use correct pronunciation and intonation. 3m. Give instructions orally.	**3.1. Prose** The Leopard- Ruskin Bond **3.2. Short Story** After Twenty Years- O Henry **3.3. Poetry** • Stopping by Woods on Snowy Evening-Robert Frost • Where the Mind is Without Fear- Rabindranath Tagore **3.4 Language components:** Language components should be integrated with: • Passages from text book/Work book. • Unseen passages Reading with correct pronunciation.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	**Speaking Skills**	
			3.5 Vocabulary Items: • Matching items (Word and its Meaning) • One-Word Substitution • Phrases and Idioms • Synonyms and Antonyms
Unit 4 **Techniques of Writing**	4a. Compose emails on given topics/ situations. 4b. Write a paragraph in words with synchronized sentence structure on the given situation / topic. 4c. Answer the questions on the given unseen passage. 4d. Summarize the given unseen passage .	4e. Face oral examinations and interviews. 4f. Grasp the main idea of any conversation and communicate accordingly.	**4.1 Email Writing** (Business) Format and Sample Enquiry, Orders and complaints Examples for Practice **4.2 Letter writing** • Types of letters, • Formats of Letters • Qualities of a good letter • Sample letters such as: - Job applications/ Cover Letter - Leave applications, Complaints, - Purchase orders, Enquiries replies etc.
Unit 5 **Mechanics of Speaking**	5a. Develop a welcome and farewell speech for the given theme/ situation. 5b. Prepare a speech for introducing a guest in the given situation. 5c. Make a weather report for the given condition .	5d. Introduce oneself with correct pronunciation, intonation, using verbal and non-verbal gestures. 5e. Speak in specified formal situations with correct pronunciation. 5f. Speak in specified informal situations with correct	**5.1 Public speaking** • Basics of Speaking • Importance of public speaking • Characteristics of good speech **5.2 Samples for Practice:** • Welcome speech • Farewell speech • Introducing oneself and another. • Discussing Weather • Disposal of E -Waste

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)		Topics and Sub topics
	Writing Skills	Speaking Skills	
		pronunciation.	• Environmental protection through non-use of Plastic • Reduction of Noise pollution by vehicles. • Conversation with the Cashier- College/ bank • Telephonic Conversations (Formal and Informal).

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Theory of Communication	04	03	04	03	10
II	Grammar	10	07	14	06	27
III	Prose and Poetry	09	04	07	08	19
IV	Techniques of Writing	05	03	04	07	14
V	Mechanics of Speaking	0	-	-	-	-
Total		**28**	**17**	**29**	**24**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10 SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

- The experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency.
- Initiating a conversation with a new comer to your college.
- Assignments using Internet. (Online Listening/Speaking/Vocabulary based exercises and uploading their score, etc. (Teacher can decide how to use various online platforms for evaluation purpose.

- Self-learning Activities using mobile apps/internet
- Discuss current affairs in English with your friends.
- Read storybooks and learn new words and sentence structures.
- Write a brief report on current environmental issues.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) Comprehension of passage and making presentation can given to the students for ***self-learning***, but to be assessed using different assessment methods.
d) Guide students on how to address issues on environment and sustainability using the knowledge of this course

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs.Similar micro-projects could be added by the concerned course teacher:

a) Book review – students should read a book and then write his reviews about the book and present it in the class.
b) Presentation – Prepare a presentation regarding current problems of environment and present it in the class,
c) Mock interviews. – Interviews conducted by students and for the students.
d) Skit or role play- write the script and present it in the class
(can be asked to take topic related to environment and pollution)
e) Find out 20 new words out of a given story, write its synonym and use the word in your own sentence.
f) Draft a story according to a given picture.
g) You are in the village fair. Describe what is happening around you in present continuous tense. (Celebration of Annual Day – past tense. etc)
h) Write a paragraph about your first day in college.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Living English Structures	W. S. Allen	Pearson Education India 1992 ISBN: 9788131728499
2	Essentials of English Grammar and Composition	N. K. Aggrawal	Goyal Brothers Prakashan 2015 ISBN : 8183896162
3	English Grammar at Glance	M. Gnanamurali	S. Chand & Co. Ltd. 2010 ISBN : 9788121929042
4	Effective English	E. Suresh Kumar & Others	Pearson 2010 ISBN : 9788131731000
5	English Communication for Polytechnics	S. Chandrashekhar & Others	Orient BlackSwan 2013 ISBN : 8125037462
6	English Fluency Step 1 & 2	-	Macmillan 2010 ISBN : 9781405003650 9781405003667
7	Active English Dictionary	-	Longman 1991 ISBN : 8131707865
8	The Pronunciation of English	Daniel Jones	Cambridge: Cambridge University Press, 4th Edition 1956 ISBN : 0521093694
9	Ed. English Pronouncing Dictionary	James Hartman & et al.	Cambridge: Cambridge University Press.17th Edition 2006 ISBN : 0521680867
10	Effective Communication Skills	Kulbhushan Kumar	Khanna Publishing House, New Delhi (Revised Ed. 2018) ISBN : 9789382609940
11	Better English Pronunciation	J.D.O'Connor	Cambridge: Cambridge University Press 1982 ISBN : 0521231523
12	An English Grammar: Comprehending Principles and Rules	Lindley Murray	Franklin Classics (10 October 2018). ISBN : 0342097008
13	Examine your English	Margaret M. Maison	Orient Longman: New Delhi, 1964 ISBN : 812500176X
14	A Practice Course in English Pronunciation	J.Sethi & et al	New Delhi: Prentice Hall, 2004 ISBN : 9788120325944
15	Technical Communication: A Practical Approach.	Pfeiffer, William Sanborn and T.V.S Padmaja	Delhi: Pearson, 2007. ISBN : 9788131700884

14. SUGGESTED LEARNING WEBSITES

- https://learnenglish.britishcouncil.org
- http://www.free-english-study.com/
- http://www.english-online.org.uk/course.htm
- http://www.english-online.org.uk/
- http://www.talkenglish.com/
- http://www.learnenglish.de/
- https://www.cambridgeenglish.org/exams-and-tests/linguaskill/
- https://dictionary.cambridge.org/dictionary/english/
- https://www.oxfordlearnersdictionaries.com/definition/academic/
- https://learnenglishkids.britishcouncil.org/

15. PO-COMPETENCY-CO MAPPING

Semester I	**Communication Skills in English (Course Code: 4300002)**						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineer-ing Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustain-ability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency	**Use reading, writing, speaking, listening skills to communicate effectively in English**						
Course Outcomes Students will be able to: CO a). Use strategies to minimise barriers of effective communication	-	-	-	-	-	2	2
CO b) Construct grammatically correct sentences.	2	-	-	-	-	2	2
CO c) Develop reading and listening skills in terms of fluency and comprehensibility	1	-	-	-	-	-	1
CO d) Compose different types of written communication.	2	-	-	-	-	2	2
CO e) Communicate orally in a given situation with a purpose.	2	-	-	-	-	2	2

Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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GUJARAT TECHNOLOGICAL UNIVERSITY

DIPLOMA PROGRAMME

IN

ENGINEERING AND TECHNOLOGY

WORKBOOK

OF

COMMUNICATION SKILLS IN ENGLISH

IMPORTANT NOTE:

This workbook is prepared for purely academic purpose only. The authors have used various open web sources and books for content creation. The aim is to help students by providing them learning material and ample exercises for practice. This book is designed for smooth functioning of the course. The content of this text must not be used for any kind commercial purpose.

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INDEX

SECTION 1

THEORY OF COMMUNICATION

What are communication skills?

Definition:

Communication skills are the abilities you use when giving and receiving different kinds of information. Some examples include communicating new ideas, feelings or even an update on your project. Communication skills involve listening, speaking, observing and empathising. It is also helpful to understand the differences in how to communicate through face-to-face interactions, phone conversations and digital communications like email and social media.

A deep understanding of the process of communication and communication skills is essential. It is vital to the success of any individual in any business. Here we shall see some of the many types of communication.

Communication styles change from person to person. During the process of communication, a person may invoke several channels or modes or methods to convey a message. But, the process of communication doesn't only depend on the source producing or relaying information.

It also equally depends on the communication method and the manner in which the receiver understands the message. Let us first understand Basic Model Of Communication

Basic Communication Model :

The sender-message-channel-receiver (SMCR) model of communication is an expansion of the Shannon-Weaver model of communication. David Berlo created this model.

According to the Shannon-Weaver model, communication includes the following concepts: sender, encoder, channel, decoder, receiver and feedback. Furthermore, there is also concept of "noise", which affects the communication process going through the channel and makes the message more difficult to understand by the receiver. Each of those concepts are defined as follows:

Sender: the originator of message.

Encoder: the transmitter which converts the message into signals (the way message is changed into signals, for example sound waves).

C**hannel**: the signal carrier or medium

Decoder: the reception place of the signal which converts signals into message. Decoding is done by the receiver when he gets the message.

Receiver: the recipient of the message from the sender. He usually gives feedback to the sender in order to make sure that the message was properly received.

Noise the message, transferred through a channel, can be interrupted by external noise (for instance, conversation may be interrupted by thunder or crowd noise).
Feedback: The receiver can get an inaccurate message. This is why feedback from the receiver is important in case the message is not properly received. Furthermore, the noise can also affect the decoding of the message by the receiver.

Communication begins at a given point. The first step is the generation of information. The second step is to put this information or data into a medium for transmission towards the intended audience.

During this process, the initiator of the communication must pay extra attention to the nature of the information. The communication skills will determine the effectiveness of their communication.

Types:

On the basis of the communication channels, types of communications are:

A. Verbal

B. Non-Verbal

C. Visual

Verbal

This involves the use of language and words for the purpose of passing on the intended message. In general terms, Verbal Communication means communication in the form of spoken words only. But, in the context of types of communication, verbal communication can be in the spoken or the written form. Thus, the verbal form may be oral or written as discussed below.

- **Written Communication:** This kind of communication involves any kind of exchange of information in the written form. For example, e-mails, texts, letters, reports, SMS, posts on social media platforms, documents, handbooks, posters, flyers, etc.
- **Oral Communication:** This is the communication which employs the spoken word, either direct or indirect as a communication channel. This verbal communication could be made on a channel that passes information in only one form i.e. sound.
  You could converse either face to face, or over the phone, or via voice notes or chat rooms, etc. It all comes under the oral communication. This form of communication is an effective form.

Non-Verbal Communication

In this type of communication, messages are relayed without the transmission of words. The messages here are wordless messages. This form of communication mainly assists verbal communication. It supplements it with gestures, body language, symbols, and expressions.

Through these, one may communicate one's mood, or opinion or even show a reaction to the messages that are relaying. One's non-verbal actions often set the tone for the dialogue. You can control and guide the communication if you control and guide the non-verbal communication. Some of the modes of non-verbal communication are:

Physical Non-verbal Communication

This is the sum total of the physically observable. For instance, hand gestures, body language, facial expressions, the tone of one's voice, posture, stance, touch, gaze, and others. Several researchers have revealed that physical nonverbal communication constitutes about 55% of our daily communications.

These are subtle signals that are picked up as part of our biological wiring. For example, if you rest your head on your palms, it will mean that you are very disappointed or angry. Similarly, other subtle hints will convey your reaction to the presenter or your audience's reaction to you.

Paralanguage

This is the art of reading between the lines. The main kind of such communication is done with the tone of one's voice. This kind of communication amounts to almost 38% of all the communication that we do every day. Along with the tone of voice, the style of speaking, voice quality, stress, emotions, or intonation serves the purpose of communication. And, these aspects are not verbal.

Visual:

Visual communication is the transmission of information and ideas using symbols and imagery. It is one of three main types of communication, along with verbal communication (speaking) and non-verbal communication (tone, body language, etc.). Visual communication is believed to be the type that people rely on most, and it includes signs, graphic designs, films, typography, and countless other examples. Visual communication can be represented in the form of a graph, a map, a chart, a Vann diagram, a pie chart, a model, a table, or even multimedia like gifs, videos, and images.

Barrier To Communication:

There are many reasons why interpersonal communications may fail. In many communications, the message (what is said) may not be received exactly the way the sender intended. It is, therefore, important that the communicator seeks feedback to check that their message is clearly understood.

The skills of Active Listening, Clarification and Reflection may help but the skilled communicator also needs to be aware of the barriers to effective communication and how to avoid or overcome them.

There are many barriers to communication and these may occur at any stage in the communication process. Barriers may lead to your message becoming distorted and you therefore risk wasting both time and/or money by causing confusion and misunderstanding.

Effective communication involves overcoming these barriers and conveying a clear and concise message. Common Barriers to Effective Communication:

- The use of jargon. Over-complicated, unfamiliar and/or technical terms.
- Emotional barriers and taboos. Some people may find it difficult to express their emotions and some topics may be completely 'off-limits' or taboo. Taboo or difficult topics may include, but are not limited

to, politics, religion, disabilities (mental and physical), racism and any opinion that may be seen as unpopular.

- Lack of attention, interest, distractions, or irrelevance to the receiver. Differences in perception and viewpoint.
- Physical disabilities such as hearing problems or speech difficulties.
- Physical barriers to non-verbal communication. Not being able to see the non-verbal cues, gestures, posture and general body language can make communication less effective. Phone calls, text messages and other communication methods that rely on technology are often less effective than face-to-face communication.
- Language differences and the difficulty in understanding unfamiliar accents.
- Expectations and prejudices which may lead to false assumptions or stereotyping. People often hear what they expect to hear rather than what is actually said and jump to incorrect conclusions.
- Cultural differences. The norms of social interaction vary greatly in different cultures, as do the way in which emotions are expressed. For example, the concept of personal space varies between cultures and between different social settings.
- A skilled communicator must be aware of these barriers and try to reduce their impact by continually checking understanding and by offering appropriate feedback.

Note: MCQs of 07 Marks to be asked from this Unit in GTU Exam so practice MCQS.

Practice Questions:

1) What is communication?

a. Communication is the means by which we stay in touch with other people and know what is happening in the world around us

b. Communication is the expression of ourselves in the form of verbal discussion

c. Communication is the varying ways in which we express ourselves

d. Communication is the various mediums we use for interaction

e. Communication is talking, listening, and interacting

2) True of False: All communication is verbal

a. True

b. False

3) What is non-verbal communication?

a. Non-verbal communication is another term for using body language

b. Non-verbal communication is about exchanging information without speaking words

c. Non-verbal communication is another term for written communication

d. Non-verbal communication is for people who cannot speak or hear

4)Which of the following is NOT a form of non-verbal communication?

a. Touch

b. Facial expressions

c. Physical proximity

d. Skype

e. Sign language

5) Which of the following is an example of body language?

a. Facial expression

b. Eye contact

c. Posture

d. Gestures

e. All of the above

6) What is paralanguage?

a. Language for the disabled

b. How something is said, rather than what is said

c. What is said, rather than how it is said

d. When how something is said matches what is being said

e. When how something is said does not match what is being said

7) Factors that influence communication, may become what to effective communication?

a. Barriers

b. Obstacles

c. Enhances

d. Improvements

e. Challenges

8) How will you know if communication was successful?

a. The person smiles and gives open body language

b. The person answers

c. It has the desired outcome

d. The person is agreeable

e. The person tells you

9) What does effective communication require?

a. Purpose or reason

b. Strategy or way of communicating

c. Acknowledgement

d. Feedback

e. All of the above

10) What is efficient communication?

a. Talking quickly and using minimal words to get the point across

b. Spending the minimum amount of time and effort to get the communication message across successfully

c. Ensuring that the message is understood and being thorough enough to get the point across

d. Being able to convey a message with just body language and gestures

e. Being able to use jargon and abbreviations while still being understood

SECTION 2

GRAMMAR

Unit 1

PARTS OF SPEECH

The **part of speech** explains how a word is used in a sentence. The part of speech indicates how the word functions in meaning as well as grammatically within the sentence. An individual word can function as more than one part of speech when used in different circumstances. Understanding parts of speech is essential for determining the correct definition of a word when using the dictionary.

There are eight main parts of speech (also known as word classes): **nouns, pronouns, adjectives, verbs, adverbs, prepositions, conjunctions** and **interjection**

NOUN - (Naming word)

A noun is the name of a person, place, thing or idea.

Examples of nouns: Daniel, London, table, dog, teacher, pen, city, happiness, hope

Example sentences: **Steve** lives in **Sydney**. **Mary** uses **pen** and **paper** to write **letters**

Practice Exercise:

Apply suitable nouns.

1. …..is late today.

2. ….is very expensive these days.

3. He has a blue ….

4. They are very good friends. Their ….is example for many of us.

5. The …..addressed the gathering.

PRONOUN - (Replaces a Noun)

A pronoun is used in place of a noun or noun phrase to avoid repetition.

Examples of pronouns: I, you, we, they, he, she, it, me, us, them, him, her, this, those

Example sentences: Mary is tired. **She** wants to sleep. **I** want **her** to dance with **me**.

Practice Exercise:

Apply suitable pronouns.

1 .I know Mr. James. ….is a very good doctor.

2. Please look after my family members. ….have arrived here today only.

3. Dr. Ranjana was my professor. ….received many awards.

4. Have you seen ….book?

5. The peacock is a beautiful bird. ….feathers are colourful.

ADJECTIVE - (Describing word)

An **adjective** describes, modifies or gives more information about a noun or pronoun.

Examples: big, happy, green, young, fun, crazy, three

Example sentences: The **little** girl had a **pink** hat.

Practice Exercise:

Apply suitable adjectives.

1. I saw a …..truck on the road.
2. There are ….buildings in mega cities.
3. The garden has ……flowers.
4. My friend is wearing a ….shirt.
5. ….students get good marks.

VERB - (Action Word)

A **verb** shows an action or state of being. A verb shows what someone or something is doing.

Examples: go, speak, run, eat, play, live, walk, have, like, are, is

Example sentences: I **like** Woodward English. I **study** their charts and **play** their games.

Practice Exercise:

Apply suitable verbs.

1. Samarth …to college daily.
2. Children …in the garden.
3. We ….newspapers.
4. The manager ….the meeting.
5. I ….this temple everyday.

ADVERB - (Describes a verb)

An **adverb** describes/modifies a verb, an adjective or another adverb. It tells how, where, when, how often or to what extent. Many adverbs end in -LY

Examples: slowly, quietly, very, always, never, too, well, tomorrow, here

Example sentences: I am **usually** busy. **Yesterday**, I ate my lunch **quickly**.

Practice Exercise:

Apply suitable adverbs.

1. The boy ran …..
2. They sang the song …..

3. Rahul can play cricket …..

4. The teacher is teaching this topic …

5. We should listen to this news …..

PREPOSITION - (Shows relationship)

A **preposition** shows the relationship of a noun or pronoun to another word. They can indicate time, place, or relationship.

Examples: at, on, in, from, with, near, between, about, under

Example sentences: I left my keys **on** the table **for** you.

In, On, At, into , for, Since, between, among, to, towards

In:

Use 1: When talking about time, we use 'in' when referring to an unspecific time of the day, a month, a season or a year.

- I always brush my teeth **in** the morning.
- My birthday is **in** June.
- It's always cold **in** winter.
- My brother was born **in** 1999.

Use 2: When talking about places, 'in' is used to indicate a location or place. Here are a few examples:

- "Mumbai is **in** India.
- I am **in** my room.

ON

Use 1: The word 'on', when talking about time, is for specific dates and days.

- He was born **on** September 24th.
- I go to the gym **on** Mondays and Wednesdays.

Use 2: When talking about places, 'on' is used when we are speaking about a surface. Something is on the surface of something else.

For example:

- The papers are **on** the coffee table.
- "I left the keys **on** the counter."

AT

Use 1: When talking about time, 'at' is used for a specific time.

- I will see you **at** 8:00 pm.
- My interview is **at** 3:00 pm.

Use 2: When talking about places, ‘at’ is used to indicate a specific place.

- We are meeting **at** the cafe.
- The football game is **at** the stadium.

INTO:

Used for showing movement: entering a place, building, or vehicle

- Hundreds of athletes marched into the stadium for the opening ceremony.
- She got into her car and drove away.

FOR:

It describes duration. It means “From the start of the period to the end of the period. so it is used for suggesting period of time.

- He has been living in Ahmedabad for several months .
- Usha has worked here for 10 years.

SINCE:

It defines a point in time in the past. It means “From a point in the past until now.”

- He has been watching TV **since 7 pm**.
- Mohan had been writing a book **since 2010**

BETWEEN:

Between is usually used with **two** separate and distinct things.
For example:

- The treasure is between the palm tree and the hut.
- Our holiday house is between the mountains and the sea.

AMONG :

Among is used with separate and distinct things **more than two**. It is used to portray the idea of being in a group or in the midst of a group. For example:

- I want to live among like-minded people.
- Share these sweets among yourselves.
-

TO :

Use 1. It is used to indicate a destination or direction:

- .Does he want to come to the park with us?

Use 2. It is used to indicate time

- Her train arrives at quarter to five.

TOWARDS:

It means in the direction of somebody/something

- They were heading towards the garden.

Sample Exercise:

1. He lives --- Hyderabad.
2. He started --- six --- the morning.
3. . The child has been missing --- yesterday.
4. The mail train is due --- 3 P.M.
5. He travelled thirty kilometres --- two hours.
6. the flower pot was kept….the shelf …the room.
7.. --- last month I have seen him but once.
8. The four friends shared the food ….themselves.
9. I saw him running ….the market.
10. The boy jumped .. the river to save the child.

CONJUNCTION - (Joining word)

A conjunction joins two words, ideas, phrases or clauses together in a sentence and shows how they are connected.

Examples: and, or, but, because, so, yet, unless, since, if.

Example sentences: I was hot and exhausted but I still finished the marathon.

Connectors - ,

If, Unless, Otherwise, Because, Therefore, Who, Which, Where, When, Why.
If & Unless
It shows Condition. if + present simple+ modal verb with future meaning

- If the weather improves, we'll go for a walk.
- Rama will go if Hari goes.

Unless means something similar to 'if … not'

- We'll go to the coast tomorrow unless it rains.
- Grievances cannot be redressed unless they are known.

Otherwise:
It is used to show what the result will be if the thing or condition, mentioned before, does not occur.

- Take your umbrella, **otherwise** you will get wet.

Because:
It connects the result of something with its reason.

- She spoke quietly because she didn't want her friend to hear.

Therefore:
It indicates the cause or result of a situation.

- I studied for long hours, therefore I got very high marks from the final exams.

Who
It is used to introduce a new part of a sentence about a **person** that was mentioned before.

- Mr. Mathur, who is a professor is known to me.

Which
It is used to introduce a new part of a sentence about a **thing** that was mentioned before.

- The book which you bought yesterday is very useful.

Where

It is used to introduce a new part of a sentence about a **place** that was mentioned before.

- The place where players are staying is a five star resort.

When:

It is used to introduce a new part of a sentence about **time** that was mentioned before

- The time when you called me, I was in a meeting.

Why:

It is used to introduce a new part of a sentence about **reason** that was mentioned before

- The officer told us the reason why he was in urgency to leave.

Practice exercise:

Join the sentence groups using suitable connectors.

1. He passed the exam. He had a good teacher.
2. I do not eat meat. I do not eat eggs.
3. She is poor. She is honest.
4. I can not tell you the reason. I will not attend the function.
5. I felt ill. I went on working.
6. Rohit scored a century. India won the match.
7. The car was badly damaged in the accident. It needs repair.
8. We feel bored. We go to the movies to relieve our boredom.
9. Mohit must give in. He must also apologize. Jatin will not forgive him otherwise.
10. The children were playing hide-and-seek.. The rain came down suddenly.

INTERJECTION - (Expressive word)

An interjection is a word or phrase that expresses a strong feeling or emotion. It is a short exclamation.

Examples: Ouch! Wow! Great! Help! Oh! Hey! Hi!

- Wow! I passed my English test.
- Great!
- Ouch! That hurts

Summary chart

Parts Of Speech

NOUN

Name of a person, place, thing or idea.

Examples: Daniel, London, table, hope
- ***Mary*** uses a blue ***pen*** for her ***notes***.

PRONOUN

A pronoun is used in place of a noun or noun phrase to avoid repetition.

Examples: I, you, it, we, us, them, those
- ***I*** want ***her*** to dance with ***me***.

ADJECTIVE

Describes, modifies or gives more information about a noun or pronoun.

Examples: cold, happy, young, two, fun
- The ***little*** girl has a ***pink*** hat.

VERB

Shows an action or a state of being.

Examples: go, speak, eat, live, are, is
- I ***listen*** to the word and then ***repeat*** it.

ADVERB

Modifies a verb, an adjective or another adverb. It tells how (often), where, when.

Examples: slowly, very, always, well, too
- ***Yesterday***, I ate my lunch ***quickly***.

PREPOSITION

Shows the relationship of a noun or pronoun to another word.

Examples: at, on, in, from, with, about
- I left my keys ***on*** the table ***for*** you.

CONJUNCTION

Joins two words, ideas, phrases together and shows how they are connected.

Examples: and, or, but, because, yet, so
- I was hot ***and*** tired ***but*** still finished it.

INTERJECTION

A word or phrase that expresses a strong emotion. It is a short exclamation.

Examples: Ouch! Hey! Oh! Watch out!
- ***Wow!*** I passed my English exam.

Practice Exercise:

To solve this exercise, you have to identify the noun, pronoun, verb, adverb, adjective, preposition, conjunction, interjection in the given sentences.

Tom went to market to buy books (_____).

He went to the market but (_____) did not buy new books.

I **liked** (_____) **him** (_____) better than he likes me.

A smart girl was dancing **quickly** (_____).

She (_____) eats apples in the morning daily.

When he was **sitting** (_____) on the grass, a snake bit him.

You (_____) caught him by his arm.

A **rich** (_____) lady bought a **beautiful** (_____) necklace.

Hurrah! (_____) I have passed the examination.

The cat is sitting **under** (_____) the chair.

Alas! (_____) I could not receive you.

The body of the cage is made of **iron**. (_____)

It is not **your** (_____) pen; it is hers.

There is still some milk **in** (_____) the jug.

Jimmy is **performing** (_____) his duties diligently.

The drawing made by you is **almost** (_____) perfect.

I shall not go **unless** (_____) you allow.

The road is **to** (_____) go by.

The flowers smell **sweet**. (_____)

He **frequently** (_____) goes to the beach.

UNIT 2. TENSES

In grammar, tense is a category that expresses time reference with reference to the moment of speaking. Tenses are usually manifested by the use of specific forms of verbs, particularly in their conjugation patterns. It is very essential to have knowledge of tenses for correct use of a language to establish effective communication.

There are three types of Tenses- **Present, Past and Future.**

Example:

- We watch movies every weekend. - Present Tense
- He wrote an application for that job yesterday. - Past Tense
- You will complete the project by next month. – Future Tense

Present Tense – The verb in present tense refers to the present time.

Past Tense- The verb in past tense refers to the past time.

Future Tense- The verb in future tense refers to the future time.

The tense of a verb shows not only time of action but also the state of action referred to. Each of these Tenses has four sub tenses-

1) **Simple,**
2) **Continuous,**
3) **Perfect and**
4) **Perfect Continuous Tense.**

Simple or Indefinite Tense:

Here the verb specifies the simple action, without anything being said about the completeness or incompleteness of the action.

Sub Tense	Person	Singular	Plural
Present	First person	I speak	We speak
	Second person	You speak	You speak
	Third person	He / She / It speaks	They speak
Past	First person	I Spoke	We spoke
	Second person	You spoke	You spoke
	Third person	He / She / It spoke	They spoke
Future	First person	I shall speak	We shall speak
	Second person	You will speak	You will speak
	Third person	He / She / It will speak	They will speak

Continuous/Progressive Tense:

Here the verb indicates incomplete or continuous action.

Sub Tense	Person	Singular	Plural
Present	First person	I am speaking	We are speaking
	Second person	You are speaking	You are speaking
	Third person	He / She / It is speaking	They are speaking
Past	First person	I was speaking	We were speaking

	Second person	You were speaking	You were speaking
	Third person	He / She / It was speaking	They were speaking

Perfect Tense:

Here the verb shows that the action is completed or perfect.

Sub Tense	Person	Singular	Plural
Present	First person	I have spoken	We have spoken
	Second person	You have spoken	You have spoken
	Third person	He/she/it has spoken	They have spoken
Past	First person	I had spoken	We had spoken
	Second person	You had spoken	You had spoken
	Third person	He/ she/ it had spoken	They had spoken

Perfect Continuous Tense:

Here the verb shows that the action started in past and still it is in progress.

Sub Tense	Person	Singular	Plural
Present	First person	I have been watching	We have been watching
	Second person	You have been watching	You have been watching
	Third person	He/she/it has been watching	They have been watching

USES OF TENSES :-

Present Tense [Simple Present Tense]

It is used:

i. To express a habitual action or an action happens regularly.
Examples:
- The manager gets up at five and starts work at seven
- Umesh practices the piano every day.

ii. For universal or general truth.
Examples:
- The earth turns 360º every day.
- Antarctica is covered with ice.

iii. In narrative such as sports events or demonstrations (substitute for the simple past). Examples:
- Virat catches the ball and he throws it to the wicket.
- First I put some butter in the pan and turn on the cooker.

iv. To express a future event that is part of a fixed timetable.
Examples:
- The train leaves at 03.00 pm sharp.
- The flight is at 07.00 tomorrow morning.

v. To state the facts and things in general that is always true.
Examples:
- India is a rich source of herbs.
- Gold isn't liquid at room temperature.

vi. In exclamatory sentences beginning with 'here' and 'there'.
Examples:
- There goes your trainer!
- Here comes the train you are waiting for!

vii. To introduce quotations.
Example:
- Swami Vivekananda says, "Arise, awake and do not stop until the goal is reached".

viii. Instead of the simple Future Tense in clauses of time and condition
Examples:
- I shall wait till you finish your lunch.
- If you heat water to 100 degrees, it boils.

Present Tense [Present Continuous Tense]

It is used:

i. To indicate an action that is happening at the moment of speaking.
Examples:
- I am just leaving office. I'll be home in an hour.
- Please be quiet. The children are sleeping.

ii. To indicate an action which may not happening at the time of speaking.
Examples:
- Aren't you teaching at the university now?
- At two in the afternoon, we are eating lunch.

iii. For definite future arrangements.
Examples:
- We are going to the beach at the weekend.
- I am not going to the party tonight.

iv. For habits that are not regular, but that happen very often. (an adverb like 'always', 'continuously' or 'constantly' are used)
Example:
- You are continuously losing your keys.
- She is constantly missing the train.
- Adhiraj is always smiling.

v. Verbs which refers to state rather than actions or progress, are not normally used in the continuous form in the present tense:
a) Perceptions: feel, smell, hear, taste, see
b) Emotions: want, wish, envy, fear, dislike, hate, hope, like, love regret, hope, refuse.
c) Thinking: think, suppose, believe, agree, consider, trust, remember, forget, know, understand, imagine
d) Appearing: appear, look, seem.

Present Tense [Present Perfect Tense]

It is used:

i. To indicate an action completed in the recent or immediate past (with just). Examples:
   - I have just finished my work.
   - He has just taken the medicine.

ii. To indicate a past action happened at an unspecified time.
   Examples:
   - I have been to France three times.
   - Madhuri has never travelled by train.
   - Manisha has studied two foreign languages.

iii. To show that something started in the past and has continued up until now. Examples:
   - Rashmi has been in England for six months.
   - Priya has loved chocolate since she was a little girl.

The adverb and adverbial phrases with unfinished time expressions can be used in Present Perfect such as: ever, never, once, many times, several times, before, so far, this month, this year, this week, today, already, yet, etc but not with specific past /finished time expressions such as: yesterday, one year ago, last week, when I was a child, when I lived in Japan, at that moment, that day, one day, etc.

Perfect Continuous Tense (Present Perfect Continuous Tense)

It is used

i. To express actions which started in the past and continue to the present. We often use this with 'for' and 'since'

- I've been living in London for two years.
- She's been working here since 2004.
- We've been waiting for the bus for hours.

ii. To express actions which have recently stopped and have a result, which we can often see, hear, or feel, in the present. We don't use a time word here. The action is over but the effect can be seen.

- I'm so tired, I've been studying.
- I've been running, so I'm really hot.
- It's been raining so the pavement is wet.

Past Tense [Simple Past Tense]

It is used:

i. To express the idea that an action started and finished at a specific time in the past. Examples:
   - I didn't see a play yesterday.
   - Did you have dinner last night?

ii. Sometime the specific time may not be mentioned. It can be implied by context. Example:
   - I didn’t sleep well (last night).

iii. To describe a past habit
   Examples:
   - They never went to school, they always skipped class.
   - Did you play a musical instrument when you were a kid?

Past Tense [Past Continuous Tense]-

It is used:

i. For an action going on at some time in the past.
Examples:
- Kavya was enjoying the games at funfair
- Stuti was preparing for IIT entrance exam.

ii. The past continuous and simple past are used together when a new action happened in the middle of longer action. Simple past used for later action.
Examples:
- While I was writing the email, the computer suddenly went off.
- What were you doing when I called you?

iii. It is also with 'Always', 'continuously' 'continually' or 'constantly' for persistent habit in the past.
Examples:
- She was always coming to class late
- I didn't like them because they were continuously complaining.

Past Tense [Past Perfect Tense]-

It is used:

i. To indicate a completed action before a certain point of time in the past.
Examples:
- When we arrived, the film had started.
- I had never seen such a beautiful beach before I went to Miami.

ii. To express the idea that something occurred before another action in the past. Examples:
- When I reached home, my mother had left for the office.
- I had written the letter before he arrived.

Future Tense [Simple Future Tense]-

It is used:

i. To talk about facts in the future time which we cannot control.
Examples:
- My uncle will turn forty this Sunday
- It will rain this week.

ii. To indicate an action that we think, expect, hope or believe will happen in the future. Examples:
- I think Brazil will win the World Cup.
- I'm sure you will enjoy the games.
- Probably, it will rain today.

iii. To indicate an action that we decide to do at the time of speaking
Examples:
- The task is not completed; I will complete it by evening.
- It is raining. I will take an umbrella.

Sample Exercises:

Rewrite the following sentences using correct form of verbs given in bracket.

1) When you arrive tonight, we…….. (go) out for dinner.

2) Whenever we meet, we …….. (plan) a trip.
3) The sun …….. (shine) brightly.
4) Vijay …….. (wait) for me when I arrived.
5) I promise I …….. (not/tell) him about the surprise party.
6) Shikhar Dhawan …….. (score) a century in the last match.
7) I …….. (get) hungry. Let's go and have something to eat.
8) . …….. (have) you ever …….. (visit) the U.S. before your trip in 2006?
9) Who …….. (invent) the bicycle?
10) Yesterday evening the phone …….. (ring) three times while we …….. (have) dinner.
11) When I met you last time, you …….. (think) of moving to a new flat.
12) She only understood the movie because she …….. (read) the book.
13) Can you …….. (help) me move this heavy table?
14) Hello Nitya, I …….. (not/see) you for ages. How are you?
15) We can go out now. It …….. (not/rain) any more.
16) He …….. (go) to that place every year.
17) There I…….. (notice) how important it…….. (be) to speak English nowadays.
18) And I…….. (already begin /) to read the novel.
19) If I …….. (pass) my exams successfully, I…….. (start) an apprenticeship in September.
20) While I …….. (do) the language course, I …….. (meet) lots of young people from all over the world.

UNIT 3. MODAL AUXILIARIES

An Auxiliary verb is a verb which helps or supports the main verb to form its tense, voice or mood. They are basically helping verbs and there are two types of Auxiliaries:

Primary & Modal.

[1] Primary Auxiliaries

a) Be (am, is, are ,was, were)

- I am a doctor.
- He was given a prize by the principal.
- They are doing their work.
- They were working here last year.

b) have (has, had) [Possession]

- We have a flat in Ahmedabad.
- Dr Tanna has a car.
- She had no money.

c) do (does, did) (Questions & Negative)

- What do you want from me? I don't have enough money.
- Does he go school on time?
- Did he complete his work?

[2] Modal Auxiliaries are used to express various moods and attitudes like permission, ability, duty, advice, suggestion, possibility …

SHALL

- He shall leave for Ahmedabad tomorrow. (Future)
- You shall be punished if you are late again. (Threat)
- You shall go out of the class. (Command)
- She shall have a prize. (Promise)
- Shall we have a cup of coffee?(Suggestion/ Proposal)
- Shall I carry your luggage? (to offer service)

SHOULD

- We should obey our elders. (Duty)
- We should keep promises.(Obligation)
- She should be in laboratory now. (Probability)

WILL

- He will come tomorrow. (Future)

- Will you lend me a pen, please? (Polite Request)
- I will speak to your customer care. (Threat)
- You will not go without my permission. (Command)
- I will teach you English (Promise)
- I will meet my target. (Determination)
- I will come to see you tomorrow. (Willingness)

WOULD

- Would you lend me your scooter, please? (Politeness)
- I wish you would get good marks.(Desire)
- I would like to have some coffee (likes/dislikes)
- I would rather stay at home than watching movie. (preference)

CAN

- She can speak English fluently. (Ability)
- We can walk 5 kms a day. (Capacity)
- Ramesh can come tomorrow. (Permission)
- She can be at home. (Possibility)

COULD

- I could run fast, when I was young. (Ability in Past)
- Could you help me in my assignment? (Request / Politeness)

MAY

- The guest may come. (Possibility)
- May I Come in Sir ? (Permission)
- It may rain today. (Uncertainty)
- May God bless you! (Wishes/Blessings)

MIGHT

- He might not come (Rare Possibility)
- Mayank has not come to school today. He might have missed the bus. (Possibility of Past)

MUST

- I must get the first prize. (Determination)
- He must have attended the meeting. (Certainty)
- You must pass mid semester exam. (Compulsion.)
- You must do your homework regularly. (Necessity)
- You must not speak loudly in the hospital. (Prohibition.)

Note:- have to/has to also suggests compulsion and necessity. Had to is used to show feeling of compulsion in past.

- I have to submit an assignment tomorrow.
- I had to submit the assignment yesterday though I was not much satisfied with my work.

NEED

- You need to go to a doctor.(Necessity)
- You need not study as the examination is over (absence of Necessity)

OUGHT TO

- We ought to love our neighbours. (Duty / Obligation / Desire)

Sample Exercise:

[1] Fill in the blanks with appropriate modal auxiliary:

1. On Saturdays, we …….go to school in informal dress.
2. Varun …… go for a vacation this summer.
3. When I was young, I …… swim across Ganga.
4. You ……not raise your voice.
5. I ……. to work hard to improve my performance.

[2] Fill in the blanks with appropriate modal auxiliary:

1) ……..we play football? (Permission)
2) The astrologer ….. leave the village as he lied to people. (compulsion)
3) The Indian Eleven ……. be disheartened. (Absence of Necessity)
4) ……we go to their help? (suggestion)
5) She ……come tomorrow.(Possibility)
6) ……have your book? (Permission)
7) Tomorrow ….. be a holiday. (Future)
8) Do not put off till tomorrow what you …. do today. (Ability)
9) He ….not tell a lie before me. (Desirability)
10) You …..come whenever you like. (Permission)
11) ……..god help you. (Blessing)
12) We …….honour our parents . (Moral obligation)
13) ……. You please let me have your book? (Polite request)
14) You …. Carry out government orders. (Compulsion)

15) He tried hard but … not lift it. (Past ability)
16) People …….. to vacate the village, as the flood has crossed the danger mark. (Necessity)
17) I ……borrow from this library very soon. (Ability)
18) We ……help the needy. (Desirability)
19) …….I carry your luggage? (Permission)
20) You …..not go until you finish this assignment. (Prohibition)
21) She ….. climb the hill when she was in college. (past ability)
22) ……..you teach my brother phonetics, please? (polite request)
23) I …….. read French. (ability)
24) They …..not enter the kitchen with shoes. (prohibition)
25) …….we have a cup of tea?(suggestion)
26) You ….. write assignment in this book. (permission)
27) We …… to take our umbrella as it is raining. (necessity)
28) We ….. take bath in the morning daily. (desirability)
29) Your wrist watch is almost new. You ……. Buy another one. (absence of necessity)
30) You ….. smoke at a petrol pump. It is highly inflammable. (negative obligation)
31) ……. You sweep my drawing room? (polite request)
32) No one …….. carry explosives in the train. (negative prohibition)

UNIT 4. SUBJECT VERB AGREEMENT

Subject – Verb Agreement means the harmony between the subject of the sentence and the verb. The verb always follows the subject of the sentence.

1. A finite verb must agree its subject in person and number.

Examples:

- I am reading a book.
- He is playing.
- The child is playing.
- The children are watching cartoons.

2. The Error of Proximity:

In cases where subject and verb are separated by a long phrase or a clause, the verb agrees with the real subject and not the noun or pronoun placed next to it.

Examples:

- The apples in the basket are fresh.
- The strong bond of affection between the two cousins was obvious.
- The joys one experiences in one's childhood are beyond description.

3. The Introductory '*There':*

In a sentence beginning with *there*, the verb agrees with the real subject that follows *there.*

Examples:

- There is no proof of his involvement in this case.
- There are major flaws in your argument.

4. Two or More Nouns or Pronouns joined by 'And'

(a) Subject consists of two or more nouns or pronouns joined by and- PLURAL Verb.

Examples:

- He and I were given the responsibility of the stage.
- Hard work and sincere efforts are the key to success.

(b) The nouns refer to the same person or thing –SINGULAR Verb

Examples:

- The director and producer of the movie was present there.
- Rice and curry is his favorite dish.

(c) The nouns convey the same meaning, placed together only for emphasis-Singular verb

Examples:

- The honour and the glory of my country is uppermost in my mind.
- The power and influence Gandhiji exerted over the Indian masses was really great.

5. Subject consists of two nouns or pronouns joined with as well as, together with, along with, in addition to: verb agrees with the first subject

Examples:

- Mr. Das as well as his friends has escaped unhurt.
- You as well as I are responsible for our losses.
- The captain with othe team members was given a hearty welcome.

6.Two subjects joined with not only, but also: Verb agrees with the latter subject

Example:

- Not only the principal but also the teachers have played an important role.

7. Two subjects joined with…or, neither…has .nor verb agreed with the latter subject.

Examples:

- Either you or Gaurav is responsible for the mistake.
- Neither Gaurav nor you are responsible for the mistake.

8. One subject singular and the other plural

The pattern is: **Either /Neither+ Singular sub +or/nor + Plural sub. Plural verb**

Examples:

- Either he or his parents are going to attend the marriage.
- Neither the moon nor the stars are shining today.

9. **Either, Neither, Each, Everyone, One of the -Singular Verb**

Examples:

- She does not care what either of her parents says.
- Neither of these two students has done well.
- Each of the students has to submit the assignment.
- Everyone in the family has been questioned.
- One of the books is going to win the Booker Prize.

10. None refers to amount or quality - Singular Verb

Example:

- None of the work was done.
  - **None followed by plural noun or pronoun: Verb usually plural but can be singular**

  Examples:

- None of the stories are interesting.
- None of his stories has appealed the audience.

11. Much, More, Little, Less - Singular Verb

Examples:

- Much of my anxiety is over.
- More than half of the time is over.
- Little has been achieved so far.
- Less of my time is now wasted on attending to phone calls.

12. A lot of, a great deal of, plenty of, most of, some of, refer to amount or quantity

Singular Verb Examples:

- A lot of time was wasted on preliminary enquiries.
- Plenty of help was available.
- Lots of food was distributed to the poor.

➢ **A lot of, a great deal of, plenty of, most of, some of refer to number.**

Plural Verb Examples:

- Lots of people are taking part in the marathon.
- Plenty of shops accept payments by a credit card.

Sample Exercise:

[1] Fill in the blanks:-

1. The sound of bells ……..(was, were) heard all over the neighborhood.
2. Sincere effort not more advice …. (is, are) the need of the hour.
3. Some of the work (remain, remains) to be done.
4. Either the captain or the bowler …. (is, are) at fault.
5. The teacher along with the students (have, has) gone on picnic.
6. Neither of the candidates (was, were) suitable.
7. The teacher as well as the students (was, were) present on the ground.
8. She, not you (have, has) given the right answer.

[2] Pick the right verb:-

1. His use of clauses and connectors (is/are) appalling.
2. One of the students in my class (own/owns) a motorcycle.
3. There (was/were) several; people in the adjoining room.
4. The deputy along with thirty miners (were/was) killed.
5. The pump including the motor and the hose (cost/costs) Rs. 10,000/-.
6. Either the sand or the cement (is/are) bad.
7. The chief engineer accompanied by two executive engineers (is/are) coming today.
8. Each of the boxes (weigh/weighs) 10 kgs.
9. None if the gas (has/have) been consumed.
10. Either Ram or his brother (work/works) as a manager here.
11. None of them (attends/attend) to their work these days.
12. Some of the work (remain/remains) unfinished.
13. Some of the pipes (run/runs) for several miles.
14. All the oil (has/have) been stolen.
15. All the laborers (is/are) tribals.
16. Apple pie and custard (is/are) my favourite dish.
17. Some people (dislikes, dislike) travelling by sea, as it (make, makes) them sea-sick.
18. The Thirty-Nine steps (was, were) written by John Buchan.
19. The secretary and the member (has, have) come to visit the institute today.
20. The trouble with these guys (is,are) their rustic approach.

21. A lot of good we take (is/are) wasted.
22. A large amount of money he invested (was/were) lost.
23. Some more milk (is/are) needed.
24. None of these dishes (is/are) to my taste.
25. Only a few students (is/are) likely to fail.
26. A little dust (is/are) visible.
27. A lot of money (has/have) been spent on buildings.
28. None of the children (is/are) intelligent.
29. The president and the secretary (were/was) arrested.

UNIT 5 Basic Sentence Patterns of English

Sentence: A sentence is a textual unit consisting of one or more words that are grammatically linked.

Here we will study basic four patterns of English. For better understanding of the same, We need to understand the following terms.

Subject: A *subject* is a part of a sentence that contains the person or thing performing the action (or *verb*) in a sentence. Traditionally the subject is the word or phrase which controls the verb in the clause.

- **The peon** rings the bell.

Verb: Verbs are words that express action or state of being. You have studied about them in parts of speech and tenses. They are action words in the sentence.

- He **runs** fast.

Object: An object is a noun, a noun phrase, or a pronoun that is affected by the action of a verb.

- Ram is reading **a newspaper**.

Adverbial: Adverbials are words that we use to give more information about a verb. They can be one word (angrily, here) or phrases (at home, in a few hours) and often say how, where, when or how often something happens or is done, though they can also have other uses..

- He speaks **fluently.**
- Lata ate breakfast **yesterday morning**.

Complement: Complement is the term used for a word or words that are needed to complete the meaning of an expression.

- Algebra is difficult.

The following are basic four patterns to make a meaningful sentence.

1. **S + V : Subject + Verb**

- He/ laughed.
- Dogs/ bark.
- We /enjoyed.

2. S+V+O: Subject + Verb+ Object

- We / received / the parcel.
- Many students / witnessed / the play.
- The police / arrested / the thief

3. S+V+A: Subject + Verb+ Adverbial

- The train / arrived / late
- It / rained / last night
- He / reads / slowly

4. S+V+C: Subject + Verb+ Complement

- They / are / players.
- I / am / an Indian.
- Her father / is / a doctor

Practice exercise

1. Identify the sentence pattern of given sentences.

1. They / worked / hard
2. It / was / a very pleasant talk
3. The winner was rewarded.
4. She / sings / a song
5. They / came / suddenly.
6. The class / became / noisy
7. People/ cried.
8. Her father / is / a doctor
9. I /refuse.
10. You/ are/ intelligent.

2. Form ten sentences of each sentence pattern.

SECTION 3

PROSE AND POETRY

Unit 1
The Leopard

Ruskin Bond

I first saw the leopard when I was crossing the small stream at the bottom of the hill.

The ravine was so deep that for most of the day it remained in shadow. This encouraged many birds and animals to emerge from cover during daylight hours. Few people ever passed that way: only milkmen and charcoal-burners from the surrounding villages.

As a result, the ravine had become a little haven of wildlife, one of the few natural sanctuaries left near Mussoorie, a hill- station in northern India.

Below my cottage was a forest of oak and maple and Himalayan rhododendron. A narrow path twisted its way down through the trees, over an open ridge where red sorrel grew wild, and then steeply down through a tangle of wild raspberries, creeping vines and slender bamboo.

At the bottom of the hill the path led on to a grassy verge, surrounded by wild dog roses. (It is surprising how closely the flora of the lower Himalayas, between 5,000 to 8,000 feet, resembles that of the English countryside.)

The stream ran close by the verge, tumbling over smooth pebbles, over rocks worn yellow with age, on its way to the plains and to the little Song River and finally to the sacred Ganges.

When I first discovered the stream it was early April and the wild roses were flowering—small white blossoms lying in clusters.

I walked down to the stream almost every day, after two or three hours of writing.

I had lived in cities too long, and had returned to the hills to renew myself, both physically and mentally. Once you have lived with mountains for any length of time, you belong to them, and must return again and again.

Nearly every morning, and sometimes during the day, I heard the cry of the barking deer. And in the evening, walking through the forest, I disturbed parties of pheasant. The birds went gliding down the ravine on open, motionless wings. I saw pine martens and a handsome red fox, and I recognized the footprints of a bear.

As I had not come to take anything from the forest, the birds and animals soon grew accustomed to my presence; or possibly they recognized my footsteps. After some time, my approach did not disturb them.

The langurs in the oak and rhododendron trees, who would at first go leaping through the branches at my approach, now watched me with some curiosity as they munched the tender green shoots of the oak. The young ones scuffled and wrestled like boys, while their parents groomed each other's coats, stretching themselves out on the sunlit hillside. But one evening, as I passed, I heard them chattering in the trees, and I knew I was not the cause of their excitement.

As I crossed the stream and began climbing the hill, the grunting and chattering increased, as though the langurs were trying to warn me of some hidden danger. A shower of pebbles came rattling down the steep hillside, and I looked up to see a sinewy, orange-gold leopard poised on a rock about twenty feet above me.

It was not looking towards me, but had its head thrust attentively forward, in the direction of the ravine. Yet it must have sensed my presence, because it slowly turned its head and looked down at me.

It seemed a little puzzled at my presence there; and when, to give myself courage, I clapped my hands

sharply, the leopard sprang away into the thickets, making absolutely no sound as it melted into the shadows.

I had disturbed the animal in its quest for food. But a little after I heard the quickening cry of a barking deer as it fled through the forest. The hunt was still on.

The leopard, like other members of the cat family, is nearing extinction in India,and I was surprised to find one so close to Mussoorie. Probably the deforestation that had been taking place in the surrounding hills had driven the deer into this green valley; and the leopard, naturally, had followed.

It was some weeks before I saw the leopard again, although I was often made aware of its presence. A dry, rasping cough sometimes gave it away. At times I feltalmost certain that I was being followed.

Once, when I was late getting home, and the brief twilight gave way to a dark, moonless night, I was startled by a family of porcupines running about in a clearing.I looked around nervously, and saw two bright eyes staring at me from a thicket. I stood still, my heart banging away against my ribs. Then the eyes danced away, and Irealized that they were only fireflies.

In May and June, when the hills were brown and dry, it was always cool and green near the stream, where ferns and maidenhair and long grasses continued to thrive.

Downstream I found a small pool where I could bathe, and a cave with water dripping from the roof, the water spangled gold and silver in the shafts of sunlightthat pushed through the slits in the cave roof.

'He maketh me to lie down in green pastures: he leadeth me beside the still waters.' Perhaps David had discovered a similar paradise when he wrote those words; perhaps I, too, would write good words. The hill-station's summer visitors had not discovered this haven of wild and green things. I was beginning to feel thatthe place belonged to me, that dominion was mine.

The stream had at least one other regular visitor, a spotted forktail, and though itdid not fly away at my approach it became restless if I stayed too long, and then it would move from boulder to boulder uttering a long complaining cry.

I spent an afternoon trying to discover the bird's nest, which I was certain contained young ones, because I had seen the forktail carrying grubs in her bill. The problem was that when the bird flew upstream I had difficulty in following her rapidly enough as the rocks were sharp and slippery.

Eventually I decorated myself with bracken fronds and, after slowly making my way upstream, hid myself in the hollow stump of a tree at a spot where the forktail often disappeared. I had no intention of robbing the bird: I was simply curious to seeits home.

By crouching down, I was able to command a view of a small stretch of the stream and the sides of the ravine; but I had done little to deceive the forktail, who continued to object strongly to my presence so near her home.

I summoned up my reserves of patience and sat perfectly still for about ten minutes. The forktail quietened down. Out of sight, out of mind. But where had she gone? Probably into the walls of the ravine where I felt sure, she was guarding hernest.

I decided to take her by surprise, and stood up suddenly, in time to see not the forktail on her doorstep, but the leopard bounding away with a grunt of surprise! Two urgent springs, and it had crossed the stream and plunged into the forest.

I was as astonished as the leopard, and forgot all about the forktail and her nest. Had the leopard been following me again? I decided against this possibility. Only man-eaters follow humans, and, as far as I knew, there had never been a man-eaterin the vicinity of Mussoorie.

During the monsoon the stream became a rushing torrent, bushes and small trees were swept away, and the friendly murmur of the water became a threatening boom.I did not visit the place too often, as there were leeches in the long grass.

One day I found the remains of a barking deer which had only been partly eaten. Iwondered why the

leopard had not hidden the rest of his meal, and decided that it must have been disturbed while eating.

Then, climbing the hill, I met a party of hunters resting beneath the oaks. They asked me if I had seen a leopard. I said I had not. They said they knew there was a leopard in the forest.

Leopard skins, they told me, were selling in Delhi at over 1,000 rupees each. Of course there was a ban on the export of skins, but they gave me to understand that there were ways and means. . . . I thanked them for their information and walked on,feeling uneasy and disturbed.

The hunters had seen the carcass of the deer, and they had seen the leopard's pug-marks, and they kept coming to the forest. Almost every evening I heard their guns banging away; for they were ready to fire at almost anything.

'There's a leopard about,' they always told me. 'You should carry a gun.''I don't have one,' I said.

There were fewer birds to be seen, and even the langurs had moved on. The red fox did not show itself; and the pine martens, who had become quite bold, now dashed into hiding, at my approach. The smell of one human is like the smell of anyother.

And then the rains were over and it was October; I could lie in the sun, on sweet- smelling grass, and gaze up through a pattern of oak leaves into a blinding blue heaven. And I would praise God for leaves and grass and the smell of things, the smell of mint and bruised clover, and the touch of things—the touch of grass and airand sky, the touch of the sky's blueness.

I thought no more of the men. My attitude towards them was similar to that of the denizens of the forest. These were men, unpredictable, and to be avoided if possible.

On the other side of the ravine rose Pari Tibba, Hill of the Fairies: a bleak, scrub-covered hill where no one lived.

It was said that in the previous century Englishmen had tried building their houseson the hill, but the area had always attracted lightning, due to either the hill's location or due to its mineral deposits; after several houses had been struck by lightning, the settlers had moved on to the next hill, where the town now stands.

To the hillmen it is Pari Tibba, haunted by the spirits of a pair of ill-fated loverswho perished there in a storm; to others it is known as Burnt Hill, because of its scarred and stunted trees.

One day, after crossing the stream, I climbed Pari Tibba—a stiff undertaking, because there was no path to the top and I had to scramble up a precipitous rock-facewith the help of rocks and roots that were apt to come loose in my groping hand.

But at the top was a plateau with a few pine trees, their upper branches catching the wind and humming softly. There I found the ruins of what must have been the houses of the first settlers—just a few piles of rubble, now overgrown with weeds,sorrel, dandelions and nettles.

As I walked through the roofless ruins, I was struck by the silence that surrounded me, the absence of birds and animals, the sense of complete desolation.

The silence was so absolute that it seemed to be ringing in my ears. But there wassomething else of which I was becoming increasingly aware: the strong feline odour of one of the cat family.

I paused and looked about. I was alone. There was no movement of dry leaf or loose stone. The ruins were for the most part open to the sky. Their rotting rafters had collapsed, jamming together to form a low passage like the entrance to a mine;and this dark cavern seemed to lead down into the ground.

The smell was stronger when I approached this spot, so I stopped again and waited there, wondering if I had discovered the lair of the leopard, wondering if the animal was now at rest after a night's hunt.

Perhaps he was crouching there in the dark, watching me, recognizing me,knowing me as the man who walked alone in the forest without a weapon.

I like to think that he was there, that he knew me, and that he acknowledged my visit in the

friendliest way: by ignoring me altogether.

Perhaps I had made him confident—too confident, too careless, too trusting of thehuman in his midst. I did not venture any further; I was not out of my mind. I did not seek physical contact, or even another glimpse of that beautiful sinewy body, springing from rock to rock. It was his trust I wanted, and I think he gave it to me.

But did the leopard, trusting one man, make the mistake of bestowing his trust on others? Did I, by casting out all fear—my own fear, and the leopard's protective fear —leave him defenseless?

Because next day, coming up the path from the stream, shouting and beating drums, were the hunters. They had a long bamboo pole across their shoulders; and slung from the pole, feet up, head down, was the lifeless body of the leopard, shot in the neck and in the head.

'We told you there was a leopard!' they shouted, in great good humour. 'Isn't he afine specimen?'

'Yes,' I said. 'He was a beautiful leopard.'

I walked home through the silent forest. It was very silent, almost as though thebirds and animals knew that their trust had been violated.

I remembered the lines of a poem by D. H. Lawrence; and, as I climbed the steepand lonely path to my home, the words beat out their rhythm in my mind: 'There was room in the world for a mountain lion and me.'

Glossary:

Ravine: Narrow Valley

Sanctuary: Shelter

Curiosity: Interest

Extinction: Loss

Pasture: Grazing Land

Precipitous: Steep

Denizens: A person, animal, or plant that lives or is found in a particular place

Glimpse: Sight

Ex: 1. Choose the correct option:

1. The author first saw the leopard when …
   (a) he was climbing the hill (b) it was caught by hunters (c) he was crossing the stream (d) he was going after forktail
2. When the author discovered the stream, it was month of …
   (a) May (b) June (c) February (d) April
3. The … was a regular visitor of the stream.
   (a) Forktail (b) Tiger (c) lion (d) sparrow
4. Leopared skins are sold in ….
   (a) Delhi (b) Kolkatta (c) Lucknow (d) Mumbai
5. ….. is called *Hill of Fairies*
   (a) Pari Hill (b) Angel Tibba (c) God Hill (d) Pari Tibba

Ex: 2. Answer the following questions:

1. Describe the valley where the leopard lived.
2. Why did the author return to mountains?
3. Why didn't his approach disturb the birds and animals?
4. What happened when the leopard sensed the author's presence?
5. What did the author do to find forktails's home?
6. What was the hunters' advice to the author?
7. What was the author's attitude towards men?

Suggested Speaking Skills Topics (For 30 Marks of PA in LAB)

1. Beauty of Nature
2. Cruelty towards Animals
3. Environment Conservation

UNIT 2 After Twenty Years

O'Henry

The policeman on the beat moved up the avenue impressively. The impressiveness was habitual and not for show, for spectators were few. The time was barely 10 o'clock at night, but chilly gusts of wind with a taste of rain in them had well nigh depeopled the streets.

Trying doors as he went, twirling his club with many intricate and artful movements, turning now and then to cast his watchful eye adown the pacific thoroughfare, the officer, with his stalwart form and slight swagger, made a fine picture of a guardian of the peace. The vicinity was one that kept early hours. Now and then you might see the lights of a cigar store or of an all-night lunch counter; but the majority of the doors belonged to business places that had long since been closed.

When about midway of a certain block the policeman suddenly slowed his walk. In the doorway of a darkened hardware store a man leaned, with an unlighted cigar in his mouth. As the policeman walked up to him the man spoke up quickly.

"It's all right, officer," he said, reassuringly. "I'm just waiting for a friend. It's an appointment made twenty years ago. Sounds a little funny to you, doesn't it? Well, I'll explain if you'd like to make certain it's all straight. About that long ago there used to be a restaurant where this store stands--'Big Joe' Brady's restaurant."

"Until five years ago," said the policeman. "It was torn down then."

The man in the doorway struck a match and lit his cigar. The light showed a pale, square-jawed face with keen eyes, and a little white scar near his right eyebrow. His scarfpin was a large diamond, oddly set.

"Twenty years ago to-night," said the man, "I dined here at 'Big Joe' Brady's with Jimmy Wells, my best chum, and the finest chap in the world. He and I were raised here in New York, just like two brothers, together. I was eighteen and Jimmy was twenty. The next morning I was to start for the West to make my fortune. You couldn't have dragged Jimmy out of New York; he thought it was the only place on earth. Well, we agreed that night that we would meet here again exactly twenty years from that date and time, no matter what our conditions might be or from what distance we might have to come. We figured that in twenty years each of us ought to have our destiny worked out and our fortunes made, whatever they were going to be."

"It sounds pretty interesting," said the policeman. "Rather a long time between meets, though, it seems to me. Haven't you heard from your friend since you left?"

"Well, yes, for a time we corresponded," said the other. "But after a year or two we lost track of each other. You see, the West is a pretty big proposition, and I kept hustling around over it pretty lively. But I know Jimmy will meet me here if he's alive, for he always was the truest, stanchest old chap in the world. He'll never forget. I came a thousand miles to stand in this door to-night, and it's worth it if my old partner turns up."

The waiting man pulled out a handsome watch, the lids of it set with small diamonds.

"Three minutes to ten," he announced. "It was exactly ten o'clock when we parted here at the restaurant door."

"Did pretty well out West, didn't you?" asked the policeman.

"You bet! I hope Jimmy has done half as well. He was a kind of plodder, though, good fellow as he was. I've had to compete with some of the sharpest wits going to get my pile. A man gets in a groove in New York. It takes the West to put a razor-edge on him."

The policeman twirled his club and took a step or two.
"I'll be on my way. Hope your friend comes around all right. Going to call time on him sharp?"

"I should say not!" said the other. "I'll give him half an hour at least. If Jimmy is alive on earth he'll be here by that time. So long, officer."

"Good-night, sir," said the policeman, passing on along his beat, trying doors as he went.

There was now a fine, cold drizzle falling, and the wind had risen from its uncertain puffs into a steady blow. The few foot passengers astir in that quarter hurried dismally and silently along with coat collars turned high and pocketed hands. And in the door of the hardware store the man who had come a thousand miles to fill an appointment, uncertain almost to absurdity,with the friend of his youth, smoked his cigar and waited.

About twenty minutes he waited, and then a tall man in a long overcoat, with collar turned up to his ears, hurried across from the opposite side of the street. He went directly to the waiting man.

"Is that you, Bob?" he asked, doubtfully.

"Is that you, Jimmy Wells?" cried the man in the door.

"Bless my heart!" exclaimed the new arrival, grasping both the other's hands with his own. "It's Bob, sure as fate. I was certain I'd find you here if you were still in existence. Well, well, well--twenty years is a long time. The old gone, Bob; I wish it had lasted, so we could have had another dinner there. How has the West treated you, old man?"

"Bully; it has given me everything I asked it for. You've changed lots, Jimmy. I never thought you were so tall by two or three inches."

"Oh, I grew a bit after I was twenty." "Doing

well in New York, Jimmy?"

"Moderately. I have a position in one of the city departments. Come on, Bob; we'll go around to a place I know of, and have a good long talk about old times."

The two men started up the street, arm in arm. The man from the West, his egotism enlarged by success, was beginning to outline the history of his career. The other, submerged in his overcoat, listened with interest.

At the corner stood a drug store, brilliant with electric lights. When they came into this glare each of them turned simultaneously to gaze upon the other's face.

The man from the West stopped suddenly and released his arm.

"You're not Jimmy Wells," he snapped. "Twenty years is a long time, but not long enough to change a man's nose

from a Roman to a pug."

"It sometimes changes a good man into a bad one," said the tall man. "You've been under arrest for ten minutes, 'Silky' Bob. Chicago thinks you may have dropped over our way and wires us she wants to have a chat with you. Going quietly, are you? That's sensible. Now, before we go on to the station here's a note I was asked to hand you. You may read it here at the window. It's from Patrolman Wells."

The man from the West unfolded the little piece of paper handed him. His hand was steady when he began to read, but it trembled a little by the time he had finished. The note was rather short.

"Bob: I was at the appointed place on time. When you struck the match to light your cigar I saw it was the face of the man wanted in Chicago. Somehow I couldn't do it myself, so I went around and got a plain clothes man to do the job."

JIMMY.

."

Glossary:

on the beat: usual path of a policeman on duty
avenue : road with trees on both sides
habitual : usual
intricate : complicated
chilly: very cold
gust: sudden violent rush of wind
pacific: peaceful
thoroughfare: a street much used by traffic and open at both ends
swagger: walk in a proud manner
vicinity: surroundings, neighbourhood
reassuringly: comfortingly and without any fear
torn down: pulled down, demolished
oddly: strangely
chum: close friend
chap: fellow, man
dragged out: caused to last an unnecessarily long time in
bustling around: moving around quickly
turns up: comes up, arrives
plodder: person who works slowly but earnestly
groove: way of living that becomes a habit
twirled: turned round quickly
club: heavy stick with one thick end
drizzle: rain in many fine drops
astir: in a state of excitement
dismally: gloomy
lasted: existed for more time
egotism: practice of talking about oneself
chat: friendly talk

Sample Exercises:

Ex: 1. Choose the correct option:

1. The location of the story is near ….
   (b) Dehradun (b) Mussoorie (c) Shimla (d) Dharmashala
3. Where was the man standing?
   (b) Near general store (b) near medical store (c) near bus stand (d) near hardware store
4. When was the appointment made ?
   (a) Before 20 years (b) before 15 years (c) after 20 years
   (d) before 10 years
5. The man was waiting for his _____.
   (b) wife (b) friend (c) brother (d) customer
6. The man and his friend Jimmy belong to _____ city.
   (a) New York (b) London (c) Mumbai (d) Paris
7. What was the time of appointment?
   (a) 12 o'clock (b) 11 o'clock (c) 10 o'clock (d) 9 o'clock
8. What did the tall man handed over to Bob?
   (a) A book (b) a bag (c) a chocolate (d) a note
9. Who wrote the note?
   (a) Bob (b) Jimmy (c) Vera (d) O'Henry

Ex: 2. Answer the following questions:

8. How did the policeman move up the avenue?
9. How was the weather that night?
10. What did the stranger say to the policeman?
11. What was there in place of the store at that spot twenty years ago?
12. Who was the stranger's friend?
13. Where did they take the last dinner?
14. What kind of man was his friend Jimmy?
15. What did Bob tell the man in the overcoat?
16. Was he really his friend Jimmy Wells?
17. Why was Bob under arrest?
18. Whose note was handed over to Bob in the end?

Suggested Speaking Skills Topics (For 30 Marks of PA in LAB)

1. Friendship
2. What is more important- duty or relations?
3. The choice between Right and Wrong .

UNIT 3 Stopping by Woods on a Snowy Evening

Robert Frost

Whose woods these are I think I know.
His house is in the village though;
He will not see me stopping here
To watch his woods fill up with snow.

My little horse must think it queer
To stop without a farmhouse near
Between the woods and frozen lake
The darkest evening of the year.

He gives his harness bells a shake
To ask if there is some mistake.
The only other sound's the sweep
Of easy wind and downy flake.

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep

Glossary:

Woods : an area of land covered with thick growth of trees
Queer: beyond or deviating from the usual or expected
Farmhouse: a house attached to a farm
Frozen: turned into ice
Harness: an arrangement of leather straps fitted to a draft animal
Flake : a crystal of snow
Promise: a verbal commitment to do something in the future
Sleep : euphemisms for death

Sample Exercise:

Q.1 Where was the speaker going? What stopped him on the way?
Q.2 What according to the speaker will surprise the horse?
Q.3 What does the speaker wish to convey through the phrase "fill up with the snow"?
Q.4 What does the poet says about the owner of the woods?
Q.5 What are the sights and sounds that the poet experiences in the woods?
Q.6 What promises do you think the poet has to keep?
Q.7 What message do the last paragraph convey?
Q. 8 What is the role played by the horse in this poem?

Q. 9 Write a short note on :

(1) Description of nature

(2) Central idea of the poem

UNIT 4 Where the Mind is Without Fear

Rabindranath Tagore,

"Where the mind is without fear

and the head is held high,

where knowledge is free.

Where the world has not been broken up into fragments by narrow domestic walls.

Where words come out from the depth of truth,

where tireless striving stretches its arms toward perfection.

Where the clear stream of reason has not lost it's way

into the dreary desert sand of dead habit.

Where the mind is led forward by thee

into ever widening thought and action.

In to that heaven of freedom, my father,

LET MY COUNTRY AWAKE!"

—

Glossary:

Fragments- pieces

Head is held high- self respect

Domestic- pertaining to family.

Striving – try hard, motivated.

Tireless - without getting tired

Stream: river

Dreary: dull

Reason: intellect

Dead habit: old customs

Desert – dry area of land

Awake- to get up from sleep

Sample Exercise:

Q.1 What is meant by "mind is without fear and head is held high". Tick the correct answer.

(i) to be fearless and self respecting

(ii) to be proud of one's high position .

(iii) to stand straight and be carefree.

Q. 2. What does the poet mean by “where knowledge is free”?

Q.3. The ‘domestic walls’ are usually associated with safety, comfort and love.What is the meaning of ‘narrow domestic walls’? Choose the correct answer.

(i) small houses which make us feel cramped

(ii) ideas which are petty and narrow-minded.

iii) a house divided into rooms by walls.

Q.4. What according to the poet do people tirelessly strive towards?

Q.5. How does the poet describe the old habit?

Q.6 How does the poet describe ‘heaven of freedom’?

Q.7. Who does the poet address as ‘thee’ and my father?

Q.8 What kind of freedom does the poet desire for his country?

Q.9 Write a short note on the central idea of the poem.

SECTION 4

Email Writing

The email writing format is the same for each of the categories, though the choice of words and language differ depending upon the type of email. One can use friendly and casual language in informal emails. The language used in formal emails should be professional, clear, and formal.

The email writing format is

Email Format

Let us look at the important **steps to follow** when writing a formal email.

1. Subject line

Grab attention with the subject line. The first part of an email which your recipient sees is the subject of the email. If you do not put it well, you risk having your email not opened until later or at all. Here are some things to keep in mind:

- Make the subject line **specific, simple, and to the point**. For example, instead of *'The internship report you asked for'*, write, *'Internship Report, {date/week/month}'*.
- The subject line should be **short**. Ideally, your subject line should stand around six words.
- Keep the most **important and informative words in the beginning** of the subject line.
- Use **markers** like *Fwd, Reply, Urgent*, or *Notice* to further narrow down the subject. It informs your reader about the nature of your email.

Some of the examples of good subject lines in formal emails can be:

- Marketing Budget, October 2018
- List of New Freelancers
- Job Application for the Post of XYZ
- Leave Application
- Query Regarding the Missing Information in the Document
- Contract Agreement - XYZ Assignment

2. Salutation

Each email is directed towards someone. Start your formal email with addressing the recipient in a manner fitting the relationship you have with them.

For people you are unfamiliar with or do not know the names of, use '*To Whom It May Concern*' or '*Dear sir/madam*'.
For senior officials, stick to their designation or follow it with their name, for example, '*To the Manager*', '*Dear Dr. Ghosh*', or '*Dear Ms. Kapoor*'.
Among colleagues, it may be appropriate to simply precede the name with a '*Hi*'.
Do not skip the salutation and always be respectful. Never use nicknames or just surnames or first names in a formal email.

3. Body of the email

The body text is the main part of your email. It is important to follow a certain pattern when writing the body of your email.

- The **opening paragraph should set the tone and reason** for your email. Introduce yourself if you are a stranger to the person you are writing to, and jot down why you are writing to them.
- For example, you can begin with '*My name is Abc, and this email is with reference to Xyz.'* or '*This is with reference to the marketing budget as discussed in the meeting.*'
- **Elaborate on your concern, question, or response** as comprehensively as possible. Write in a way that is easy to understand, but at the same time, do not lose your point in providing unnecessary information. Say only what is required.
- The **closing of the email** should also support the nature of your email. If you are asking a question, close with something like '*Hope to have an answer from you soon*', or *'Looking forward to hearing from you soon*', and if you are addressing a question, end with '*Hope I have sufficiently answered your query/doubts.'*
- Signature
- These are the last words of your email, capable of forming a lasting impression on your reader.

- Sign off with a simple word or phrase, which conveys respect. Safe choices are *'Best regards', 'Warmly', 'Sincerely', 'Kind regards'*, or simply *'Thanks'*.
- If you are writing to someone for the first time or someone who is not an immediate colleague or senior, use your full name.

- Furnish your name with contact information. Your phone number and/or work address are enough.
- If you are writing on behalf of or as an employee of an institution, make sure to mention it along with adequate contact details
- To make your signature even more effective, you may also choose or design an attractive (but not flashy) template.

Formal Email Samples

Formal emails are sent in a whole variety of situations. While they use the same rules, they may have to be modified according to their purpose.

Now that you are familiar with the format of a formal email, let us have a look at few email samples.

Email sample 1: A request

Subject: Extension on Report Deadline

Dear Mr./Ms. {Recipient's sir name},

I am writing this to request you for an extension on the XYZ project report which is due on {date}. My mother has taken ill unexpectedly, and I must leave for home tonight. I'm afraid it will take me a week before I can return to the office and complete the report.

Kindly grant me an extension till {date} for the same. I promise to deliver the project report by then.

Sincerely,
{Your name}
{Phone number}

Sample Emails

1.Inquiry

Question: Draft an email to make an inquiry for raincoats and umbrellas from a wholesaler in Mumbai .

To: rambrellasuppliers@gmail.com

From: tirupatiagency@gmail.com

Subject: Inquiry for different varieties of raincoats and umbrellas.

Dear Sir,

We would like to buy raincoats and umbrellas (product) for the next monsoon. You are a leading manufacturer of raincoats and umbrellas. We have also visited your website and we are interested in starting business with you.

We would like to see your company catalogue which has details of all the products that you manufacture. We would like to have all the details of different models and sizes of your products we intend to sell them during the coming rainy season.

Let us know the prices of your products and the rate of discount you allow Please inform us the time you will take to deliver the goods.

We hope to receive a prompt reply to this inquiry.

Thank You

Yours sincerely,

_____(Name)

2. Reply to inquiry

Question: You have received an inquiry for raincoats and umbrellas Draft a suitable reply.

To: tirupatiagency@gmail.com

From: rambrellasuppliers@gmail.com

Subject: reply to inquiry for different varieties of raincoats and umbrellas.

Dear Sir,

We have received your mail regarding the inquiry for different raincoats and umbrellas. We appreciate your interest in our products.

We have attached our company catalogue of all our products that we manufacture and price list with this mail.

We shall allow you 30% discount on the prices of these products. We can supply your goods within 10 days of receiving the order. You have to settle the account within 15 days of receiving the goods.

Please note that we will give you 3% extra rebate if your order exceeds Rs. 500000.

We are keen on executing your order quickly and carefully.

Thank You

Yours sincerely,

_____ (Name)

3. Placing an order

Question: Place an order of Air conditioners for your newly constructed branch office.

To: kabirworld21@gmail.com

From: gujaratagro@gmail.com

Subject: order for air conditioners for new office

Dear Sir,

We have received your mail reply to our inquiry about the air conditioners .We are thankful to you for your prompt reply.

We have studied the specification of the air conditioners and have found that it is according to our need. The terms and conditions of business stated by you are suitable to us. So, we request you to supply us 15 air conditioners as shown below:

Sr.No	Type	capacity	Quantity	Unit Price	Total Price
1	Voltas AC with inverter	1.5 ton	3	35000	105000
2	Voltas AC with inverter	2.0 ton	5	52000	260000
3	Voltas AC without inverter	1..5ton	2	33000	66000
4	Voltas AC without inverter	2.0 ton	5	50000	100000
				Total	531000

Please note that the air conditioners ought to be installed before 15th May 2021 since our new office is to start functioning from 18th May 2021..

Thank You

Yours sincerely,

_____(Name)

4. Complaint: Delay in Delivery of goods

Question: You have placed an order for table and ceiling fans for coming summer season. But the order has not been executed even after one month. Draft the complaint to the supplier about delay in delivery of goods.

To: newindia@gmail.com

From: Gujaratelectronics@gmail.com

Subject: complaint for delay in delivery of fans.

Dear Sir,

We refer to our order dated 2nd April 2021 for Usha Table and Ceiling Fans. We have specially instructed you to supply them before 18th April 2021but we are sorry we have not yet received the goods.

We had ordered the goods for the coming summer season. The delay in delivery of our order has caused great loss to our business.

We, therefore , request you to supply them within 7 days of receiving the mail. If you fail to do so, we shall be compelled to cancel our order.

We look forward to your prompt and positive response..

Thank You

Yours sincerely,

_____(Name)

5. Adjustment to above Complaint.

New India Electrical Suppliers have received a complaint from Gujarat Electronics, Ahemdabad about delay in delivery of goods. Draft a suitable reply.

To: Gujaratelectronics@gmail.com

From: newindia@gmail.com

Subject: reason for delay in delivery of fans

Dear Sir,

We have received your mail regarding delay in delivery of your order for table and ceiling fans. We are sorry for the inconvenience caused to you due to this delay.

The workers and staff in our office were on strike so the administrative work was badly paralyzed . Due to this we could neither execute your order nor intimate you about the delay in delivery.

However, the strike has been called off now. We hope we shall be able to dispatch the goods with four or five days. We trust you will understand our position and cooperate.

Thank You

Yours sincerely,

_____ (Name)

Complaint: shortage in goods

Question: You have placed an order for 500 compass boxes. But the consignment had only 475 boxes. Draft a complaint to the supplier.

To: omegainstruments@gmail.com

From: swastikstationers@gmail.com

Subject: complaint for shortage in number of boxes..

Dear Sir,

We are thankful to you for executing our order no. 24/A dated 20th April 2021 for500 Camel Compass boxes. However, we are sorry to point out that the execution of the order has not been as careful as it ought to be.

Our shop assistant has opened the container of compass boxes. He has reported that there are 475 compass boxes in it instead of 500.

Please make the necessary adjustment. We are sure that you will execute our orders more carefully in future.

Thank You

Yours sincerely,

_____(Name)

Adjustment to above Complaint.

Omega Instruments have received a complaint from Swastik Stationers that he has received 475 instead of 500 ordered by him. Draft a suitable reply.

To: swastikstationers@gmail.com

From: omegainstruments@gmail.com

Subject: adjustment for remaining 25 boxes

Dear Sir,

We have received your mail on 25th May 2021. We regret to note that you have received 475 Compass Boxes instead of 500 against your order no.24/A of 20th April 2021 .

We have dispatched the remaining 25 compass boxes by Maruti Couriers. You will receive them tomorrow evening.

We request you not to judge our services by this isolated incident. We shall try to render consistently efficient services in future.

Thank You

Yours sincerely,

_____ (Name)

Complaint: damaged goods

Question: You have placed an order for 250 Flower Vases. But you found that the consignment had 23 flower vases in damaged condition. Draft a complaint to the supplier.

To : duraguardglasses@gmail.com

From: suhasininovelties@gmail.com

Subject: complaint for damaged flower vases.

Dear Sir,

We have received 250 flower vases against our order no. 76/C dated 20th June 2021. However, when our shop assistant opened the box, he found 23 vases in damaged condition.

This damage is due to the fact that you have not packed the goods in thermocoal lined boxes according to our instructions.

Please send us 23 new flower vases. Alternatively permit us to adjust their price in the settlement of the invoices.

Thank You

Yours sincerely,

_____(Name)

Adjustment to above Complaint.

Duraguard Glasses Limited have received a complaint from Suhasini Novelties that he has received 23 flower vases in damaged condition. Draft a suitable reply.

To: suhasininovelties@gmail.com

From: duraguardglasses@gmail.com

Subject: adjustment for damaged flower vases

Dear Sir,

We have received your mail on 25th July 2021. We are sorry to note that you have received 23 flower vases in damaged condition out of total 250 in the consignment against your order no.76/C of 20th June 2021 .

We accept our liability in this matter . We have enclosed a credit note for Rs. 2300 along with this mail against 23 damaged flower vases.

We regret the trouble caused to you in this transaction. We assure you to execute your orders more carefully in future.

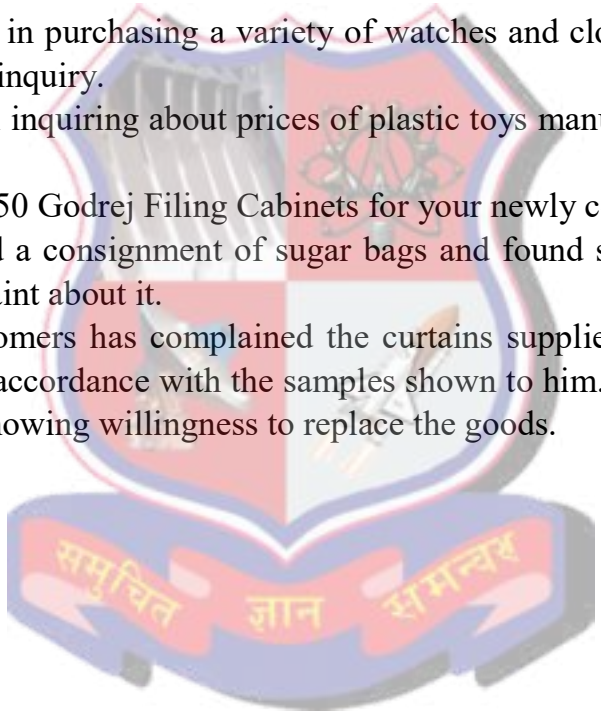
Thank You

Yours sincerely,

_____ (Name)

Exercise:

1. You have placed an order for 15 HP scanners to National Systems Limited, but received only 12 scanners. Draft an email to the supplier complaining about it.
2. Draft an email asking for the illustrated catalogue and quotation of certain electronic goods required by your firm.
3. Draft a complaint to Swagat Furnitures asking for compensation as you found some of the pieces of furniture delivered in the damaged condition.
4. The Book Store in your college requires 15 copies of Oxford Advanced Dictionary. Place an order for it.
5. The proprietor of sports goods manufacturing company has received a complaint from one of their customers regarding non-execution of his order in stipulated time. Draft a suitable reply.
6. You are interested in purchasing a variety of watches and clocks from Quartz Palace. Draft an email for inquiry.
7. You have an email inquiring about prices of plastic toys manufactured by you. Draft a reply.
8. Place an order for 50 Godrej Filing Cabinets for your newly constructed office.
9. You have received a consignment of sugar bags and found shortage in weight .Draft an email to complaint about it.
10. One of your customers has complained the curtains supplied by you are of inferior quality and not in accordance with the samples shown to him. Draft a reply expressing your regrets and showing willingness to replace the goods.



Business Letters

A **business letter** is a letter from one company to another, or between such organizations and their customers, clients, or other external parties. The overall style of letter depends on the relationship between the parties concerned. Business letters can have many types of content, for example to request direct information or action from another party, to order supplies from a supplier, to point out a mistake by the letter's recipient, to reply directly to a request, to apologize for a wrong, or to convey goodwill. A business letter is useful because it produces a permanent written record, and may be taken more seriously by the recipient than other forms of communication.

Qualities of a Good Letter:

The 7 Cs of business communication which make it are:

1. Clarity
2. Correctness
3. Conciseness
4. Courtesy
5. Concreteness
6. Consideration
7. Completeness

#1: Clarity

Practicing clarity in your communication ensures that the message is received accurately. You should know what you wish to say and how to say it. Use language that can be easily understood, and resist the temptation to include unnecessary information.

Example:

Instead of saying, “We have considered the consequences of the existing policy on the hiring strategies we employ with our human resources department and updated them accordingly,” say, “We have updated our hiring policy.”

#2: Correctness

You must communicate with correctness – correct grammar, language, data, etc. In written communication, you should proofread before sending.

Example:

“You may enter the building during opening hours but must show relevant I.D.”

Immediately, the recipient of this information has two questions:

- “What are the opening hours, and what ID is considered relevant?

Correctness in this communication is conveyed by saying, “You may enter the building during the opening hours of 9am to 5pm daily, but must show your employee identity card.”

#3: Conciseness

Never use more words than is necessary. Brevity is more easily understood, though you must avoid discourtesy. Concise messages save you and the recipient time, too. To be concise, follow these rules:

- Eliminate unnecessary words

- Use action verbs
- Remove repetition

Example:

“As a matter of fact, during the month of June, all employees must ensure that they wear appropriate clothing to ensure they stay cool while the air-conditioning is being repaired.”

Becomes:

“Indeed, during June, employees must wear appropriate clothing to stay cool while the air-conditioning is repaired.”

#4: Courtesy

Employ courtesy when communicating. This shows you respect the recipient and helps to build goodwill. You must ensure that you are sincere, thoughtful, and do not use discriminatory language.

Example:

“I don’t appreciate how your team ignores requests for collaboration from my team. The work we do is equally as important as your work. Could you make certain that your team collaborates more readily from now on?”

Such a message is unlikely to encourage a negative response. Instead, a more effective approach would be:

“I understand that your team is extremely busy and receives many requests to collaborate on project work. However, my team is working a highly urgent project with enormous mutual benefits. I would greatly appreciate if you could ask your team to collaborate more effectively with mine to move this project forward faster. If there is any help that we can provide to make this happen, please let me know.”

#5: Concreteness

Concrete communication is specific, clear, and meaningful. It avoids vagueness, uses available facts and figures to add authenticity, and builds around an active voice.

Example:

An example would be poor communication of underperformance during a one-to-one. You might say, “Your sales numbers are on the low side. They need to be improved to at least the team’s average.”

Give your employee concrete direction with evidence and an active voice:

“Your sales conversion rate is below 50%. You must improve this to the team average of 65% or higher.”

#6: Consideration

Be considerate with your messaging by putting yourself in the position of the recipient. Focus on communicating to ‘you’, considering needs and issues experienced by the recipient.

Example:

Imagine that you are unable to pay a promised bonus. How do you communicate this?

“We are unable to pay bonuses now. The business is awaiting payment from a major client. Once this payment is received, we can consider paying contractual bonuses as soon as is practicable.”

This could be better conveyed as follows:

“Unfortunately, we are not presently in the position to pay your bonus. However, as soon as our major client has settled their account, we will pay any bonuses owed to you. We’re sorry about this delay, but are sure you understand our need for positive cash flow and the long-term benefits this will deliver to you.”

#7: Completeness

Your message should be complete, delivering all the facts needed for the recipient to make an informed decision. Incomplete messages often receive poor responses.

To ensure your communication is complete, ask if it answers the what, when, why, who, where, and how.

Example:

"You haven't completed the task that I set you," is a message full of ambiguity. Instead, make sure you include all relevant facts:

"The data analysis for client ABC that I asked for on March 5 should have been completed by today. Will you have it finished this afternoon?"

Format:

A business letter must include:

1. Address

The address of the person receiving the correspondence includes a formal name, street address, city, state, and pin code.

2. Date

The date is put for any business communication.

The date is a critical piece of information documenting when the correspondence was sent.

This is important for correspondence that may be kept for future reference.

3. Subject Line

This indicates the subject of the letter so the receiver gets the idea what is the letter about.

4. Salutation

The salutation is the formal way of addressing the person.

Common salutations are *Dear* or *To Whom It May Concern*.

5. Introduction

The first few sentences of a letter are introductory.

The introduction section introduces the subject of the letter.

It is a summary in a sentence or two that explains the goal of the letter.

For example, an introduction may be something like:

I am writing today to further explore a vendor relationship with XYZ Corporation.

6. Body of the Letter

The body of the letter is where the bulk of the information is shared.

The body of the letter explains in detail all aspects of what is being communicated.

This would include detail of the information being shared.

For instance, the body may be something like this:

We understand that XYZ Corporation can provide tools for 10% less than other competitors. And, that the focus on service after the sale is amongst the best in the industry.

7. Closing

The closing of the letter summarizes what the letter was about and any next steps or action items.

This section gives the reader a heads up that the communication is coming to a close.

For instance, the closing may be something like this:

Please call me at your earliest convenience to discuss a vendor relationship and to explore if we can come to a mutually beneficial relationship. I look forward to speaking with you soon.

8. Signature

The signature section has a complimentary closing.

Examples are *Sincerely, Warmest Regards, Respectfully Yours, Very Truly Yours,* or *Cordially Yours*.

Be sure to gauge the audience when selecting a complimentary closing.

After the complimentary closing, space is left for the signature that goes above the typed name and title of the person sending the letter.


ABC Corporation
2435 West Elm Street
Small Town, USA 11223
888-987-6543
June 19, 2019
Date
James Smith
XYZ Corporation
Big Town, USA 21212
Address
Dear Jim:
Salutation
Introduction
I am writing today to further explore a vendor relationship with XYZ Corporation.
Body
We understand that XYZ Corporation can provide tools for 10% less than other competitors. And, that the focus on service after the sale is amongst the best in the industry.
Please call me at your earliest convenience to discuss a vendor relationship and to explore if we can come to a mutually beneficial relationship.
Closing
I look forward to speaking with you soon.
Sincerely,
Jack Jones
Signature
Jack Jones
ABC Corporation

Sample Letters

1. Order Letter

From

_____
_____
_____

Date: _____ (Date on Which Letter is Written)

To,

_____
_____
_____
_____

Subject: Order Letter

Dear Sir,

I am the purchase manager of XYZ Company and I am personally writing this letter to order goods for our site work. As we have been purchasing goods from you company since some time now, I am writing this letter to order material.

Along with this letter I am attaching the list of materials or goods that is needed. Please make sure you send it across in a week as the requirement is a bit urgent this time.

I hope there is enough stock left with you to complete this order of ours. Thanking you for your support and timely orders till date.

Thanking You,

Yours truly,

_____

Name and Signature

2. Complain letter

From

_____ (your name)
_____
_____ (your address)

Date _____ (date of writing letter)

To

_____ (name of recipient)
_____ (designation)
_____ (name of organization)
_____ (address)
_____

Dear Sir/Madam,

I purchased a ….(mention item with specifications) from your store on …(mention date) . The piece is on …. warranty (mention duration) . It was delivered on …(mention delivery date, if any), and your representative familiarized me with its operation on …(mention date), …(briefly explain the problem faced with the piece and repairs undertaken if any).

Since the piece is on warranty …, I request you to kindly …(mention how you want concerned authority to assist you). I am enclosing a copy of …(mention documents you are enclosing along with the letter). I am hoping for immediate action taken regarding this issue.

Thanking You
_____ (your name)

3. Leave Application

Sender's name and address:

Date:

Receiver's name and address:

Subject: Sick Leave application

Respected Mr. /Mrs. [Name of the recipient] (or Sir/Madam),

I am writing this application to notify you that I am suffering from severe viral infection and therefore, I need sick leave from work. I caught this infection last night and I will not be able to come to the office for at least [number of days]. As notified by my doctor, it is best that I take rest and recover properly before resuming work. The letter from the doctor is also attached for your reference.

Kindly grant me a leave for [number of days] days.

.

I hope you will understand and grant me a leave for aforementioned period. Waiting your approval.

Yours Sincerely,

[Your Name]

[Signature]

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I &II – Semester
Course Title: **Applied Physics**
(Course Code: 4300004)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering, Ceramic Technology, Civil Engineering, Environment Engineering, Fabrication Engineering, Mechanical Engineering, Mechatronics Engineering, Mining Engineering, Chemical Engineering, Textile Manufacturing Technology, Marine Engineering, Printing Technology	First
Metallurgy Engineering, Plastic Engineering, Textile Processing Technology	Second

1. RATIONALE

Physics is branch of science mainly deals with interaction of energy and matter and considered as the mother of all engineering disciplines. Diploma engineers (technologists) have to deal with various materials while using/ maintaining machines. More over the basic knowledge of principles of physics helps diploma students to lay foundations of core engineering courses. The laws and principles of physics, formulae and knowledge of physical phenomena and physical properties provides a means of estimating the behavior of things before we design and observe them. This course of applied physics has been designed as per program requirements to help students to study the relevant core engineering courses. The complicated derivations have been avoided and micro projects are introduced. This course will help the diploma engineers to use/apply the basic concepts and principles of physics solve well designed engineering problems and comprehend different technology-based applications.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use principles of physics to solve broadly defined engineering problems**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.
b) Solve various engineering problems by the concept of linear momentum and circular motion.
c) Apply basic concepts of properties of matter in solving engineering problems efficiently.
d) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.

e) Use the concept of waves and sound waves for various acoustics and other engineering applications involving wave dynamics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Use Vernier caliper to measure the dimensions of a given object.	I	02*
2	Use micrometer screw gauge to measure diameter of a given wire and determine volume of a given metallic piece.	I	02
3	Use Hooke's law to determine force constant of a given spring.	III	02
4	Use Searle's method to determine Youngs modulus of the given metallic wire.	III	02*
5	Use capillary rise method and travelling microscope to determine the surface tension of a given liquid.	III	02*
6	Use Stokes' law to determine the viscosity of a given liquid (e.g., glycerin).	III	02
7	Use different types of thermometers to measure temperature of a hot bath and convert it into different scales.	IV	02*
8	Use Searle's method to measure the coefficient of thermal conductivity of a given metallic rod.	IV	02
9	Use Searle's method to determine the coefficient of linear expansion of the given metallic rod.	IV	02
10	Determine acceleration due to gravity 'g' by using simple pendulum.	V	02
11	Use sonometer to find the frequency of given tuning fork.	V	02
12	Use resonance tube to determine velocity of sound in air at room temperature.	V	02*
13	Use ultrasonic interferometer to determine the velocity of ultrasonic waves in different liquids.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
14	Use electrical vibrator to find the frequency of AC mains.	V	02
	Total		28

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Vernier caliper analog - least count 0.02 mm	1, 4
2	Micrometer screw gauge analog (0-25 mm) – least count 0.01mm	2, 4
3	Rigid support, spring, 20 g hanger, six 20 g slotted weight, fine pointer, vertical wooden scale, hook	3
4	Young modulus apparatus (Searle's pattern): two aluminum graduated scales mounted on pillar supports, two pointers with clamps for attaching to specimen, brass and steel rod, cord and hook for carrying weight.	4
5	Travelling microscope - high magnification power, stainless steel scale with Vernier least count - 0.02 mm for taking the recordings, horizontal scale graduated up to 20 cm, vertical scale graduated up to 15 cm.	5
6	One meter high and 5 cm broad glass cylindrical jar with millimeter graduations along its height, steel balls	6

S. No.	Equipment Name with Broad Specifications	PrO. No.
7	Hot water bath	7
8	Mercury filled glass thermometer 0-110 °C, Mercury filled glass thermometer 0-250 °C. digital food thermometer, bimetallic thermometer.	7
9	Searle's thermal conductivity apparatus - made up of pure copper and outer boxes are of wooden polished material, 04 thermometers, steam generator, measuring cylinder, constant water level tank, pinch cork, rubber tube	8
10	Linear expansion apparatus, steam generator, rubber tubing, metal rods of aluminum, iron, copper, brass, and steel.	9
11	A bob	10
12	A sonometer with set of tuning forks, two sharp edge wedges and a weight box.	11
13	Resonance tube apparatus, tuning forks of different frequencies, rubber pad, thermometer	12
14	Stop watch (least count = 1/100 s)	8, 10
15	Clamp with stand.	5
16	0.5 kg hanger, 0.5 kg slotted weight.	4
17	Hot plate (1800 W)	8, 9
18	Ultrasonic interferometer - gold plated quartz crystal, operating voltage - 220 Volt, display - analog, frequency - 2MHz with position control	13
19	Electrical Vibrator, uniform cord, weight pan, weight box, pulley, meter scale, sensitive balance	14

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Follow safe practices
d) Handle equipment carefully
e) Practice energy saving processes.
f) Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Units and Measurements**	1.a Explain Physical quantities and their units. 1.b Convert unit of a given physical quantity in one system of units into another systems of units. 1.c Explain method to measure the dimensions of given object by using relevant instruments. 1.d Estimate errors in the measurement. 1.e Apply the concept of Least count, errors and significant figures to solve the given problems.	1.1 Measurement and units in engineering and science 1.2 Physical quantities; fundamental and derived quantities 1.3 Systems of units: CGS, MKS and SI, definition of units (only for information and not to be asked in examination), interconversion of units MKS to CGS and vice versa, Requirements of standard unit 1.4 Vernier caliper, Micrometer screw gauge 1.5 Accuracy, precision and error, estimation of errors - absolute error, relative error and percentage error, error propagation, significant figures
Unit – II **Circular motion**	2.a Apply the concept of linear momentum and its conservation to explain recoil of gun and rockets propulsion. 2.b Apply the concept of centripetal and centrifugal forces to solve given engineering problems.	2.1 Force, momentum, law of conservation of linear momentum, its applications such as recoil of gun, rocket propulsion, impulse and its applications 2.2 Circular motion, angular displacement, angular velocity, angular acceleration and their interrelation 2.3 Centripetal and centrifugal forces examples: banking of roads and bending of cyclist
Unit– III **General Properties of Matter**	3.a Explain the Hooke's law, stress-strain curve and moduli of elasticity. 3.b Explain surface tension, cohesive and adhesive forces. 3.c Apply Ascent formula to determine surface tension of	**3.1 Elasticity** 3.1.1 Deforming and restoring Force 3.1.2 Stress-Strain with their types 3.1.3 Hooke's law 3.1.4 Moduli of elasticity, Young's modulus, Bulk modulus, Shear modulus

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	the given liquid. 3.d Explain viscosity, coefficient of viscosity, terminal velocity and Stokes' law. 3.e Apply the concept of viscosity in explaining hydraulic system. 3.f Explain types of fluid motion and Reynold number	3.1.5 Stress-Strain curve **3.2 Surface Tension** 3.2.1 Surface tension; concept and units 3.2.2 Cohesive and adhesive forces 3.2.3 Molecular range and sphere of Influence 3.2.4 Laplace's molecular theory 3.2.5 Angle of contact, Ascent Formula (No derivation) 3.2.6 Surface energy 3.2.7 Applications of surface tension 3.2.8 Effect of temperature and impurity on surface tension **3.3 Viscosity** 3.3.1 Viscosity and its SI units 3.3.2 Newton's law of Viscosity 3.3.3 Viscous force, velocity gradient and coefficient of viscosity and its SI units, free fall of an object through viscous medium and terminal velocity 3.3.4 Types of fluid motion, stream line and turbulent flow, critical velocity, Reynold's number 3.3.5 Stokes' law 3.3.6 Effect of temperature on viscosity 3.3.7 Applications of viscosity in hydraulic systems
Unit– IV **Heat and Thermometry**	4.a Distinguish between heat and temperature. 4.b Explain modes of heat transmission. 4.c Explain various temperature scales and conversion between them. 4.d Explain heat capacity and specific heat. 4.e Explain types of thermometers and their uses. 4.f Apply the concept of coefficient of thermal conductivity to solve	4.1 Heat and temperature 4.2 Modes of Heat transfer: Conduction, Convection and Radiation 4.3 Temperature measurement scales: Kelvin, Celsius and Fahrenheit and interconversion between them 4.4 Heat capacity and specific heat 4.5 Types of thermometers: Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer and their uses.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	Engineering problems. 4.g Explain expansion in solids and coefficient of linear expansions in solids.	4.6 Coefficient of thermal conductivity and its engineering applications. 4.7 Expansion of solids, coefficient of linear expansion
Unit– V **Wave motion and its applications**	5.a Explain wave and wave motion with example. 5.b Distinguish between longitudinal and transverse waves. 5.c Explain frequency, periodic time, amplitude, wave length and wave velocity 5.d Explain sound waves, light waves and their properties 5.e Explain amplitude, phase, phase difference and wave equation. 5.f Explain principle of superposition of waves, interference and beat formation. 5.g Explain reverberation, reverberation time, echo, noise and coefficient of absorption of sound. 5.h Apply Sabine's formula to calculate reverberation time. 5.i Explain ultrasonic waves and their properties. 5.j Explain engineering and medical applications of ultrasonic waves.	5.1 Waves, wave motion, and types of waves: longitudinal and transverse waves 5.2 Frequency, periodic time, amplitude, wave length and wave velocity and their relationship 5.3 Properties of sound and light waves. 5.4 Phase, phase difference and various terms of wave equation $(y = Asin(\omega t + \varphi))$ [derivation of equations of velocity and acceleration is not required] 5.5 Superposition of waves, Interference: constructive and destructive interference ,conditions for stationary interference pattern, beat formation 5.6 Reverberation, reverberation time, echo, noise and coefficient of absorption of sound 5.7 Sabine's formula (derivation not required) for reverberation time, methods to control reverberation time and their applications 5.8 Ultrasonic waves and their properties, applications of ultrasonic waves in the field of engineering and medical

***Note**: The UOs need to be formulated at the 'Applcation Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

- 'Definition of units' is only for information and not to be asked in examination.
- Students can be introduced to system of units other than SI, MKS, CGS unit systems.
- Application level based numerical should be given at the time of instructions and assessment in each unit
- Derivation of Ascent formula is not required only statement and related terms have to be explained at the time of instruction and assessment.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Units and Measurements	08	4	4	5	13
II	Circular motion	06	3	3	4	10
III	General Properties of Matter	12	4	7	9	20
IV	Heat and Thermometry	08	3	4	6	13
V	Wave motion and its applications	08	4	5	5	14
Total		**42**	**18**	**23**	**29**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare model to demonstrate concepts of physics.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Measure physical quantities using smart phone.
e) Prepare showcase portfolios.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L" in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability using the knowledge of this course

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14** - **16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Measurement: Measure physical quantities using smart phone applications.
b) Prepare proto type Vernier Calipers of given least count.
c) Collect wires and sheets of different gauges from market and estimate errors in measurements using analog and digital Vernier Calipers.
d) Elasticity: Prepare working model to demonstrate the stress – strain behavior of different wires of different thickness and material.
e) Viscosity: Collect 3 to 5 liquids and prepare a working model to differentiate liquids based on viscosity and demonstrate their applications.
f) Motion: Prepare model of ball rolling down on inclined plane to demonstrate the conservation of energy and motion of an object in inclined plane.
g) Waves in string**:** standing waves in string using woofer loudspeaker.
h) Noise Level measurement**:** measure noise Level at different places in campus.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Text Book of Physics for Class XI (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN 81-7450-508-3(Part-I) & ISBN 81-7450-566-0 (Part-II)
2	Text Book of Physics for Class XII (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN 81-7450-631-4 (Part-I) & ISBN 81-7450-671-3 (Part II)
3	Applied Physics, Vol. I and Vol. II	TTTI Publications	Tata McGraw Hill, Delhi, 2019
4	Concepts in Physics Vol. I and Vol. II	H C Verma	Bharti Bhawan Ltd. New Delhi, 2019 ISBN-13: 978-8177091878 ISBN-13: 978-8177092325
5	Engineering Physics	DK Bhattacharya	Oxford University Press, New

S. No.	Title of Book	Author	Publication with place, year and ISBN
		& Poonam Tandon	Delhi, ISBN:9781680158687
6	B. Sc. Practical Physics	C. L. Arora	S. Chand Publication, New Delhi, ISBN: 9788121909099
7	A Textbook of Engineering Physics	M.N. Avadhanulu, P.G. Kshirsagar, TVS Arun Murthy	S. Chand Publication, 11th edition ,New Delhi, 2018 ISBN-13: 978-9352833993
8	SEARS and ZEMANSKY'S University Physics with modern Physics	Hugh D. Young & Roger A. Freedman	Person Publication 14th Edition, USA, ISBN 10: 0-321-97361-5; ISBN 13: 978-0-321-97361-0 (Student edition)
9	Physics for Scientists and Engineers with Modern Physics	John W. Jewett & Raymond A. Serway	CENGAGE Learning, 10th edition, Boston, 2010, ISBN-10: 1337553298
10	University Physics (Volume I, II & III) (Open-source Material)	William Moebs, Samuel J. Ling & Jeff Sanny	OPENSTAX, Houston, Texas, 2016, ISBN-13: 1-947172-20-4
11	PHYSICS for SCIENTISTS & ENGINEERS with Modern Physics	Douglas C. Giancoli	Pearson, 7th edition, Delhi, 2015, ISBN-13: 978-1292057125
12	Principles of Physics	Jearl Ealker, David Halliday, Robert Resnick	Wiley India, Navi Mumbai 10th edition, 2015, ISBN-13: 978-8126552566
13	NCERT Physics	NCERT	NCERT Physics
14	Physics in Daily Life With illustrations	L.J.F. Hermans & Wiebke Drenckhan	EDP Sciences, France, 2012, ISBN: 978-2-7598-0705-5
15	Introductory Physics: Building Models to Describe Our World (Open-Source Material)	Ryan Martin, Emma Neary, Joshua Rinaldo & Olivia Woodman	Creative Commons license, 2019, GitHub

14. SUGGESTED LEARNING WEBSITES

a) https://ocw.mit.edu/courses/physics/
b) https://www.einstein-online.info/en/category/elementary/
c) https://academicearth.org/physics/
d) www.nptel.iitm.ac.in
e) http://phys23p.sl.psu.edu/phys_anim/Phys_anim.htm
f) http://www.atoptics.co.uk/
g) https://www.khanacademy.org/science/physics
h) http://www.olabs.edu.in/

i) http://vlabs.iitb.ac.in/vlab/
j) https://phet.colorado.edu/
k) http://physics.bu.edu/~duffy/vlabs.html
l) https://virtuallabs.merlot.org/vl_physics.html
m) www.datasheetcafe.com

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Applied Physics (Course Code: 4300004)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency *Use principles of physics to solve broadly defined engineering problems*	3	1	1	2	1	-	1
Course Outcomes							
CO a) Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.	3	1	1	2	-	-	1
CO b) Solve various engineering problems by the concept of linear and circular motion.	3	1	-	-	1	-	1
CO c) Apply basic concepts of properties of matter in solving engineering problems efficiently	3	1	-	2	-	-	1
CO d) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.	3	1	1	2	1	-	1
CO e) Use the concept of waves and sound waves for various acoustics and other engineering applications involving wave dynamics	3	1	1	2	1	-	1

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for no correlation with CO and PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Shri Dineshkumar V. Mehta Lecturer in Physics	Government Polytechnic, Gandhinagar	9879690825	dv_mehta@yahoo.com
2	Lt (Dr.) Duhita B. Lakhatariya Lecturer in Physics	Government Polytechnic, Ahmedabad	9725201631	duhita.167@gmail.com
3	Shri Jignesh B. Chauhan Lecturer in Physics	Government Polytechnic, Kheda	9428486344	jbclph@gmail.com
4	Shri Aditya kumar B. Patel Lecturer in Physics	K.D. Polytechnic, Patan	9979534522	graquantum@gmail.com

S. No.	Name and Designation	Institute	Contact No.	Email
5	Late Dr. Gaurang S. Patel Lecturer in Physics	Dr. S. & S. S. Ghandhy College of Engineering & Technology, Surat	9909986859	goru16686@gmail.com

NITTTR Resource Person

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr Hussain Jeevakhan Assistant Professor	Department of Applied science and education	0755-261600*360	hjeevakhan@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I & II – Semester

Course Title: Sports and Yoga
(Course Code: 4300015)

Diploma programme in which this course is offered	Semester in which offered
Civil, Environment, Automobile, Fabrication, Marine, Mechanical, Electrical, Electronics and Communication, Metallurgy, Plastics, Bio Medical, Instrumentation and Control, Power Electronics, Computer, Information Technology, CACDDM, Ceramics, Printing, Textile Design, Textile Manufacturing, Textile Processing	First
Architectural Assistantship, Mining, Chemical, Mechatronics	Second

1. RATIONALE

Physical activity is vital to the holistic development of students, fostering their physical, social and emotional health. Sports and Yoga are essential part of our life for good health and peace of mind. Yoga is considered itself as a sport which plays through your own physical ability. Yoga provides you all the benefits that you are willing to have from generic sports like badminton, football, cricket, etc. Yoga is the application of physical postures, control of breath, purification and relaxation of mind / body and spiritual principles aimed at bringing greater unity and balance to the mind and body. The use of breathing techniques known as *Pranayama* enables a person to focus on breath and helps to calm and still the mind and cultivate concentration ability. *Pranayama* can also help to energise and revitalize the body.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply sports and yoga activities to keep the body physically and mentally fit.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the following Course Outcomes (COs) achievement:

a) Practice physical activities and yoga for strength, flexibility and relaxation.
b) Use techniques for increasing concentration and decreasing anxiety for stronger academic performance.
c) Perform yoga exercises in various combination and forms.
d) Improve personal fitness through participation in sports and yoga activities.
e) Follow sound nutritional practices for maintaining good health and physical performance.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	2	0	0	0	50	0	50

This is designed to facilitate attainment of COs holistically, as there is no examination.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1.	Perform following Yoga Asanas under the guidance of yoga trainer :- • Surya Namaskar (Sun Salutation) • Tadasana (Mountain pose) • Vrikshasana (Tree pose) • Vajrasan (Hand under foot pose) • Pada-hastasana (Hand under foot pose) • Ushtrasana (Camel pose) • Dhanurashana.(Bow Pose) • Bhjangasana (Snake pose) • Halasana (Plough pose) • Shavasana/Yoga Nidra • Bhastrikai Pranayam • Kapalbhati Pranayam • Anulom Vilom Pranayam • Bhramari Pranayam	III	12*
2.	Participate in any sports activities of your choice : • Indoor sports/games (Badminton, Chess, Carrom, Table Tennis) • Outdoor sports/games (Cricket, Kabaddi, , Volley ball, Basketball, Football, Hockey)	IV	14
3.	Prepare report on any sports events including associated rules, playground specification, rules for judgement, etc.)	IV	02*
	Total		**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	-Not applicable-	Nil

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Yoga Mats/ Blankets Straps Blocks Bolsters Chairs Meditation cushions Eye pillows (tissues or washable cloth to cover them) Mat cleaning wipes Strong floorings Temperature control, fans, portable heaters (if needed) Chime, bells, or gong (for bringing people out of corpse pose, or silent meditation) Essential oil diffuser Yoga CD's CD player Lighting system that allows for dimming Effective sound system Salt lamp – they purify air and look lovely Sandbags	1
2	Sports and games accessories as per the decision of college.	2

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Follow safe practices.
b) Practice good housekeeping.
c) Demonstrate working as a leader/a team member.
d) Maintain tools/accessories/ equipment.
e) Follow ethical practices.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction to Physical fitness**	1a. Explain importance of physical education. 1b. Describe importance of Physical Fitness & Wellness 1c. Explain the components of physical fitness. 1d. Demonstrate healthy life style. 1e. Prevent health threats by changing life style.	1.1 Aims & Objectives of Physical Education 1.2 Changing trends in Physical Education 1.3 Meaning & Importance of Physical Fitness & Wellness 1.4 Components of Physical fitness 1.5 Components of health related fitness 1.6 Components of wellness 1.7 Preventing health threats through lifestyle change 1.8 Concept of positive lifestyle
Unit – II **Fundamentals of Anatomy & Physiology in sports & yoga**	2a. Explain importance of anatomy and physiology. 2b. Describe effects of exercise in various body systems. 2c. Describe concept of correct posture. 2e. Explain corrective measures for posture deformities.	2.1 Anatomy, physiology and its importance. 2.2 Effect of exercise on various body system i.e. circulatory system, respiratory system, neuro- muscular system 2.3 Concept and advantages of correct posture. 2.4 Posture deformities and corrective measures.
Unit– III **Yoga & Pranayama**	3.1 Explain importance of yoga. 3.2 Perform various pranayama for increasing concentration. 3.3 Use meditation and other relaxation techniques for improving concentration.	3.1 Meaning & Importance of Yoga Asanas, Pranayama & Meditation 3.2 Yoga & related Asanas - Sukhasana, Tadasana, Padmasana & Shashankasana 3.3 Relaxation techniques for improving concentration - Yog-Nidra

Unit– IV **Sports/ games**	4.1 Describe various warming exercises. 4.2 Select any game/sports of your choice. 4.3 Explain latest rules of any game/sports. 4.4 Describe specifications of play fields and related sports equipment.	4.1 Warming up and limbering down exercises 4.2 Tournaments- Knock out, League/ Round Robin & combination 4.3 Following sub topics related to any one Game/Sport of choice of student out of: Badminton, Chess, Carrom, Table Tennis, Cricket, Kabaddi, , Volley ball, Basketball, Football, Hockey, etc. 4.4 History of the Game/Sport. 4.5 Latest General Rules of the Game/Sport. 4.6 Specifications of Play Fields and Related Sports Equipment. 4.7 Effect of anxiety & fear on sports performance.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching/ Practical Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Physical fitness	**- Not Applicable -**				
II	Fundamentals of Anatomy & Physiology in sports & yoga					
III	Yoga & Pranayama					
IV	Sports/games					
Total						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare a list of specifications for various tools/equipment/machines used in gymnasium/indoor sports complex.
b) Undertake a market survey of local dealers for procurement of sports items/ equipment/machines.
c) Visit the sports shop and collect all relevant information about any sport item and submit the detailed report.
d) Download video clips showing correct practices for yogasanas, pranayam and any sports/games.
e) Prepare a chart showing different types of yogasanas.
f) Prepare a chart showing different types of pranayams.

g) Prepare a chart showing the field details of any sports/games.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
c) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Arrange visit to nearby yoga centre and sports complex and use of videos/animations for understanding various steps , processes related to the activities .

12. SUGGESTED MICRO-PROJECTS

- Not Applicable -

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Modern Trends and Physical Education class 11 & class 12	Ajmer Singh	Kalyani Publication, New Delhi ISBN : 9789327264319
2	Light on Yoga	B.K.S. Iyengar	Thomson's Publication, New Delhi ISBN: 8172235011
3	Health and Physical Education	V.K.Sharma	NCERT Books; Class11,12 Saraswati House Publication, New Delhi
4.	Yoga and Stress Management	Acharya Yatendra	Fingerprint Publishing ISBN: 938905303X
5.	Patanjali Yoga Sutras	Swami Vivekanand	Fingerprint Publishing ISBN: 9389567351
6.	Pranayam Rahasya	Ramdev	Patanjali-Divya Prakashan,Haridwar ISBN: 978-8189235017
7.	Yoga its Philosophy & Practice	Ramdev	Divya Prakashan, Haridwar

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14. SOFTWARE/LEARNING WEBSITES

- https://youtu.be/dAqQqmaI9vY
- https://youtu.be/c8hjhRqIwHE
- https://youtu.be/MrR04m1zoJ8
- https://youtu.be/P-jwGj7YqNM

- https://youtu.be/3p4r_ad2Y7g
- https://youtu.be/mndOIVCwFss
- https://youtu.be/J68MR3dBzto

15. PO-COMPETENCY-CO MAPPING

Semester-I & II	Sports & Yoga (Course Code: 4300015)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustain-ability & environ-ment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	Apply sports and yoga activities to keep the body physically and mentally fit.						
Course Outcomes CO a) Practice Physical activities and yoga for strength, flexibility, and relaxation.	2	-	-	-	1	-	2
CO b) Use techniques for increasing concentration and decreasing anxiety for stronger academic performance.	3	-	-	-	1	-	2
CO c) Perform yoga exercises in various combination and forms.	2	-	-	-	1	-	2
CO d) Improve personal fitness through participation in sports and yoga activities.	2	-	-	-	1	-	2
CO e) Follow sound nutritional practices for maintaining good health and physical performance.	3	-	-	-	1	-	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Akash Gohil, Sports Officer	GTU, Sports Section	9712989788	sports_officer@gtu.edu.in

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Prof. M.C.Paliwal, Associate Professor	Civil Engg. Education	9407271980	mcpaliwal@nitttrbpl.ac.in
2.	Dr. K.K. Jain, Professor	Mech. Engg. Education	9425017472	kkjain@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester- I/II/III

Course Title: Computer Applications and Graphics
(Course Code: 4300019)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical (CAD/CAM)	First
Mechanical Engineering, Automobile Engineering, Fabrication Technology, Renewable Energy, Marine Engineering	Second
Mechatronics Engineering	Third

1. RATIONALE

The objective of this subject is to make the students understand and applythe functioning of office application software, basic engineering drafting software. It will provide the student hands-on experience on different application software used for office automation and improve day-today problem-solving skills using online resources for creating business documents, data analysis, graphical representations and creating, editing and printing technical drawings. It will also enable the student to use Internet services for different communication. Development of sketching ability strengthens effective engineering communication & presentation. This course helps to develop the skills in student to generate various digital production drawings as required in industry using various CAD software.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Develop basic skills using various IT software tools for creating professional documents, analyzing data, preparing multimedia presentation and use internet services.**
- **Prepare production drawings using computer and relevant software following standards codes and norms.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for theachievement of the following COs:

a) Utilize various computer hardware, peripheral devices and software tools.
b) Create professional documents, analyzing data and presentation using various IT

software tools.

c) Interpret cyber security in use of internet services for various applications.

d) Draw simple Mechanical components/assembly in 2D using CAD software.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are thesub-components of the Course Outcomes (Cos).All PrOs are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify and prepare report document including sample specifications that contains brief information regarding various components of computer systems and peripheral devices available in the institute's computer labs.	I	02
2	Demonstrate the installation procedure of computer peripheral devices/software in Desktop/Laptop from the following list: - Computer Mouse & Keyboard (Wired/Wireless) - Webcam - Microphone - Scanner - Printer - Projector - Data Storage Devices (USB/Portable Hard Disk drive) - Operating systems/software tools	I	02
3	Install preferable web browser in the computer system and perform various use of web browser for accessing the internet facility.	I	02
4	Demonstrate participation in any three Digital India Platforms from the following list. Digital India Platforms: BHIM, Dig-Locker, mParivahan,The Unique Identification Authority of India (UIDAI), Digital Gujarat.	I	02
5	Create a text document incorporating various page setup feature, font, language and character feature, pictures-shape-icons-smart-	II	06

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	art feature, header-footer with page number feature, using an equation and symbols, plot data table and chart/graph with referring published technical paper or any technical survey/Project report. Submit the completed report in PDF format.		
6	Create spreadsheet document with use of sort & filter features, conditional formatting features, font & alignment setting, cell property and formatting features, analyze data using formulas and functions and present it through charts with referring student's results data sheet. Submit the completed spreadsheet in PDF format.	II	06
7	Create slide presentation of relevant topic using basic formatting features, insert and design slide, drawing tools, shape and picture style, object fill and effects, data table or 2D-3D charts, animation and transition effects, short media clip and hyperlink. Submit the completed presentation in PDF format.	II	06
8	Study of the features of firewall in providing network/cyber security and to set Firewall Security in computer operating system and visit site https://cert-in.org.in/	III	02
9	Draw and edit 4 simple problems of different geometrical shapesin AutoCAD software using Drawing Tools, Modifying tools, Dimensioning tools, etc. Submit the completed drawings in PDF format.Write steps to prepare each drawing. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.	IV	4
10	Prepare orthographic production drawings of minimum four mechanical components with all necessary views, dimensions, tolerances, notes, title block, etc. using CAD software (Real industrial component may be selected by student as student activity and approved / assigned by teacher.) Submit the completed drawings in PDF format.Write steps to prepare each drawing/component. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.	IV	12
11	Prepare 2D drawings of minimum one mechanical assemblyand its components with all necessary views, dimensions, tolerances, notes, title block, etc. using CAD software. (Following are some samplesfor reference, teacher may assign any other branch specific assembly). Take print out of the same using printer/plotter. 1. Drawing of cotter joint assembly 2. Drawing of knuckle joint assembly 3. Drawing of Flanged coupling assembly	V,VI	12

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	4. Drawing of Machine vice assembly Write steps to prepare each drawing/component/assembly. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.		
			56

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1.	Lab Records and regularity	20
2.	Question answer / Writing steps of exercise	20
3.	Execution of exercise	20
4.	Printout/Result	10
5.	Viva voice	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specificationsfor the PrOsis a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Computer system with latest configuration.	All
2.	Laser printer-scanner, plotter.	All
3.	Related software. (OS, open office, CAD software, MS office, Auto CAD, Anti-Virus software, Gujrati-Hindi language input tool software etc.).	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs andPrOs.More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical and electronics equipment.
c) Maintain tools and equipment.
d) Realize importance of E-waste management. (Environment related).

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I **Basics of Computer Systems & Internet and applications**	1a Describe computer system and its components. 2a Explain functions of CPU, ALU and memory unit of a computer system. 3a Describe basic terminologies of Internet. 4a Utilize the internet for various applications.	1.1 Computer system block diagram, concept of hardware and software. 1.2 CPU, control unit, Arithmetic Logic Unit(ALU), memory unit, power unit and interfacing ports. 1.3 Input Output unit: monitor, keyboard, external hard disk, mouse, printers, plotters, scanner, projectors, webcam, Mic, etc. 1.4 Introduction to internet and basic internet terminologies: browser, webpage, website, URL. 1.5 Google search engine introduction and search query. 1.6 Applications of Internet Digital Platforms. (BHIM, Digi-Locker, mParivahan, NSDL, Digital Gujarat, Passport seva, UIDAI.)

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-II Documenta-tions, Spreadsheet & Presentation using Software.	2a. Write steps for text formatting, page Setup features, checking spelling and grammar, with header and footer for a text document. 2b. Write steps for inserting graphics/clipart, shapes and table in a text document. 2c. Write steps to mail merge documents for inviting students. 2d. Write steps for creating spreadsheet and representing in the form of chart. 2e. Write steps to setup page as per given layout and print a spreadsheet sheet. 2f. Write steps for creating presentation and apply basic formatting features using spreadsheet. 2g. Write steps to insert objects,	**Using Text Processing** 2.1. Basics of font type, size, color, effects and other text formatting features. 2.2. Page settings and margins including header and footer in word document. 2.3. Spelling and grammatical checks. 2.4. Table and its options, inserting rows or columns, merging and splitting cells, arithmetic calculations in a table. 2.5. Working with pictures, drawings and word-art, Mail merge. **Using Spreadsheet** 2.6. Introduction to data, cell address, data types, formatting, number, text and date concept of hyperlink in spreadsheet. 2.7. Understanding formulas, operators and common spreadsheet functions. 2.8. Types of graphics: art, auto shapes, Images, charts. 2.9. Concept of print area, margins, header, footer and other page setup options. **Using Professional Presentation** 2.10. Creating new slides, working with text boxes, fonts, tables, Layouts, themes, effects, background and colors. 2.11. Selecting, deleting, moving, copying, resizing and arranging objects. 2.12. Working with drawing tools, applying shape or picture styles, applying object borders, object fill, object effects, clip art collection and modifying clip art. 2.13. Embed a video, link to a video, size a video, video playback options. 2.14. Configuring a sound playback, assigning sound to an object, adding a digital music sound track, transition effects and timings. **Using Gujarati/Hindi IME** 2.15. Installation of Guajarati/Hindi IME software. 2.16. How to change language English to Gujarati/Hindi.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	clips, video, audio, with special effects and hyperlink in a multimedia presentation. 2h. Write steps for installing Indic IME Gujarati for creating a document.	2.17. Introduction about the Gujarati/Hindi keyboards. 2.18. Introduction about the Gujarati IME and create Documents in Gujarati/Hindi.
Unit-III Information Security.	3.a. Explain concepts of Information Security for Data Protection. 3.b. Write various methods tosecure your personal computer Describe cyber laws for data protection and IPR.	3.1. Need for Information Security. 3.2. Definition of various terms of Information Security. - Cryptography - Vulnerability - Threat - Attack - Encryption - Decryption 3.3. Security services. 3.4. Cyberattacks: Introduction of common types of attacks. 3.5. Preventing Tools: Antivirus, Firewall. 3.6. Cyber Law: IT Amendment Act 2008 (Section 66 & 67).
Unit–IV Creatingdigitaldrawingsusing aComputerAided Drafting(CAD)Software.	4.a. Start Computeraideddraftingsoftware(AutoCAD). 4.b. Invokecommandsin AutoCAD. 4.c. Setlimits&Coordinatesystems. 4.d. Useobjectselection. 4.e. Create basic & advance 2D entitiesClose & save work	IntroductiontoBasicDraw CommandsinanyComputerAidedDraftingsoftwarelikeAutoCADPowerdraft,Microstation: 4.1. Systemrequirements &Understandingtheinterface. 4.2. Explain Drawing standards.(IS-696 /SP 46) (Drawing/ printing/ storage). 4.3. Componentsof aCADsoftwarewindow:SuchasQuick Access Toolbar, Ribbon, Command Bar, Orientation tools, Status bar, Different Menu / Tools / commands, etc. 4.4. Filefeatures:Newfile,savingthefile,Openinganexistingdrawingfile,CreatingTemplates,Quit. 4.5. Settingupnewdrawing:Units,Limits,Grid, Snap,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		4.6. MethodsofSpecifyingpoints-AbsolutecoordinatesandRelativeCartesian&Polarcoordinates. 4.7. Use of objectSnap 4.8. Conceptofmodel spaceandpaperspace. 4.9. Standardsizesofsheet.Selectingvariousplottingparameterssuchas Papersize,paperunits,Drawingorientation,plotscale,plotoffset,plotarea, printpreview. 4.10. Creatingviewportsinmodel spaceandcreatingfloatingviewportinpaperspace.Shiftingfrommodel spacetopaperspaceandviceversa. 4.11. Take print outs from a CAD Software.
Unit–V EditingDrawingusingaCADsoftware.	5a. Modifyexisting2Dentities. 5b. Usedifferentarraysinexisting2Ddrawing. 5c. Viewgivendrawingentitiesproperly. 5d. Enquireaboutvariousattributes ofexisting2Dentities.	IntroductiontoBasicEdit,InquiryanddisplayCommands. 5.1. Copy,Rotate,Move,Erase,Mirror,Array,Trim,Break,Extend,Chamfer,Fillet. 5.2. Zoom window,Zoom in-out,PAN. 5.3. List,Dblist,Area,Massprop.
Unit–VI Advanceeditingofadrawingusing aCADSoftware.	6a. Uselayersforpropermanagement ofdrawings. 6b. Setpropertiesofexistingdrawingentitiesasperrequirement. 6c. Abletodimensiongiven2Dentities withperfection. 6d. UseBlockseffectivelytocreateperfectdrawings.	IntroductiontoAdvancedModify&otherutility CommandsinanyComputerAidedDraftingsoftwarelikeAutoCADPowerdraft,Microstation: 6.1. Properties,Linetype,color,lineweight 6.2. ConceptofLayers. 6.3. ConceptofBlocks. 6.4. ConceptofHatch. 6.5. Dimensioning:Typesofdimensioning:Linear-Horizontal,Vertical,Aligned,Rotated,Baseline,Continuous,Diameter,Radius,AngularDimensions. 6.6. Dimscale variable. 6.7. Editingdimensions. 6.8. TextStyles: Selectingfont,size,alignmentetc.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Not applicable						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Undertake micro-projects in team/individually.
b) Encourage Students for creating and designing forms related to Departmental work.
c) Prepare a portfolio for the Digital India platform and identify digital services for Indian citizens.
d) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc. to further enhance their learning.
e) Select at least four simple mechanical components each made up of minimum 5-6 manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex.No10).
f) Select at least one simple mechanical assembly in group of 5-6 students, each made up of minimum 5-6 components. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex.No.11).
g) Bring Actual assembly from workshop/industry, measure dimensions, sketch it and make 2D production drawing for the same.(For Ex.No.11)
h) Prepare the Charts that classify recycling process for electronic waste and plastics.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.

   About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature may be given to the students for ***self-learning***, but to be assessedusing different assessment methods.

   Guide students on addressing the issues on environment and sustainability using the knowledge of this course.
c) Introduce IS Codes of drawing for self-study.
d) Guide studentsfor keeping the drawings in digital form and reduce use of paper.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs.Similar micro-projects could be added by the concerned course teacher:

a) Word documents: Prepare Subject teacher shall assign document/Reports to be prepared by each student covering all the major features of word processing software.
b) Slide Presentations: Prepare slides show with all Presentation features such as: classroom presentation, presentation about department, presentation about institute, presentation of report. (Subject teacher shall assign a presentation to be prepared by each student).
c) Spreadsheets: Prepare Pay bills/salary statements, tax statement, student's assessment record, Students fees system, earning and expenditure statement of a company to ascertain profit-loss etc. using spreadsheet. (Teacher shall assign a spreadsheet to be prepared by each student).
d) Bring an industrial production drawing/component from workshop. Learn to interpret and List the commands to be used to draw it.
e) Sorting of e-waste: Compile a reportfor sorting different types of electronic and plastic waste.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Fundamentals of Computers, Sixth Edition	Rajaraman V, Adabala N	Prentice Hall India Learning Private Limited. ISBN: 8120350677
2.	Computer Course	R Taxali	Tata McGraw Hills. New Delhi. ISBN: 9780070700376

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
3.	INFORMATION TECHNOLOGY	Dennis P. Curtin, Kim Foley, Kunal Sen, Cathy Morin	Tata McGraw Hills Publication. ISBN: 978-0074635582
4.	MS-Office for Dummies	Wallace Wang	Wiley India, New Delhi. ISBN: 9788126578559
5.	Sams Teach Yourself Internet and Web Basics All in One	Ned Snell, Bob Temple, Michael Clark	Sams Publishing, Indiana, USA, ISBN:0672-32533-0
6.	Computer Fundamentals	R.S. Salaria	Khanna Book Publishing Company ISBN: 978-9381068533
7.	MachineDrawingincludingAutoCAD	Ajeet Singh	McGrawhill
8.	ProductionDrawing	KLNarayan	NewAgePublication
9.	FundamentalofGeometricToleranceanddimensioning	AlexKrulikowski	Cengage Learning
10.	EngineeringGraphicswithAutoCAD	Sarkar.A.K	PHIindia
11.	EssentialsofEngineeringDrawingandGraphicsusing AutoCAD	Jeyapoovan	Vikaspublication
12.	AutoCADUser Guide	Autodesk	AutodeskPress.

14. SOFTWARE/LEARNING WEBSITES

a. https://www.tutorialspoint.com
b. https://edu.google.com/intl/ALL_in/teacher-enter/products/forms/?modal_active=none
c. www.w3schools com
d. https://support.microsoft.com/en-us/training
e. https://edu.gcfglobal.org/en/topics/googleapps/
f. https://www.udemy.com
g. https://www.coursera.org/
h. https://www.digitalindiaportal.co.in/
i. https://getintopc.com/

j. https://nptel.ac.in/
k. https://magazine.opensourceforu.com/
l. https://www.electronicsforu.com/
m. https://www.redhat.com/en
n. https://www.netacad.com/
o. https://www.cert-in.org.in/
p. https://www.youtube.com/results?search_query=engineering+drawing
q. https://www.youtube.com/c/MechanicalEnggSubjectsGTU/playlists
r. https://youtu.be/MT1T31GtGpg
s. https://youtu.be/WEwkepkv6mg
t. https://youtu.be/trJQIvatIpI
u. https://nptel.ac.in/courses/112/103/112103019
v. https://nptel.ac.in/courses/112/105/112105294
w. https://en.wikipedia.org/wiki/Engineering_drawing
x. https://www.slideshare.net/search/slideshow?searchfrom=header&q=engineering+drawing
y. https://www.scribd.com/search?content_type=tops&page=1&query=engineering%20drawing&content_types=tops,books,audiobooks,summaries,articles,documents,sheet_music,podcasts
z. http://www.cognifront.com/tools.php
aa. https://www.youtube.com/watch?v=bmAlJAMndwM
bb. https://www.youtube.com/watch?v=904_RPjGJg4
cc. https://www.youtube.com/watch?v=jzlDouas0Wc
dd. https://www.youtube.com/watch?v=VuHdV38fyjc
ee. https://www.youtube.com/watch?v=iOzlIJge_G0
ff. https://www.youtube.com/watch?v=-l0iRdH3MbA
gg. https://www.youtube.com/watch?v=vI5xhCD5mXQ
hh. https://www.youtube.com/watch?v=GDrD9nEZ9LY

15. PO-COMPETENCY-CO MAPPING

Semester I	Instrumentation Workshop (Course Code: 4311702)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation&Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency 1. Develop basic skills using various IT software tools for	3		2	2	2		2

creating professional documents, analyzing data, preparing multimedia presentation and use internet services.							
2. Prepare production drawings using computer and relevant software following standards codes and norms.	3		2	2	2	1	2
CO 1) Utilize various computer hardware, peripheral devices and software tools.	3			2			2
CO 2) Create professional documents, analyzing data and presentation using various IT software tools	3	1	2	2	2		2
CO 3) Use internet services for various applications.	2			2	2		2
CO 4) Draw simple Mechanical assembly in 2D using CAD software.	3		2	2	2	1	2

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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Sr. No.	Name and Designation	Institute	Contact No.	Email
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2.	Prof.N.G.Parmar,Lecturer in Mechanical Engineering	R.C.TechnicalInstitute ,Ahmedabad	9426333054	ng_parmar@yahoo.co.in
3.	Prof. H.V.Patel, Lecturer in Automobile Engineering.	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9978872090	hvpautodept@gmail.com
4.	Prof. R.B.Zapadiya, Lecturer in Fabrication Techmology	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9033219351	rohan.zapadiya@gmail.com

BOS Resource Persons

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I & II – Semester

Course Title: **Engineering Workshop Practice**
(Course Code: 4301901)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering, Marine, Metallurgy, Mechatronics, Fabrication Technology, Ceramics	First
Automobile Engineering, Textile Processing Technology, Printing Technology, Textile Manufacturing Technology	Second

1. RATIONALE

Workshop practice is the backbone of the real industrial environment which helps to develop and enhance relevant technical hand skills required by the technician working in the various engineering industries and workshops. This course intends to impart knowledge of basic workshops such as fitting, sheet metal, plumbing, carpentry and welding shop to perform his/her duties in industries. Students are able to perform various operations using hand tool, equipment and machineries in various shops. Working in workshop develops the attitude of group working and safety awareness.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Prepare simple jobs as per given specification using appropriate tools, instruments and equipment following safe working and good housekeeping practices.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the following Course Outcomes (COs) achievement :

a) Use the preliminary safety measures while working in different shops of engineering workshop.
b) Select the appropriate tools/equipment required for specific job.
c) Perform various fitting and sheet metal operations to produce simple jobs.
d) Use various tools for performing plumbing and carpentry operations.
e) Perform various joining operations using welding, brazing and soldering methods.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	0	0	25*	25	50

(*): For this practical only course, 25 marks under the practical CA has two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare a general layout of workshop.	I	02
2	Perform mock drill practice for various safety equipments and common workshop tools.	I	02*
3	***Fitting shop*** **:** Prepare one simple fitting job with following operations • Marking operation as per drawing • punching operation as per drawing • filing operation as per drawing	II	04*
4	Prepare job with following operations: • chamfering operation as per drawing • sawing operation as per drawing	II	04
5	Prepare job with following operations: • drilling operation as per drawing • tapping operation as per drawing	II	04*
6	***Sheet metal shop :*** Perform various joining operations like soldering, brazing etc.	III	02
7	Prepare the report with sketch, specifications and applications of demonstrated sheet metal tools.	III	02
8	Prepare sheet metal utility job using following operations : • Cutting and Bending • Edging • Soldering • Riveting.	III	06*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	***Carpentry shop:*** Demonstration of different carpentry tools including power tools.	IV	02
10	Prepare the report with sketch, specifications and applications of demonstrated carpentry tools.	IV	02
11	Prepare one simple carpentry job involving operations like measuring, marking, cutting and assembly.	IV	06*
12	Prepare following carpentry job as per given drawing: • T-Joint, • Dovetail Joint		04*
13	***Plumbing shop:*** Demonstration of different plumbing tools and pipe fittings.	V	02
14	Prepare the report with sketch, specifications and applications of demonstrated plumbing tools and pipe fittings.	V	02
15	Prepare following plumbing job as per given drawing: • T joint pipe fitting job • elbow joint pipe fitting	V	04*
16	***Welding shop:*** Demonstration of different welding tools/machines.	VI	02
17	Prepare the report with sketch, specifications and applications of demonstrated welding tools/machines.	VI	02
18	Prepare simple job using arc welding method.	VI	04*
	Total		**56**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1.	Safety instructions	10
2.	Job sample drawing	10
3.	Selection of tool/equipment	20
4.	Sequence of operations and procedure	30
5.	Time limit	10
6.	Dimensional accuracy	10

7.	Oral test	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	**Fitting Shop** Bench vices 50/100/150 mm. Hand vice, Machine vice Marking table Surface plate Angle plate Universal scribing block Scriber Marking gauge Fitting tables Tri square Right angle Combination set V block with clamps C clamps Set of needle files Ball pane Hammer - 750 Gms. Pair of outside spring caliper- 250 mm. Pair of Inside spring caliper 150 mm. Vernier caliper Micrometer outside & inside Bevel protractor Odd leg caliper Files (smooth & rough)-round, flat, safe edge, square, knife edge, triangular, half round One pair of divider Hacksaw frame with blade 12”* 300 mm. Centre punch Dot punch Prick punch Letter punch-Number punch Flat chisel 20 mm. Set of sorted twist drills, taps and dies (with holders/wrench) Set of spanners-Fix, Ring, box, Allen and Adjustable Set of screw drivers-sorted Scraping tool Set of pliers Filler and radius gauge etc.	2, 3, 4 & 5

S. No.	Equipment Name with Broad Specifications	PrO. No.
2	**Sheet Metal Shop** Rubber mallet Wooden mallet Slip 12", 10" Slip ordinary Half moon stake Side stake Exiting stake Cross stake Funnel stake Tea & bottom stake Stake holding stand Combination pliers S.W.G Hand riveting m/c Spinning hath 6' with die Power hydraulic press m/c Riveting m/c Round stake Soldering and Brazing kits etc.	2, 6, 7 & 8
3	**Carpentry Shop** Carpentry tables Carpentry vices Bar cramp Plane machine-small ("Randha machine") Wood and metal Jack planes- 45 mm. Set of sorted wooden jack planes Smoothing plane Rebate plane Cross cut saw Compass saw Set of sorted saws Round hole saw Tenon saw 350 mm. Set of chisels-Firmer, Dovetail, Paring, and Mortise Adze tool Auger bit Hand drill with set of sorted drill bits Gimlet Small precision brace Mallet Wood rasp file Claw hammer Pincer Marking gage 150 mm.	2, 9, 10 , 11 &12

S. No.	Equipment Name with Broad Specifications	PrO. No.
	Steel rule 24” Measuring Tape 300 mm. C clamps Tri square Right angle Compass and divider Set of chisels Ball pane Hammer - 750 Gms. Hardware- nails, screws etc. Set of screw drivers Wood work punches Set of Gouges etc.	
4	**Plumbing Shop** Various samples of pipe fittings-like joints, elbows, tees, unions, bend, nipples, couplers, reducers, four way etc. of Metal and PVC Water taps, plug, ferule Pipe bending machine manual/hydraulic Pipe vice Pipe wrenches Pipe spanners Set of spanners-Fix, Ring, box, Allen and Adjustable. Set of screw drivers-sorted Set of chisels Hammers Teflon taps, cotton thread Set of dies and holders Hacksaw, pipe cutter Adhesive for PVC pipe fittings etc.	2, 13, 14 &15
5	**Welding Shop** Arc welding set with necessary accessories Welding cables Electrodes Fluxes Electrode holders Ground clamps Chipping hammer Wire brush Try Square Hammers, tongs, chisels and anvil Screw Wrench Tip Cleaner, Swage block and Personal Protective Equipment like safety gloves, face shield /screen etc.	2, 16, 17 & 18

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Follow safe practices.
b) Practice good housekeeping.
c) Demonstrate working as a leader/a team member.
d) Maintain tools/equipment.
e) Follow ethical practices.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Workshop Introduc-tion & Safety**	1a. Sketch general workshop layout 1b. Follow the preliminary safety rules in workshop including the dressing and behavioral safety manners 1c. Recognize the importance of keeping the workshop clean and tidy 1d. Demonstrate an awareness of the workshop safety rules written in the safety contact	1.1 Workshop layout 1.2 Importance of different sections/shops of workshop 1.3 Introduction to workshop safety 1.4 Personal safety 1.5 Use of tools 1.6 Workshop cleanliness 1.7 Fire precautions 1.8 Safety contract ***(See Annexure-1)***
Unit – II **Fitting Shop**	2a. Appreciate the importance of fitting operations in engineering works 2b. Select the proper fitting material for the job undertaken 2c. Indentify and use various tools/equipment used in	2.1 Introduction 2.2 Fitting tools: 2.2.1 Holding tools, 2.2.2 Striking tools, 2.2.3 Cutting tools, 2.2.4 Measuring, Marking and Testing tools etc.

	fitting shop 2d. Prepare a simple job according to the specifications	2.3 Fitting operations: 2.3.1 Method of filing, 2.3.2 Marking, 2.3.3 Sawing, 2.3.4 Chipping etc. 2.4 Materials used in fitting shop 2.5 Preparation of fitting job 2.6 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 1.*
Unit– III **Sheet Metal Shop**	3a. Appreciate the importance of sheet metal operations in engineering works 3b. Select the proper sheet material for the job undertaken 3c. Indentify and use various tools/ equipment used in sheet metal shop 3d. Prepare a simple job according to the Specifications	3.1 Introduction 3.2 Metals used in sheet metal work 3.3 Hand tools 3.4 Sheet metal joints 3.5 Soldering 3.6 Brazing 3.7 Preparation of sheet metal job 3.8 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 2.*
Unit– IV **Carpentry Shop**	4a. Appreciate the importance of carpentry operations in engineering works 4b. Select proper wood material for the job undertaken 4c. Indentify and use various tools/equipment used in carpentry shop 4d. Prepare a simple job according to the specifications	4.1 Introduction 4.2 Advantages of timber 4.3 Structure of wood 4.4 Selection of timber 4.5 Seasoning of timber 4.6 Methods of seasoning 4.7 Common defects in timber 4.8 Classification and conversion of wood 4.9 Carpentry tools 4.10 Cutting tools, Planes and Boring tools etc. 4.11 Preparation of carpentry job 4.12 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 3.*

Unit– V **Plumbing Shop**	5a. Appreciate the importance of plumbing operations in engineering works 5b. Select proper grade and type of different pipes required for the job undertaken 5c. Indentify and use various tools/ equipment used in plumbing shop 5d. Prepare a simple job according to the specifications	5.1 Introduction 5.2 Types of pipes 5.3 Pipe fittings including valves 5.4 Plumbing tools 5.5 Pipe joints 5.6 Preparation of plumbing job 5.7 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 4.*
Unit– VI **Welding Shop**	6a. Appreciate the importance of welding in engineering works 6b. Select the proper material and welding machine for the job undertaken 6c. Indentify and use various tools/ equipment used in welding shop 6d. Prepare a simple job according to the specifications	6.1 Introduction 6.2 Types of welding 6.3 Arc welding: 6.3.1 Principle of arc welding, 6.3.2 Electric arc welding 6.4 Arc welding electrodes 6.5 Fluxes 6.6 Equipments used in arc welding 6.7 Types of welded joints 6.8 Comparison between AC and DC welding 6.9 Preparation of work before welding 6.10 Advantages of welding 6.11 Disadvantages of welding 6.12 Common welding defects 6.13 Preparation of welding job 6.14 Safe and correct practices ***Note**: List of Major Equipment / Instruments of this lab mentioned above under the Point 6 at Serial No. 5.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching/ Practical Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Workshop Introduction & Safety	**- Not Applicable -**				
II	Fitting Shop					
III	Sheet Metal Shop					
IV	Carpentry Shop					
V	Plumbing Shop					
VI	Welding Shop					
Total						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare a list of specifications for various tools/equipment/machines used in the engineering workshop.
b) Undertake a market survey of local dealers for procurement of workshop tools/ equipment/machines and raw material.
c) Visit the local sheet metal trader/timber merchant/plywood merchant/fabricator, collect all relevant information and submit the detailed report.
d) Download movies showing correct practices for fitting, sheet metal work, carpentry, plumbing and welding

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability (Hand operated tools are being used which are not consuming generated energy)

g) Guide students for using data manuals.
h) Arrange visit to nearby industries and workshops and use of videos/animations for understanding various workshop process.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a utility job using various carpentry operations as per given drawing.
b) Prepare a utility job using various plumbing operations as per given drawing.
c) Prepare a utility job using various sheet metal operations as per given drawing.

Note :

- *Utility job will be assigned by the teacher.*
- *Utility Job will be completed in a group of 4 to 5 students and students have to maintain lab work manual consist of job drawing, operations details, required raw materials, tools, equipments, date wise performance record.*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Workshop Practice	H.S. Bawa	McGraw Hill Education, Noida ISBN: 978-0070671195
2	A Textbook of Manufacturing Process (Workshop Technology)	J.K.Gupt and R.S. Kurmi	S.Chand and Co. New Delhi ISBN:81-219-3092-8
3	Introduction to Basic Manufacturing Process and Workshop Technology	Rajender Singh	New Age International, New Delhi ISBN: 978-81-224-3070-7

14. SOFTWARE/LEARNING WEBSITES

- http://www.abmtools.com/downloads/Woodworking%20Carpentry%20Tools.pdf
- http://www.weldingtechnology.org

- http://www.newagepublishers.com/samplechapter/001469.pdf
- http://www.youtube.com/watch?v=TeBX6cKKHWY
- http://www.youtube.com/watch?v=QHF0sNHnttw&feature=related
- http://www.youtube.com/watch?v=Kv1zo9CAxt4&feature=relmfu
- http://www.piehtoolco.com
- http://sourcing.indiamart.com/engineering/articles/materials-used-hand-tools/

15. PO-COMPETENCY-CO MAPPING

Semester-I & II	Engineering Workshop Practice (Course Code: 4301901)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustain-ability & environ-ment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	**Prepare simple jobs as per given specification using appropriate tools, instruments and equipment following safe working and good housekeeping practices.**						
Course Outcomes CO a) Use the preliminary safety measures while working in different shops of engineering workshop.	2	-	-	3	2	-	-
CO b) Select the appropriate tools/equipment required for specific job.	2	-	-	3	-	-	-
CO c) Perform various fitting and sheet metal operations to produce simple jobs.	-	-	-	2	1	-	-
CO d) Use various tools for performing plumbing and carpentry operations.	-	-	-	1	1	-	-
CO e) Perform various joining operations using welding, brazing and soldering methods.	-	-	-	2	1	-	-

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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NITTTR Resource Persons

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2.	Dr. A.K. Sarathe, Associate Professor	Mech. Engg. Education	9425392466	aksarathe@nitttrbpl.ac.in
3.	Dr. Sharad K. Pradhan, Associate Professor	Mech. Engg. Education	9300802353	spradhan@nitttrbpl.ac.in

Annexure-1

SAMPLE SEFTY CONTRACT:
(To be filled by the students and submitted to concerned faculty/staff)
-- Use for reference purposes only --

1. You have to read and sign the safety contract.
2. The safety contract says that you understand that safety is your responsibility.
3. The safety contract to be signed before you carries out any work in the workshop and if you don't observe and obey the safety rules, you will not be allowed in the workshop.

Safety Contract

Date: .....

Name of Institute: .....

Name of Course with Code: Engineering Workshop Practice (3301901)

Name of Faculty/Staff with Designation: 1.....

2. .....

3. .....

I recognize that :

1. Safety is my responsibility when using a tool.
2. Safety regulations have been provided to me.
3. The possibility of accident and injury increases if I do not follow all the safety guidelines.
4. I must act responsibly to ensure my own safety AND the safety of others in the work area.

I agree to :

1. Never work in the shop without my faculty supervision.
2. Read and practice all the safety regulations that have been distributed to me in this course or have been posted in the work areas.
3. Act in a responsible manner at all times in the workshop.
4. Follow all instructions given by the faculty.
5. Immediately report any unsafe condition or activity to my faculty.

6. Wear eye protection at all times when working with tools or working anywhere near someone who is using tools.
7. Cut or Tie back long hair, remove jewelry, secure loosed clothing, and wear safety shoes in the Workshop.
8. Clean all work areas and put equipment away before leaving the workshop.

I, _____, have read and agree with all the safety instructions.

Particulars:

Programme: ....

Batch No.: ..... Student Signature

Enrollment No.: .....

----------x----------

CAD/CAM

2ND Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
Semester-II

Course Title: Manufacturing Engineering Processes-I
(Course Code: 1326501)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	Second Semester

1. RATIONALE

This subject of Manufacturing Engineering Processes-I provides knowledge and embeds skill to students to produce various products using metal forming, metal casting, metal joining plastic moulding processes and Heat treatment processes. Materials and Manufacturing processes are the most important element in any engineering industry. Mechanical Engineer is a key person for shop floor activities related to manufacturing. He/she should have knowledge and associated skill of manufacturing processes. Hence emphasis is given on skill development by adding practices in all topics in this Manufacturing Engineering Processes-I subject. Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

Metal forming processes, Casting processes, Plastic moulding process and Welding processes are essential components of many industries such as the automotive industry, machines and equipment industry, construction industry, aviation industry, and more.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Produce the job as per given specification by selecting and applying appropriate manufacturing processes like Casting, Forming, Moulding and Joining.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Classify various mechanical manufacturing processes.
b) Recommend heat treatment process to improve mechanical properties.
c) Select appropriate casting process to produce mechanical components.
d) Select appropriate metal forming process to produce mechanical components.
e) Select appropriate moulding method to produce plastic components.
f) Select appropriate metal joining process for various applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken

during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the* ***PrOs*** *marked* ***'*'*** *are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Preparatory activity a. Recall Mechanical properties of materials. b. Safety Practices to be followed in metal forming, casting, non-metal moulding, metal joining processes and heat treatment processes.	ALL	02
2	Examine the given specimen by use of Metallurgical Microscope.	II	02
3	Perform hardening process on ferrous material. Measure the hardness before and after hardening.	II	04
4	Prepare a pattern for the given components/drawings, considering pattern allowances.	III	06
5	Prepare a sand mould using prepared pattern. Also pour molten metal and get the casting. (Use wax in place of molten metal for the purpose of demonstration.)	III	06
6	Prepare a job using hot/cold forging/smithy process.	IV	06
7	Study of Plastic moulding processes. (Demonstration of processes shall be carried out compulsory during industrial visit)	V	02
8	Prepare a job using arc welding. Highlight effect of process parameters	VI	06
9	Prepare a job using gas welding. Highlight effect of process parameters	VI	04
10	Prepare a job using spot/seam resistance welding.	VI	04
11	Prepare two jobs, one using soldering and another using brazing.	VI	02
12	Visit nearby Rolling mill/Hot-Cold material processes, foundry, plastic processing industry, fabrication industry and prepare a two page report comprises of types of item produced, quantities, different sections, equipments used with specification and materials.	ALL	–
13	Micro Project as suggested in section no. 4	ALL	10
14	SCHOOL WITHIN SCHOOL: Each student will prepare and present report on: a. His/her observation for the jobs made. b. PPT on topic assigned by teacher.	ALL	02
	Total hours		**56 Hrs.**

Note

i. More ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. The following are some ***sample*** *'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed* ***Practical Exercises*** *of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify components (Knowledge)	10
2	Prepare experimental setup. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

Sr. No.	Major Equipments	PrOs. No.
1	Material Science and metallurgy 1. Metallurgical Microscope with standard specimen 2. Heat treatment Furnace 3. hardness tester	2,3
2	Pattern Making: Wood cutting planer machine/Wood jack plane, Carpentry vice, Flat file, Hammer, Steel rule, Right angle, Saw	4
3	Molding Cope and drag Boxes, Molding sand with additives and binder, Vent wire, Furnace or Oven, Consumable (Wax)	5
4	Smith forging Anvil, Furnace, Hammers, Tong, Steel rule, Air blower, Swage block	6
5	Arc welding Arc welding Machine with electrode holder, Tong, Chipping hammer, Wire brush, Hand gloves, Welding Face Shield, Safety goggles	8
6	Gas welding Oxy acetylene gas cylinders with regulators, Welding torch, Tong, Chipping Hammer, Steel rule, Hand gloves, Safety goggles	9
7	Spot/Resistance welding Spot welding machine, Plier cutter, Hammer, Steel rule	10
8	Soldering/ Brazing Brazing torch, Consumables, Tong, Hammer, Anvil, Wire brush, Soldering iron & lead wire	11

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.

b) Follow safety practices while using equipment.

c) Realize the importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below: i. 'Valuing Level' in 1st year ii. 'Organization Level' in 2nd year. iii. 'Characterization Level' in 3rd year

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Engineering Materials and Manufacturing Processes	1.a Define various properties of materials. 1.b Classify and describe various Engineering Materials. 1.c Classify various manufacturing processes.	1.1 Define Physical, Mechanical, electrical, electromagnetic and thermal properties of materials. 1.2 Engineering Materials: Classifications, properties and Applications. 1.3 Classification of various Manufacturing Engineering processes.
Unit – II Material Science and Metallurgy	2.a Draw and Interpret TTT curves and Iron carbon diagram. 2.b Explain various heat treatment processes. 2.c Recommend heat treatment process to improve mechanical properties 2.d Examine specimens using microscope.	2.1 Time Temperature Transformation curve-(TTT curve). i. Need and application. 2.2 Iron carbon equilibrium diagram. i. Need and application. 2.3 Heat treatment processes: Procedure and properties changes in Hardening, Annealing, Normalizing, Case hardening, Tempering, Nitriding). 2.4 Types of quenching mediums and their applications. 2.5 Powder metallurgy : Basic concept of powder metallurgy and its applications, Process steps.
Unit – III Metal Casting Processes	3.a Identify various metal casting processes. 3.b. Select appropriate casting processes to produce mechanical components. 3.c. Identify casting defects, their causes and suggest remedies.	3.1 Basic concept, advantages, Limitations and applications of Casting process. 3.2 Steps of sand moulding process. 3.3 Pattern: Definition, Types, Applications and allowances 3.4 Cores: Definition, Types, Applications 3.4 Mould making equipment's and their applications. 3.5 Special Casting processes: Basic principle and applications 0f i. Centrifugal casting. ii. Die casting. iii. Investment casting 3.6 Casting defects - types, causes, effects and remedies. 3.7 Safety precautions in Casting processes.
Unit – IV Metal Forming Processes	4.a Compare hot and cold working Processes. 4.b Identify various metal forming processes. 4.c Select the appropriate metal forming process to produce a given mechanical component.	4.1 Concept of hot and cold working processes. 4.2 Classification of metal forming processes. 4.3 Working principle and applications of Forging, Rolling, Drawing, and Extrusion. 4.4 Safety precautions in metal forming processes.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– V **Plastic Moulding processes**	5. a Classify plastic materials 5. b Suggest appropriate moulding method for a given Plastic component. 5.c Identify injection mould parts	5.1 Plastic materials: Types and applications of commonly used i.e. PP, HDPE, LDPE, PS, PCE, ABS etc 5.2 Construction, Working and Applications: i. Injection moulding ii. Blow moulding iii. Extrusion moulding iv. Rotational moulding 5.3 Construction of Injection mould with nomenclature.
Unit– VI **Metal Joining Processes**	6.a Explain different welding processes. 6.b Identify the area of applications of a particular joining process. 6.c Select metal joining methods for various applications. 6.d Practice standard safety norms during any joining process.	6.1 Classification of metal joining processes. 6.2 Working principle, equipments, consumables, advantages, limitations and applications of following metal joining processes. (i) Arc welding: Metal Arc Welding, MIG (Metal Inert Gas), TIG (Tungsten Inert Gas), Submerged arc welding. (ii) Gas welding: Oxy-acetylene Gas welding, cutting, Types of flames. (iii) Resistance welding: spot welding set up and working. 6.3 Types of weld joints 6.4 Soldering: Procedure and Applications 6.5 Brazing: Procedure and Applications 6.6 Comparison of Welding, Brazing and Soldering. 6.7 Safety precautions in metal joining processes.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Engineering Materials and Manufacturing Processes**	**04**	**4**	**0**	**0**	**04**
II	**Material Science and Metallurgy**	**08**	**4**	**10**	**0**	**14**
III	**Metal Casting Processes**	**10**	**4**	**10**	**4**	**18**
IV	**Metal Forming Processes**	**06**	**4**	**6**	**4**	**14**
V	**Plastic Moulding Processes**	**06**	**0**	**3**	**3**	**06**
VI	**Metal Joining Processes**	**08**	**3**	**7**	**4**	**14**
Total		**42**	**19**	**36**	**15**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.* **At Least 3 CO'S should be met to achieve in the Mid Sem Exam.**

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

Sr. No.	Activity.
1	Select four industrial components (approved by teacher) and list various methods of manufacturing used to produce these components.
2	Select at least two components which are made by casting only. Also state the type of casting method used.
3	Prepare a list of industries/workshops in the nearby area which are producing components by casting/forming/moulding/Joining.
4	Prepare a list of plastic items which are produced using different types of molding methods. Name the process used.
5	Prepare a list of household items which are prepared by joining processes.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** : Use different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **10**-**16** ***(ten to sixteen)***

student engagement hours during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.
A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects can be added by the concerned course teacher:

a) Prepare a small useful product like flower pot / stool / table / bench / laboratory equipment/set-up utilizing laboratory resources.
b) Using Drafting software, prepare a pattern drawing/forged component drawing.
c) Survey/Visit nearby vendor, prepare sample specifications of manual metal arc welding machine, injection moulding machine, forging and casting equipments.
d) Maintenance of available infrastructure related to fabrication i.e. benches, stool, table, doors, grills, solar structure, etc.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Material Science	GBS Narang	Khanna Publishers New Delhi
2.	Material Science and Metallurgy	D S Nutt	S K Kataria and Sons Delhi
3.	Physical Metallurgy	Sydney Avener	Tata MacGraw Hill Education
4.	Workshop Technology I & II	J. A. Schey	Tata MacGraw Hill Education
5.	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Sons
6.	Workshop Technology I, II &	W. A. J. Chapman	Arnold
7.	Manufacturing Processes	M. L. Begman	Wiley India
8.	Production Technology	R.K. Jain and S.C. Gupta	Khanna publication
9.	Injection Mould Design	Pye R G W	East-West Press
10.	Audles Welding Guide	F.D. Graham	Wiley India
11.	Foundry Engineering	P.L. Jain	Tata MacGraw Hill Education
12.	Principle of Foundry	Jain & Gupta	National Book Trust, India
13.	Production Technology	H.H. Marshall	Machinery Publishing Company
14.	Elements of Workshop Technology (Vol I & II)	Hajra Chowdhary & Bhattacharya	Media Promoters

14. SOFTWARE/LEARNING WEBSITES

1. https://www.youtube.com/watch?v=1oZnxZj6-Ig (Green Sand moulding- animation)
2. https://www.youtube.com/watch?v=2CIcvB72dmk (metal casting Basics)
3. https://www.youtube.com/watch?v=EIBDp6U8bHo (Sand Casting)
4. http://www.youtube.com/watch?v=Yk1JOYzwRP4 (Loose piece Pattern)
5. http://www.youtube.com/watch?v=khEvhjlh_SM (Foundry Pattern making)
6. http://www.youtube.com/watch?v=f7FXtnXVqzY (Aluminium Casting)
7. http://www.youtube.com/watch?v=bzSSfBgkWfc&NR=1&feature=endscreen (Die Casting)
8. http://www.youtube.com/watch?v=pTTap4WiEAU (Gravity Die Casting)
9. http://www.flamingfurnace.com/ (Casting projects)
10. https://www.youtube.com/watch?v=3UNhaBOmLjM (Hand Forging)
11. https://www.youtube.com/watch?v=MyMTkLqZyEE (Press forging-Squeezing)
12. https://thelibraryofmanufacturing.com/forming_basics.html

13. https://www.youtube.com/watch?v=6xnKmt_gsLs (Rolling)
14. https://www.youtube.com/watch?v=9MU0vSN_w-A (Cold roll forming)
15. http://www.sme.org
16. http://www.youtube.com/watch?v=6xnKmt_gsLs (Hot Rolling)
17. https://www.youtube.com/watch?v=b1U9W4iNDiQ (Plastic Injection Moulding)
18. https://www.youtube.com/watch?v=Eyfd4iICUM4 (Injection moulding Machine)
19. https://www.youtube.com/watch?v=sDJpf6pKyuE (Rotational moulding machine)
20. https://olimy.com/technical/usual-mold-parts-and-their-function.html (Injection mould)
21. https://www.youtube.com/watch?v=pMtqDWUpJds (Arc welding Basics)
22. http://www.youtube.com/watch?v=CJ42scaWFnw (Brazing video)
23. https://www.youtube.com/watch?v=s9ouyi7h8zA (MIG welding)
24. https://www.youtube.com/watch?v=tNYmo2_DI6c (TIG welding)
25. https://www.youtube.com/watch?v=8fdVgj5pTPY&t=4s (SAW)

15. PO-COMPETENCY-CO MAPPING

Semester II	Manufacturing Engineering-1 (Course Code:)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Produce the job as per given specifications by selecting and applying appropriate manufacturing processes like Casting, Forming ,Moulding and Joining.						
(1) Classify various mechanical manufacturing processes.	3						
(2) Recommend heat treatment process to improve mechanical properties	3	2		2			
(3) Select appropriate casting process to produce mechanical components.	3		2	3			
(4) Select appropriate metal forming process to produce mechanical components.	3			3			
(5) Select appropriate moulding method to produce Plastic components.	3			2			
(6) Select metal joining process for various applications	2			2			

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	R.A. Prajapati, L.M.E.	GP, AHMEDABAD	9429435748	rap1432000@yahoo.com
2.	N.G.PARMAR, L.M.E.	RCTI, AHMEDABAD	9426333054	ng_parmar@yahoo.co.in

BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmedabad	9227200147	gpasiraj@gmail.com
2.	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B&B Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
3	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	Asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
Semester-II

Course Title: Basics of Mechanical Design
(Course Code: 1326502)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	2nd Semester

1. RATIONALE:
Design is a key branch of study in mechanical engineering, as it is the process of designing parts, components and products with an understanding of design constraints and the environment. This course curriculum provides the students with basic knowledge of the design process and familiarity with various loads, stresses, strains, etc. A diploma holder in this course is required to assist in the Design and development of a prototype and other components. For this, they must be conversant with the basic principles related to the Design of components & machines and the applications of these principles for designing. The aim of the subject is to develop knowledge and skills about various aspects related to the basics of mechanical Design. In this course, students will learn basic concepts of Mechanics, concepts and applications of direct stress and strain, static load, stress & strain, bending stress and torsional shear stress centroid, the centre of gravity & moment of inertia.

2. COMPETENCY:
The course content should be taught, and the curriculum should be implemented to develop different skills leading to the achievement of the following competency.

Use the principle of Mechanics to design components and to solve broad-based engineering-related problems

3. COURSE OUTCOMES (COs):
The practical exercises, underpinning knowledge, and the relevant skills associated with this competency are to be developed in the student to display the following COs:

a) Identify the force systems for given conditions by applying the basics of mechanics.
b) Evaluate material properties under longitudinal and transverse loads.
c) Compute bending stress and shear stress in various components for the given situation.
d) Calculatethe centroid and centre of gravity of various components in engineering Systems.
e) Determine the moment of inertia of a section about a given axis.

4. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate the integration of COs and the remaining 20 marks should be the average of 2 tests to be taken during the semester for assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; **T** - Tutorial/Teacher Guided Theory Practice; **P**- Practical; **C** - Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES:

The following practical outcomes (PrOs) are the sub-components of the COs.*These PrOs need to be attained to achieve the COs.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Verify and calculate resultant force through the Law of Parallelogram using analytical and graphical methods.	1	2
2	Verify the Law of Triangle using analytical and graphical methods.	1	2
3	Verify and calculate the resultant force through the Polygon Law of Forces using analytical and graphical methods.	1	2
4	Demonstration of tension test on mild steel.	2	2
5	Demonstration of measurement of Thermal Stress and Strain of any suitable material/s.	2	2
6	Demonstration of measurement of Bending Stress and Strain of any suitable material/s.	3	2
7	Calculate the centroid of the different geometric plane sections.	4	2
8	Calculate the Center of Gravity of Standard Solids.	4	2
9	Compute the Moment of Inertia of a given section	4	2
	Total Hrs.		**18**

Note

i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.** While designing exercises, make sure that all COs are covered equally.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs (1 to 7)	Weightage in %
1	Identify components for the experimental setup.	10
2	Prepare experimental setup.	20
3	Operate the equipment setup.	20
4	Follow safe practices	10
5	Record observations correctly.	20
6	Interpret the result and conclude.	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED:

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO No.
1	Apparatus for Law of Parallelogram.	1,2
2	Universal Force table with all accessories.	3
3	Centroids reference tables.	7
4	Centre of Gravity apparatus, Gravimeter etc.	8

7. AFFECTIVE DOMAIN OUTCOMES:

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the COs as mentioned above. More could be added to fulfil the development of this course competency.

a) Practice & follow valid Experimental, Calculation and Design Standards to assure quality work in the Design of mechanical components.

b) Follow ethical practices as a Team leader and enable team members to do so at work.

c) Design mechanical components considering human ergonomics.

d) The student should be able to identify eco-friendly or recycled material/s before selection for mechanical applications. (Environment related)

The ADOs are best developed through field-based exercises/project work. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy', should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year
iii. 'Characterization Level' in 3rd year

8. UNDERPINNING THEORY:

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for COs and competency development, the significant supporting theory is given below. If required, the course teacher could include more such higher-level UOs to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics

Unit I Basics of Engineering Mechanics	1a Define the scope of Engineering Mechanics 1b Explain the effect of force on a given object. 1c Identify the force system for the given situation. 1d Calculate the resultant forces graphically and analytically.	1.1 Significance and relevance of mechanics,statics,Dynamics 1.2 Units of measurement (SI units) 1.3 Force,its characteristics and effects 1.4 Force system and its classification, 1.5 Resultant of forces using analytical and graphical methods.(law of parallelogram, law of triangle and law of polygon) 1.6 Free body diagram, Bow's notation, equilibrium condition, and Lami's theorem. 1.7 Moment of Force couple Characteristics of couple 1.8 Resultant of co-planer, non-concurrent forces. (simple numerical examples of the topics mentioned above)
Unit II Direct Stress & Strain	2a Understand basic stress and strain 2b Evaluate Material Properties Under Longitudinal, Lateral Loads & Thermal Variation 2c Analyze Composite & Compound Sections for Stress & Strain. 2d Compute Strain Energy under Different Types of Loading on elements.	2.1 Different types of Loads and their effects 2.2 Direct Stress, linear Strain, Hook's Law, Stress-Strain Curve for mild steel under tension, Modulus of Elasticity, Yield, Creep, Breaking & Ultimate Stress and Factor of Safety. 2.3 Lateral Strain and Poisson's ratio. Bulk Modulus & Volumetric Strain.Shear Stress, Shear Strain & Shear Modulus. 2.4 Thermal Stresses & Strain for yielding & non-yielding conditions. 2.5 Differentiate Sudden, Gradual & Impact Load, Strain Energy & Proof Resilience (simple numerical examples of topics mentioned above)
Unit III Bending and Torsional Stress	3a Understand bending theory 3b Understand Torsional Moment 3c Understand Eccentric Axial Loading 3d State fundamental equation of bending and twisting 3e Calculate the numerical of bending stress, torsional stress	3.1 Concept and theory of pure bending, assumptions, Bending equation (without derivation), Equation of maximum bending moment in various beams with different loading conditions, Section Modulus, Bending stresses and their nature

	and Eccentric Axial Loading	3.2 Axial load, Eccentric load Concept of eccentricity, Limit of eccentricity, Eccentric Loading for rectangular and circular sections. 3.3 Twisting moment, Angle of twist, Shear stress in the shaft, the strength of shafts, Polar moment of inertia, Torsional rigidity, assumptions in the theory of torsion, Equation of Torsion (without derivation), Relationship of Power,Torsion and RPM (simple numerical examples of the topics mentioned above)
Unit IV Centroid, Center of Gravity & Moment of Inertia	4.a Differentiate between Centroid and Center of Gravity 4.b Calculate the centroid of different geometric plane section 4.c Calculate the CG of standard solids 4.d Compute the Moment of Inertia of symmetric and asymmetric section	4.1 Concept of Centroid and Centre of Gravity 4.2 Axis of Reference and Symmetry, Centroid of Standard and composite Shapes 4.3 Center of Gravity of Standard and composite Solids. 4.4 Moment of Inertia & Its significance. 4.5 Parallel & Perpendicular Axis Theorem. 4.6 Moment of Inertia of simple sections like T,I,L and C sections. (without Derivations) (simple numerical examples of the topics mentioned above)

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Engineering Mechanics	06	05	04	05	14
II	Direct Stress and Strain	12	04	06	10	20
III	Bending and Torsional Stress	12	03	05	10	18
IV	Centroid, Center of Gravity & Moment of Inertia	12	03	05	10	18

	Total	**42**	**15**	**20**	**35**	**70**

***Legends:R**=Remember, **U**=Understand, **A**=Apply and above (Revised Bloom's taxonomy)*

***Note**:* This specification table provides general guidelines to assist studentsin their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

10. SUGGESTED STUDENT ACTIVITIES:

Other than the classroom and laboratory learning, the following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct the following activities in groups and prepare short reports on each activity. They should also collect/record physical evidence for their (student's) portfolio, which will be helpful for their placement interviews:

a. Prepare charts showing force systems and their classifications, moment and couple of forces, resultant of forces etc. and their associated components with practical examples from the mechanical engineering domain.
b. Prepare charts showing different types of loads, stresses, strains and associated components with real practical examples from the mechanical engineering domain.
c. Prepare charts showing different types of Bending and Torsional Stresses and their associated components with practical examples from the mechanical engineering domain.
d. Prepare charts showing the Centroid, Center of Gravity, Moment of Inertia and its associated components with genuine practical examples from mechanical engineering.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any):

These are sample strategies which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub-topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics,*** which are relatively more straightforward or descriptive,are to be given to the students for ***self-learning*** but assessed using different assessment methods.
e) Concerning ***section No.10***, teachers must create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability
g) Theory, Tutorial & Practical aspects are covered in the best way, which every student must learn before undergoing actual mechanical component design.

12. SUGGESTED MICRO-PROJECTS:

Only one micro-project is planned to be undertaken by a student that needs to be assigned to the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should preferably be undertaken individually to build up the skill and confidence in every student to become a problem solver so that they contribute to the projects of the industry. In special situations where groups

have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contribution in the project work and give a seminar presentation before submission. The total duration of the micro-project should be about **14 - *16 (fourteen to sixteen) student engagement hours*** during the course. The student should submit a micro-project by the semester's end to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. **The concerned course teacher could add similar micro-projects:**

a) Take 2-3 objects around you(e.g.Fan,Chair,Table etc.) and identify their loading condition and types of stress generated with illustrated sketches.
b) Identify 5 to 7 elements around you having bending failure,the torsional shear failure and eccentric loading, static loading condition and maximum stress generated using illustration.
c) Preparean excel base sheet to calculate the centroid and centre of gravity for different Geometrical sections/solids.
d) Prepare an excel base sheet to calculate the Moment of Inertia for different Geometrical sections.
e) List different types of instruments/tools etc. used to calculate/measure different types of calculations/measurements listed in **Section No-5 Practical Outcomes (PrOs)** and write detailed specifications of such instruments/tools with their applications in the mechanical engineering domain.
f) Detailed comparison of traditional and advanced methods used for the calculations/measurements enlisted in **Section No-5 Practical Outcomes (PrOs).**

13. SUGGESTED LEARNING RESOURCES:

Sr. No.	Title of Book	Author	Publication with the place, year and ISBN
1	Engineering Mechanics	R. S. Khurmi	S. Chand, New Delhi. (2019) ISBN: 978-93-5283-396-2
2	Engineering Mechanics	D.S. Kumar	S. K. Kataria& Sons, New Delhi (2021 reprint) ISBN: 978-93-5014-311-7
3	Engineering Mechanics7th Edition	Bear & Johnston	New media-McGraw Hill (India), Noida (1999) ISBN: 978-00-7239-513-6
4	Applied Mechanics	Dr.H.J.Shah & S.B.Junnarkar	CHAROTAR Publication, Anand(2013) ISBN:978-93-803-5861-1
5	Engineering Mechanics	D.S.Bedi	Khanna Publications, New Delhi(2019) ISBN:978-93-861-7326-3
6	Applied Mechanics	R. S. Khurmi N. Khurmi	S. Chand & Co. Ltd, New Delhi (2018) ISBN: 978-8121916431

7	Applied Mechanics	S. B. Junnarkar, Dr. H. J. Shah	Charotar *Publishing* House Pvt. Ltd., Anand (2015) ISBN: 978-9385039065
8	Strength Of Material (Part-I &Ii)	Stephen Timoshenko	CBS Publishers & Distributors Pvt. Ltd., New Delhi (3rd Edition) ISBN: 978-0898746211
9	Strength Of Materials	Dr B. C. Punmia Er. Ashok Kr. Jain DrArun Kumar Jain	Laxmi Publications, New Delhi (2019) ISBN: 978- 8131809259
10	Strength Of Materials (Mechanicsofsolids)	R.S.Khurmi N.Khurmi	S Chand Publishing (2019) ISBN:97-893-528-339-79
11	Strength Of Materials	Dr R.K.Bansal	Laxmi Publications (P) Ltd. NewDelhi(2005) ISBN:97-881-700-814-70
12	Strength Of Materials	S. Ramamrutham & R.Narayanan	Dhanpat Rai Publishing Company(2011) ISBN:97-881-874-335-45
13	Strength Of Materials (Mechanics Of Materials)	R.S.Laheri A.S.Laheri	S.K. Karatia& Sons, Delhi. (2010) ISBN: 97-881-857-494-40

13. SOFTWARE/LEARNING WEBSITES:

a. https://swayam.gov.in/
b. https://nptel.ac.in/
c. https://www.youtube.com/playlist?list=PL63F5D8638872CC3E
d. https://www.asme.org/
e. https://www.astm.org/
f. https://www.iso.org/home.html
g. https://www.ansi.org/
h. https://www.aws.org/home
i. https://www.edx.org/
j. http://www.efunda.com/home.cfm
k. https://www.howstuffworks.com/
l. http://icrank.com/cgi-bin/pageman/pageout.cgi?path=%2Findex_html.html
m. https://www.matweb.com/
n. https://www.engineeringtoolbox.com/
o. https://www.coursera.org/learn/engineering-mechanics-statics

14. PO-COMPETENCY-CO MAPPING:

Semester II	**Basics of Mechanical Design (1326502)**						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline-specific knowledge**	**PO 2 Problem Analysis**	**PO3 Design /development of**	**PO4 Engineering Tools, Experi**	**PO 5 Engineering practices for**	**PO 6 Project Management**	**PO 7 Life-long learning**

Sr. No.	Name and Designation	Institute	Contact No.	Email

			solutions	mentation &Testing	society, sustainability & environment		
Competency							
Identify the force systems for given conditions by applying the basics of mechanics.	3	2	-	3	-	-	3
Evaluate material properties Under Longitudinal and transverse loads	3	3	-	3	-	-	3
Compute bending stress and shear stress invarious components for a given situation.	2	3	2	3	-	-	3
Calculatethe centroid and centre of gravity of various components in engineering Systems.	2	3	2	-	-	-	3
Determine the moment of inertia of a section about a given axis	3	3	2	-	-	-	3

Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE:

GTU Resource Person

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Prof. B. D. Parmar Lecturer in Mechanical Engineering	Government Polytechnic, Junagadh	9998910580	bdpar@yahoo.com
2	Dr R.P.Rethaliya Incharge head of the applied mechanic's department	B&BInstitute of Technology, Vallabh Vidyanagar	9825825542	rprbbit@gmail.com

16. GTU BOS and Branch Coordinator Person

BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email

1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanical Engg.	Government Polytechnic Ahmedabad	9227200147	gpasiraj@gmail.com
2.	Dr.Rakesh.D.Patel BOS Member HOD Mechanical Engg.	B&B Institute of Technology V V Nagar	9825523982	rakeshgtu@gmail.com
3	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	Asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
Semester-II

Course Title: Computer Aided Drafting-I
(Course Code: 1326503)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering(CAD/CAM)	2nd Semester

1. RATIONALE

The students of mechanical engineering programme are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the drawing of component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. Development of sketching ability also strengthens effective engineering communication & presentation. Now a days the market driven economy demands frequent changes in product design to suit the customer needs. With the introduction of computers, the task of incorporating frequent changes as per requirement is becoming simpler. This course has been introduced at Diploma level in order to develop the skills in student so that they can generate various digital production drawings as required in industry using CAD software.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Prepare production drawings using codes, norms and standards.**
- **Prepare 3D surfaces and 3D models in AutoCAD.**

3. COURSE OUTCOMES

The practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Draw production drawings of mechanical Components/assemblies using codes, norms and standards in AutoCAD.
ii. Create and edit 3D models in AutoCAD.
iii. Extract two-dimensional views from a three-dimensional model for detail drafting.
iv. Create 3D surface models using a variety of techniques.
v. Prepare a report with Sketch of mechanical components showing each step with dimensions and sequence of commands with name, options and values.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). All PrOs are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
1	a. Preparatory activity i. List different software used for CAD ii. Compare all software packages with application point of view.	2
2	**Recall AutoCAD 2D drawing commands.** a. Prepare orthographic production drawings (with all dimensions, tolerances, notes, title block, etc.) of 5 mechanical components ((i.e Gears, Bearings, tail stock etc. or should be based on real industrial components selected by student as student activity and approved by teacher) each made up of minimum 5-6 manufacturing operations using AutoCAD (Mechanical). Submit the completed drawings in PDF format. b. Prepare report on following. i. Select at least two physical mechanical components (approved by teacher). Sketch them with dimensions. ii. Write steps to prepare each drawing using AutoCAD (Mechanical). Steps must include followings. • Sketch of components at each step with dimensions. • Sequence of commands with name, options and values.	8
3	a. Select minimum 5 assemblies related to Mechanical engineering having 5-6 components. Create 3D models of all mechanical components and assemble them in AutoCAD.	24

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
	b. Calculate mass properties assuming appropriate material. c. Submit the completed drawings in PDF format. b. Prepare report on following: i. Select physical mechanical assembly in group of 5-6 students (approved by teacher). Measure and draw them with dimensions. • Sketch of each component and assembly for the same. • Sequence of commands with name, options and values.	
4	a. Prepare production drawings by Extracting 2D views from 3D models for detail drafting, cut section from 3D using layout, SOLVIEW and SOLDRAW command in a pre-defined template including title block and instructions. Use Geometric dimensioning and tolerance (GD & T) in each drawing in AutoCAD. b. Take printout of the same in A3 sheet using predefined template and layouts. c. Prepare report on following: • Sketch of each component and assembly for the same. • Sequence of commands with name, options and values.	10
5	d. Create minimum 5 surface models related to mechanical engineering. e. Submit the completed drawings in PDF format. f. Prepare report on following: • Sketch of each component • Sequence of commands with name, options and values.	12
		56

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1.	Lab Records and regularity	20

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
2.	Question answer / Writing steps of exercise	20
3.	Execution of exercise	20
4.	Printout/Result	10
5.	Viva voice	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Computer system with latest configuration.	All
2.	Laser printer-scanner, plotter A3 size.	All
3.	Related software. (Auto CAD, Anti-Virus software).	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical and electronics equipment.
c) Maintain tools and equipment.
d) Realize importance of E-waste management. (Environment related).

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I **Basics of CAD Software**	1a List Computer Aided Software packages. 2a Compare all available software packages.	1.1 Discuss about available software in CAD field and their capabilities. 1.2 List and compare all software packages.
Unit-II Creating production drawings using a Computer Aided Drafting (CAD) Software (AutoCAD).	2a. Invoke commands in AutoCAD. 2b. Create basic & advance 2D entities Close & save work 2c. Modify existing 2D entities. 2d. Enquire about various attributes of existing 2D entities. 2e. Use layers for proper management of drawings. 2f. Use Blocks effectively to create perfect drawings.	Recall to Basic Draw Commands, modify commands in Auto CAD. 2.1. Explain Drawing standards. (IS-696 /SP 46) (Drawing/ printing/ storage). 2.2. Recall Quick Access Toolbar, Ribbon, Command Bar, Orientation tools, Status bar, Different Menu / Tools / commands, etc. 2.3. Methods of Specifying points-Absolute coordinates and Relative Cartesian & Polar coordinates. 2.4. Recall Use of object Snap, polar tracking, use of dynamic input and Commands of Draw and modify menu. Concept of Layers. Concept of Blocks. Concept of Hatch. Dimensioning.
Unit-III Creating and editing 3D models in AutoCAD.	3.a. Use of UCS (user coordinate system) in 3D modelling. 3.b. Create basic and advance 3D models. 3.c. Edit 3D models. 3.d. Create file exchanges and calculate mass properties.	Introduction to UCS and 3D coordinates, 3D commands, creating 3D models and editing 3D models. 3.1. Introduction to user coordinate systems, working with user coordinate systems, additional ways to change the UCS, managing user coordinate systems and displays, creating text with thickness, text and the UCS, and dimensioning in 3D. (**Commands and variables:**

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		UCS, **UCSICON**, **DDUCSP**, **UC**, **UCSMAN**, **UCSFOLLOW**, and **PROPERTIES**) 3.2. Using rectangular 3D coordinates, the right-hand rule of drawing, displaying 3D views, 3D construction techniques, constructing wireframe objects, and constructing solid primitives. (**Commands: PLAN**, **UCS**, **3DORBIT**, **HIDE**, **BOX**, **SPHERE**, **CYLINDER**, **CONE**, **WEDGE**, and **TORUS**.) 3.3. Overview of solid modeling, constructing solid primitives, creating composite solids, and working with regions. (**Commands: BOX**, **SPHERE**, **CYLINDER**, **CONE**, **WEDGE**, **TORUS**, **SUBTRACT**, **UNION**, **INTERSECT**, **INTERFERE**, **REGION**, **BOUNDARY**, and **AREA**.) 3.4. Creating solid model with **EXTRUDE**, **REVOLVE** and Boolean operations with CSG. 3.5. Changing properties, aligning objects in 3D, 3D rotating, 3D mirroring, creating 3D arrays, filleting solid objects, chamfering solid objects, constructing details and features on solid models, and removing details and features. (Commands**: PROPERTIES**, **ALIGN**, **ROTATE3D**, **MIRROR3D**, **3DARRAY**, **FILLET**, and **CHAMFER etc)** 3.6. Overview of solid model editing, face editing, edge editing, body editing, and using **SOLIDEDIT** as a construction tool. 3.7. solid model analysis, and solid model file exchange. (**Commands:MASSPROP**, **ACISOUT**, **EXPORT**, **ACISIN**, **IMPORT**, and **STLOUT etc)**
Unit– IV Extracting 2D	4.a. Create orthographic views from 3D model.	Creating 2D views by extracting it from 3D models.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
views from 3D models for detail drafting.	4.b. creating Layout, pre-defined template 4.c. Use Geometric dimensioning and tolerance (GD & T)	4.1. Understanding viewports, creating viewports, drawing in multiple viewports, regenerating viewports, and creating a standard engineering layout. 4.2. Use **SOLVIEW**, **SOLDRAW** command to generate orthographic views/sectional orthographic views, layers, and layout viewports automatically for 3D solids 4.3. Standard sizes of sheet. Selecting various plotting parameters such as Paper size, paper units, Drawing orientation, plot scale, plot offset, plot area, print preview. 4.4. Create templates and layouts 4.5. Apply Geometric dimensioning and tolerance (GD & T) in a given drawing with following commands. (**Commands: TOLERANCE, QLEADER, MLEADER)** 4.6. Take print outs from a CAD Software in A3 size sheet.
Unit – V Create surface models in AutoCAD.	5 a . Create surface models. 5b. Edit surface models. 5c. Rendering to given model 5d. Enquire about various attributes of existing 2D entities.	Introduction to surface modelling editing surfaces and assigning material & rendering the models and finding is properties. 5.1. Overview of surface modeling, creating 3D faces, creating invisible 3D face edges, and drawing surface primitives. (**Commands: 3DFACE**, **AI_BOX**, **AI_WEDGE**, **AI_PYRAMID**, **AI_CONE**, **AI_DOME**, **AI_DISH**, **AI_SPHERE**, and **AI_TORUS etc**.) 5.2. 3D mesh techniques, constructing a 3D mesh, constructing a single-plane mesh, constructing a 3D polyface mesh, polygon mesh variations, constructing enclosed surfaces with **EDGESURF**, creating a surface

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		mesh with **RULESURF**, constructing tabulated surfaces with **TABSURF**, constructing revolved surfaces with **REVSURF**, drawing wireframe holes, and surfacing around wireframe holes. 5.3. Using grips to edit surface models, trimming and extending objects in 3D, creating surfaced fillets and rounds, editing polygon meshes, and editing polygon meshes with grips.(**Commands: TRIM**, **EXTEND**, **EDGE**, and **PEDIT etc**.) 5.4. Lights, creating scenes, rendering models, and rendering preferences and statistics.(**Commands: LIGHT**, **SCENE**, **RENDER**, **RPREF**, and **STATS etc)** 5.5. Creating surface finishes with materials; granite, marble, and wood; assigning materials to objects; using maps; mapping textures to objects; and material libraries.(**Commands: RMAT**, **SETUV**, and **MATLIB etc** .) 5.6. List, Dblist, Area, Massprop.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Not applicable						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Undertake micro-projects in team/individually.
b) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc. to further enhance their learning.

c) Select at least four simple mechanical components each made up of minimum 5-6 manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex. No2).
d) Select at least one simple mechanical assembly in group of 5-6 students, each made up of minimum 5-6 components. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex.No.3).
e) Bring Actual assembly from workshop/industry, measure dimensions, sketch it and make 2D production drawing for the same. (For Ex.No.4)
f) Prepare the Charts that classify recycling process for electronic waste and plastics.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.

About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature may be given to the students for ***self-learning***, but to be assessed using different assessment methods.

Guide students on addressing the issues on environment and sustainability using the knowledge of this course.

c) Introduce IS Codes of drawing for self-study.
d) Guide students for keeping the drawings in digital form and reduce use of paper.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Bring an industrial production drawing/component from workshop/industry. Learn to interpret and List the commands to be used to draw it.
b) Add-ons of AutoCAD software are to be downloaded and used for a given specialized exercise.
c) Sorting of e-waste: Compile a report for sorting different types of electronic and plastic waste.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Machine Drawing including AutoCAD	Ajeet Singh	McGraw hill
2.	Production Drawing	K L Narayan	New Age Publication
3.	Fundamental of Geometric Tolerance and dimensioning	Alex Krulikowski	Cengage Learning
4.	Engineering Graphics with AutoCAD	Sarkar .A.K	PHI india
5.	Essentials of Engineering Drawing and Graphics using AutoCAD	Jeyapoovan	Vikas publication
6.	AutoCAD User Guide	Autodesk	Autodesk Press.

14. SOFTWARE/LEARNING WEBSITES

a. https://www.tutorialspoint.com
b. https://edu.google.com/intl/ALL_in/teacher-enter/products/forms/?modal_active=none
c. www.w3schools com
d. https://support.microsoft.com/en-us/training
e. https://edu.gcfglobal.org/en/topics/googleapps/
f. https://www.udemy.com
g. https://www.coursera.org/
h. https://www.digitalindiaportal.co.in/
i. https://getintopc.com/
j. https://nptel.ac.in/
k. https://magazine.opensourceforu.com/
l. https://www.netacad.com/
m. https://www.cert-in.org.in/
n. https://www.youtube.com/c/MechanicalEnggSubjectsGTU/playlists
o. https://youtu.be/MT1T31GtGpg
p. https://youtu.be/WEwkepkv6mg
q. https://youtu.be/trJQlvatIpI
r. https://nptel.ac.in/courses/112/103/112103019
s. https://nptel.ac.in/courses/112/105/112105294
t. https://en.wikipedia.org/wiki/Engineering_drawing
u. https://www.slideshare.net/search/slideshow?searchfrom=header&q=engineering+drawing

v. https://www.scribd.com/search?content_type=tops&page=1&query=engineering%20drawing&content_types=tops,books,audiobooks,summaries,articles,documents,sheet_music,podcasts
w. http://www.cognifront.com/tools.php
x. https://www.youtube.com/watch?v=C4c_kJtwtxc
y. https://www.youtube.com/watch?v=bmAlJAMndwM
z. https://www.youtube.com/watch?v=904_RPjGJg4
aa. https://www.youtube.com/watch?v=jzlDouas0Wc
bb. https://www.youtube.com/watch?v=VuHdV38fyjc
cc. https://www.youtube.com/watch?v=iOzlIJge_G0
dd. https://www.youtube.com/watch?v=-l0iRdH3MbA
ee. https://www.youtube.com/watch?v=vI5xhCD5mXQ
ff. https://www.youtube.com/watch?v=GDrD9nEZ9LY

15. PO-COMPETENCY-CO MAPPING

Semester II	Computer Applications and Graphics (Course Code: 4300019)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency **1.** Prepare production drawings using computer and relevant software following standards codes and norms.	3		3	2		2	2
2. Prepare 3D surfaces and 3D models in AutoCAD.	2		3		2		
CO 1) Draw production drawings of mechanical Components/assemblies using codes, norms and standards in AutoCAD.	3		3				
CO 2) Create and edit 3D models in AutoCAD.	3		3	2	2		2
CO 3) Extract two-dimensional views from a three-dimensional model for detail drafting.	2		3		2		2
CO 4) Create 3D surface models using a variety of techniques.	3		3	2	2		2

CO 5) Prepare a report of mechanical components with Sketch of components at each step with dimensions and sequence of commands with name, options and values.						2	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. A.A.Lohia, HOD in Mechanical Engineering	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9898189552	altaf.lohia@gmail.com
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BOS Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I – Semester

Course Title: **Environment and Sustainability**
(Course Code: 4300003)

Diploma programme in which this course is offered	Semester in which offered
Chemical, Mechatronics, Computer	First
Civil, Environment, Mining, Architectural Assistantship, Mechanical, Automobile, Marine, Metallurgy, Fabrication, Electrical, Electronics and Communication, Instrumentation and Control, Bio Medical, Power Electronics, IT, Textile Manufacturing, Textile Processing, Textile Design, Printing, Plastics, Ceramics, CACDDM , Computer Science and Engineering.	Second

1. RATIONALE

For a country to progress, sustainable development is one of the key factors. Environment conservation and hazard management is of much importance to every citizen of India. Considerable amount of energy is being wasted. Energy saved is energy produced. Environmental pollution is on the rise due to rampant industrial mismanagement and indiscipline. Renewable energy is one of the answers to the energy crisis and also to reduce environmental pollution. Therefore this course has been designed to develop a general awareness of these and related issues so that the every student will start acting as a responsible citizen to make the country and the world a better place to live in.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Adopt the sustainable practices to resolve the environment related issues.**

3. COURSE OUTCOMES (Cos)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Adopt relevant ecofriendly product in the given situation to protect ecosystem
b) use relevant method of pollution reduction in the given situation
c) Use of renewable resources of energy for sustainable development
d) Use the relevant techniques in given context to reduce impact due to climate change
Use relevant laws and policies for developing the sustainable environmental development

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	0	0	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.
Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *- End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES – Not Applicable

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the* ***PrOs*** *marked* ***'*'*** *are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Total		**44**

Note

i. *More* ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some* ***sample*** *'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed* ***Practical Exercises*** *of this course required which are embedded in the COs and ultimately the competency..*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED – (Not Applicable)

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1		

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Ecosystem	1a. Explain the Structure with components of the given Ecosystem 1b. Explain Carbon, Nitrogen, Sulphur and phosphorus cycle for the given ecosystem. 1c. Justify the need to conserve the given Ecosystem on the w.r.t. following points: • carrying capacity of earth • Biomes, • Ecologically sensitive area 1d. Explain the term biodiversity with its importance. 1e. Illustrate the importance of IUCN red list in environmental engineering. 1f. Calculate global ecological overshoot and virtual water requirement of given natural and man-made materials.	1.1 Structure and components of ecosystem 1.2 Types of Ecosystem, changes in ecosystem 1.3 Various natural cycles like carbon, Nitrogen, Sulphur, Phosphorus 1.4 Ecosystem conservation, carrying capacity of earth, Biomes in India, (ESA) Ecologically sensitive areas 1.5 Bio diversity, its need and importance, International Union for Conservation of Nature (IUCN) red list 1.6 Concept of Ecological foot print, virtual water, global ecological overshoot
Unit – II Pollution and its types	2a. Explain the term, "pollution and pollutant" in the given situation. 2b. Classify the air pollution on the basis of its source 2c. Use relevant equipment to control given type of air pollution.	2.1. Definition of pollution and pollutant 2.2. Air pollution, classification and its sources 2.3. Air pollution control Equipments 2.4. Water pollution, pollution parameters like BOD,COD, pH, Total suspended solids, Turbidity, Total Solids 2.5. Waste water treatment like primary,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	2d. Explain relevant techniques of treatment to deal with given type of water pollution. 2e. Apply relevant techniques of Solid waste management based on its characteristics. 2f. Explain drawbacks of noise pollution in given situation. 2g. Describe the environmental degradation due to Plastic waste and E- waste	secondary and tertiary 2.6. Solid waste generation, sources and characteristics of Muncipal solid waste 2.7. Collection and disposal of Muncipal waste and Hazardous waste 2.8. Noise pollution- its effects, sources and measurement 2.9. Plastic waste and its hazard 2.10. E waste and its hazard
Unit– III Renewable sources of energy	3a. Justify the need of renewable energy adopting relevant energy policy in given situation. 3b. Explain the working of the solar thermal and PV systems with sketch in given situation. 3c. Justify the need of Advanced collector, Solar Pond, Solar water heater, Solar dryer in the given system. 3d. Emphasize the importance of wind power in India 3e. Select the relevant type of wind turbines in the given situation. 3f. Identify the relevant types of Sources of biomass energy. 3g. Draw the neat labelled diagram of simple biogas plant to explain its working. 3h. Identify the sources of the energy generation for the given situation.	3.1 Need of Renewable energy and energy policy 3.2 Solar energy: National solar mission 3.3 Features of solar thermal and PV systems Advanced collector, Solar Pond, Solar water heater, Solar dryer, polycrystalline, monocrystalline and thin film PV systems 3.4 Wind Energy: Growth of wind power in India 3.5 Types of wind turbines – Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT) 3.6 Types of HAWTs – drag and lift types 3.7 Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel 3.8 Anaerobic digestion, Biogas production mechanism, utilization and storage. 3.9 New energy sources: Geothermal energy, Ocean energy sources, Tidal energy conversion, Hydrogen energy
Unit– IV Climate Change	4a. Explain the term, “climate change” in context of environment. 4b. Describe the ill effects of Global warming due to various causes arising in the given situation. 4c. Explain the term, “greenhouse effect” with its causes. 4d. Relate the impact of Ozone depletion in climate change due to its causes.	4.2 Definition of climate change 4.3 Global warming-causes, effect, process 4.4 Greenhouse effect 4.5 Ozone depletion 4.6 Factors affecting climate change 4.7 Impact and mitigation 4.8 Climate change management

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	4.1 Identify Factors affecting climate change in given locality. 4e. Justify the need of relevant Climate change management system to reduce the impact of climate change in the given context.	
Unit– V Environmental legislation and sustainable practices	5.a Use relevant policy or law in relation with environment in given situation 5.b Relate the relevant provision of given act in given situation. 5.c Explain the necessity of the Environmental management system in given situation. 5.d Use the principle of Rain water harvesting in the given situation. 5.e Justify the necessity of Green building in India. 5.f. Adopt the relevant rating system for energy calculation for the given building. 5.f Explain the terms, "Cradle to cradle concept" and "Life cycle analysis" 5.g Emphasize the importance of Carbon credit system in India. 5.h Explain the importance of 5R concept.	5.1 Environmental policies in India 5.2 Air act, water act, Environment protection act, wild life protection act, Forest conservation act, Biodiversity act 5.3 Environmental management system: ISO 14000, definition and benefits 5.4 Rain water harvesting 5.5 Green building and rating system in India 5.6 Cradle to cradle concept and Life cycle analysis 5.7 Green label 5.8 Carbon credit system its advantages and disadvantages 5.9 Concept of 5R(Refuse, Reduce, Reuse, Repurpose, Recycle) 5.10 Eco tourism: advantages and disadvantages

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Ecosystem	08	6	6	2	14
II	Pollution and its types	10	4	6	6	16
III	Renewable sources of energy	10	4	6	6	16
IV	Climate Change	08	4	6	4	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
V	Environmental legislation and sustainable practices	06	5	3	2	10
Total		**42**	**12**	**28**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare specification of some renewable sources of energy.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Undertake a market survey of different green materials.
e) Prepare showcase portfolios.
f) Prepare report on various issues related to environment and sustainable development
g) Publish a research paper on themes related to environment and sustainable development.
h) Compare the pollution (water, air and noise) data of various cities with standard values as laid by pollution control board.
i) Undertake some small mini projects on various issues related to environment and sustainable development.
j) Submit a report on visit to an energy park
k) Prepare power point on clean and green technologies
l) Submit a report on visit to garbage disposal system in your city/town.
m) Submit a report on analysis of the life cycle of any one or two eco-friendly product/s.
n) Calculate ecological footprint using various calculator available on web with a report recommending ways and means to reduce ecological footprint.
o) Give seminar on relevant topic.
p) Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability
g) Guide students for using data manuals.
h) Guide students for using data manuals.
i) Arrange visit to nearby industries and workshops for understanding various sources of pollution.
j) Use video/animation films to explain various processes related to environment and sustainable development
k) Use different instructional strategies in classroom teaching.
l) Write the report on properties of various eco-friendly construction materials like Stone, aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
m) Display various technical brochures of recent projects/themes related to environment and sustainable development
n) Visit the Pollution control board office and its various projects to demonstrate the various practices adopted for control of Pollution

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Natural cycles**: Build a Chart showing different natural cycles like Carbon, Nitrogen,Sulphur and phosphorus cycle.)
b) **Solar Energy:** Build a model of Solar water heater/Solar cooker
c) **Wind energy:** Build a model of wind mill
d) **Best out of waste**: Build useful items from waste materials like used plastic bottles, discarded pens etc.

e) Compare the pollution (water, air and noise) data of various cities with standard values as laid by pollution control board.
f) Surf different websites related environment and sustainable development, Pollution control.
g) Prepare energy audit report of any residential building.
h) Collect relevant information about the software used in pollution control.
o) Visit to ongoing project and study various aspects related to environment and sustainable development

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Renewable Energy Technologies: A Practical Guide for Beginners	Solanki, Chetan Singh	PHI Learning, New Delhi, 2010 Print Book ISBN: 9788120334342 eBook ISBN: 9789354437151
2	Ecology and Control of the Natural Environment	Izrael,Y.A.	Kluwer Academic Publisher eBook ISBN: 978-94-011-3390-6 Softcover ISBN: 978-94-010-5499-7
3	Green Technologies and Environmental Sustainability	Singh, Ritu, Kumar, Sanjeev	Springer International Publishing, 2017 eBook ISBN 978-3-319-50654-8
4	Environmental Noise Pollution and Its Control	G.R. Chhatwal, M. Satake, M.C. Mehra, Mohan Katyal, T. Katyal, T. Nagahiro	Anmol Publications, New Delhi ISBN: 8170411378 ISBN: 8170411378
5	Wind Power Plants and Project Development	Earnest, Joshua & Wizelius, Tore	PHI Learning, New Delhi, 2011 ISBN-10: 8120351274 ISBN-13: 978-8120351271
6	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009 ISBN-13 - 978-8120344709
7	Environmental Studies	Anandita Basak	Pearson Publications ISBN 8131785688, 9788131785683 ISBN: 9788131721186, 8131721183
8	Environmental Science and Engineering	Aloka Debi	University Press ISBN: 9788173718113 ISBN-10: 8173716080 ISBN-13: 978-8173716089
9	Coping With Natural Hazards: Indian Context	K. S. Valadia	Orient Longman ISBN-10: 8125027351 ISBN-13: 978-8125027355
10	Introduction to Engineering and Environment	Edward S. Rubin	Mc Graw Hill Publications ISBN-10 : 0071181857 ISBN-13 : 978-0071181853

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) www.khanacademy
c) http://www1.eere.energy.gov/wind/wind_animation.html
d) http://www.nrel.gov/learning/re_solar.html
e) http://www.nrel.gov/learning/re_biomass.html
f) http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/
g) http://www.epa.gov/climatestudents/
h) http://www.climatecentral.org
i) http://www.envis.nic.in/
j) https://www.overshootday.org/
k) http://www.footprintcalculator.org/
l) https://www.carbonfootprint.com/calculator.aspx

15. PO-COMPETENCY-CO MAPPING

Semester II	Environment and Sustainability (Course Code: .....)								
	POs and PSOs								
Competency & Course Outcomes	**PO 1** Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design/ development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning	**PSO 1** Environmental planning & deisgn	**PSO 2** Execution & Maintenance
Competency - Adopt the sustainable practices to resolve the environment related issues									
a. Adopt relevant ecofriendly product in the given situation to protect ecosystem	2	1	1	-	2	1	1	2	2
b. use relevant method of pollution reduction in the given situation	2	2	1	1	2	-	2	2	2
c. Use of renewable resources of energy for sustainable development	2	2	2	1	2	2	1	2	2
d. Use the relevant techniques in given context to reduce impact due to climate change	2	2	2	1	2	1	2	2	2
e. Use relevant laws and policies for developing the sustainable environmental development	2	2	2	1	1	1	1	2	2

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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NITTTR Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I/II – Semester

Course Title: Basics of Electrical and Electronic Engineering
(Course Code: 4300014)

Diploma programme in which this course is offered	Semester in which offered
Civil Engineering, Environment, Mining, Chemical, Plastics Engineering	First
Mechanical Engineering, Automobile , Metallurgy , Marine Engineering, Fabrication , Ceramics	Second

1. RATIONALE

Electrical engineering is one of the core engineering, which every common man uses in day to day life. This course is offered in all branches of engineering. Need of knowledge about fundamental electrical concepts for every branch is considered for this course.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply the basic principles of electrical and electronics engineering in relevant engineering discipline applications.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Apply fundamentals of DC circuits and batteries in relevant engineering discipline.
b) Apply fundamental of AC circuits in relevant engineering discipline.
c) Use electrical and electronics instruments for measuring various parameters.
d) Distinguish various electrical machines based on their working and applications.
e) Classify green energy sources with emphasis on working of solar and wind power plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
--	2	2	3	--	--	25*	25	50

(*): *For this practical only course, 25 marks under the practical CA has two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify resistors, inductors and capacitors.	I	02*
2	Verify Ohm's law in the given electric circuit.	I	02
3	Verify Kirchhoff's current law in the given electric circuit.	I	02
4	Verify Kirchhoff's voltage law in the given electric circuit.	I	02
5	Find equivalent resistance for series connection.	I	02
6	Find equivalent resistance for parallel connection.	I	02
7	Find equivalent voltage for series and parallel connection of batteries.	I	02
8	Measure voltage, current and power in the given DC circuit.	I	02
9	Measure voltage, current and power and power factor in single phase AC circuit.	II	02*
10	Measure various parameters for generated wave using function generator and CRO.	II	02
11	Carry out following wiring: (1) Staircase (2) Godown.	II	02
12	Calculate unit consumption for given electrical load.	II	02
13	Test the operation of protective devices like Fuse, MCB and ELCB.	II	02
14	Identify electronic components like types of diodes, transistors, SCR.	III	02*
15	Use digital meters like multi-meter, clip-on meter for measuring various parameters	III	02*
16	Identify various transducers available in the laboratory.	III	02
17	Measure output voltage of half wave and full wave rectifier.	III	02
18	Identify various parts of DC machines stating its function	IV	02
19	Identify various parts of AC machines stating its function	IV	02
20	Measure output voltage of the given single-phase transformer.	IV	02*
21	Identify components of solar power system stating its function.	V	02*
22	Identify components of wind power system stating its function.	V	02*
	Minimum 14 Practical Exercises		**28 Hrs.**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course)that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

S.No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare experimental setup.	20
2	Operate the equipment setup or circuit.	20
3	Follow safe practices while working in the lab.	10
4	Record observations correctly.	20
5	Interpret the result and conclude.	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Variable DC power supply: 0- 30V, 2A, Short Circuit protection, display for voltage and current	8
2	Discrete Component Trainer/ Analog Component Trainer: Fixed and variable D.C. Supplies, AC Supplies, Actual Components like transistors, SCR, LDR, photo diode, resistors, capacitors, inductors, diodes, LED's, transformers, 2 mm patch cords for interconnecting components	1 to 7, 13, 15,16
3	Auto-transformer: Single phase, 0- 230 V ,0-260 V, 8A	9,14,19
4	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max), Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	2 to 9, 12,14,16,19
5	Demonstration model for staircase and godown wiring.	10
6	Demonstration model for operation of fuse, MCB, ELCB and RCCB.	11
7	Clamp on meter: AC/DC current up to 40 A, 600 V	2 to 9, 12,14,16,19
8	Cut section of AC and DC rotating machines	17,18
9	Solar Energy demonstration Kit (Meters, Chargeable Batteries, with sample load)	21
10	Wind Energy demonstration kit or Wind turbine working Model (Small capacity)	22

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this course competency.

a) Work as a leader/a team member.

b) Follow safety practices while using electrical equipment.
c) Realize the importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I DC Circuits	1a. Distinguish basic electrical components. 1b. Explain effect of temperature on resistance. 1c. Determine voltage, current and resistance in electrical circuit using Ohm's law. 1d. Apply Kirchhoff's voltage and current law for given electrical circuit. 1e. Calculate equivalent resistance for given connection. 1f. Select relevant battery for given application.	1.1 Concept of Electric Potential, EMF, Current, Power and Energy 1.2 Resistor, Inductor and Capacitor 1.3 Effect of temperature on resistance of conductor 1.4 Ohm's law: Applications and limitations 1.5 Kirchhoff's voltage law and Kirchhoff's current law 1.6 Types of connections: series and parallel connections of resistors 1.7 Battery: Concept of cell and battery, Rating of battery, Series and parallel connection of batteries, Applications
Unit – II AC Circuits and Wiring	2a. Interpret parameters related to alternating waveform. 2b. Describe behavior of pure resistor, inductor and capacitor with AC supply. 2c. Explain concept of power triangle and power factor. 2d. Interpret given wiring diagram. 2e. Justify the need of electrical safety and protective device.	2.1. Basic Terminology: Cycle. Time-period, Amplitude, Frequency, RMS value. Average value, Form factor, Peak factor 2.2. Pure resistor, inductor and capacitor with AC supply 2.3. Power triangle and power factor 2.4. Domestic wiring: Types of AC supply, Concealed and conduit wiring, Power rating of domestic appliances, fitting and fixtures, Sample example of one room electrification, Staircase wiring and godown wiring, electrical unit consumption and billing, Basic

		concept of energy audit 2.5. Electrical Safety: Fuse, MCB, ELCB, RCCB, Need of Earthing, First aid against electrical shock
Unit– III Electronics and Instrumentation	3a. Explain working of diode, transistor and SCR. 3b. Interpret block diagram of battery charger, inverter and UPS. 3c. Explain working principle of different types of electrical transducers. 3d. Describe the procedure of measuring electrical parameters using given digital instruments/CRO.	3.1 Basic construction, characteristics: Diode, NPN and PNP Transistor, SCR 3.2 Applications of transistor: Common base amplifier 3.3 Basic block diagram of battery charger, inverter and UPS (ON line/OFF line) 3.4 Block diagram of instrumentation system , Transducers: Basic understanding of transducer, LDR, Thermistor, Thermocouple, LVDT and strain gauge 3.5 Meters: Multi meter, Clamp-on meter, Digital energy meter 3.6 Use of Cathode Ray Oscilloscope (CRO)
Unit– IV Electrical Machines	4a. Classify electrical machines. 4b. Describe the construction of DC motor and generator. 4c. Explain working principle of transformer. 4d. Enlist applications of various electrical machines. 4e. Explain the use of DG set as emergency supply.	4.1 Types of electrical machines: Static and Rotating, AC and DC. 4.2 Basic construction and applications of DC machines: DC motor and generator. 4.3 Basic construction and principle of working: Transformer ,Auto transformer 4.4 Basic construction and applications of AC machines: , Single phase and three phase induction motor, Alternator 4.5 Construction and applications of BLDC motor 4.6 Use of DG set as emergency supply
Unit– V Green Electrical Energy	5a. Justify the need of green energy. 5b. Classify sources of green energy. 5c. Interpret block diagram of solar power plant. 5d. Interpret block diagram of wind power plant.	5.1 Need of green energy 5.2 Classification of green energy 5.3 Solar energy: PV cell, Panel and Arrays, Block diagram of solar power system 5.4 Wind energy: Block diagram of wind power system

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Tutorial Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	DC circuits	04	Not Applicable			
II	AC circuits and wiring	06				
III	Electronics and Instrumentation	06				
IV	Electrical Machines	08				
V	Green Electrical Energy	04				
Total		**28**				

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare specification of some electrical and electronic components.
b) Calculate total installed electrical load of any premises.
c) Undertake a market survey of different semiconductor components.
d) Prepare a chart for different types of electrical machines and their applications.
e) Give seminar on innovation in renewable energy sources.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.
g) Guide students for using data manuals.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Half wave and Full wave rectifier:** Design and assemble half wave and full wave rectifier using diodes.
b) **Extension board:** Prepare Extension board few sockets and switches.
c) **Electricity bill:** Calculate power consumption of your home and check your energy bill.
d) **Market Survey**: Prepare budget for making a trainer kit for demonstrating characteristics of electronics components.
e) **Working Model making for wind /solar power plant**: Search on internet video/animation preferably dynamic animation which demonstrates the parts and working of a solar and wind power system and prepare a report.
f) **Solar/Wind power generation in India:** Prepare a report on current installed capacity of RES with emphasis on solar
g) **Electronic waste**: Compile a report of handling electronic waste with figures, tables and comparative charts and strategies used/suggested.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Basic Electronics and Linear Circuits	Bhargava N.N., Kulshreshtha D.C. and Gupta S.C.	McGraw Hill Education, New Delhi, ISBN: 9780074519653
2	A text book of Electrical Technology-Vol.1	Theraja B. L. Theraja A.K.	S. Chand Publication ISBN: 9788121924375
3	A text book of Electrical Technology-Vol.2	Theraja B. L. Theraja A.K.	S.Chand Publication
4	A text book of Electrical Technology -Vol.4	Theraja B. L. Theraja A.K.	S.Chand Publication
5	A Course in Electrical and Electronic Measurements	Sawhney A. K.	Dhanpat Rai & Co.

S. No.	Title of Book	Author	Publication with place, year and ISBN
	and Instrumentation		
6	Non-Conventional Energy Sources	Rai G. D.	Khanna Publications ISBN:978-8174090737

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) https://ndl.iitkgp.ac.in
c) www.electronicsforu.com
d) www.electrical4u.com
e) www.vlab.co.in

15. PO-COMPETENCY-CO MAPPING

Semester I & II	Basics of Electrical and Electronic Engineering (Course Code: 4300014)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation &Testing	PO 5 Engineering practices for society, sustain-ability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Apply the basic principles of electrical and electronics engineering in relevant engineering discipline applications.						
Course Outcomes CO a) Apply fundamentals of DC circuits and batteries in relevant engineering discipline.	3	1	1	3	-	-	2
CO b) Apply basic fundamental of AC circuits in relevant engineering discipline.	3	2	2	3	-	-	2
CO c) Use electrical and electronics instruments for measuring various parameters.	3	2	2	3	-	-	2
CO d) Distinguish electrical machines with relevant application.	3	1	1	2	-	-	2
CO e) Classify green energy sources with emphasis on working of solar and wind power plant.	3	-	-	2	3	-	2

Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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S. No.	Name and Designation	Institute	Contact No.	Email
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NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
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2	Dr. A.S. Walkey, Associate Professor, NITTTR, Bhopal	Electrical and Electronics Engineering Education	8989792155	aswalkey@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -II

Course Title: Indian Constitution
(Course Code: 4300016)

Diploma programmes in which this course is offered	Semester in which offered
Auto Mobile, Bio Medical, Power Electronics, Plastic, Computer, IT, Chemical, Civil, Electrical, Electronics and Communication. Environmental, Information Technology, Instrumentation and Control,Marine,Mechanical,Mechatronics,Mettalurgy,Mining,Textile Processing Technology, Textile Manufacturing Technology, Architectural Assistantship, CADCAM, Ceramic, Fabrication Technology, Printing Technology, Textile Designing	Second

1. RATIONALE

This course will survey the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. It will also socio-political equations. The various challenges faced by the constitution and the corresponding coping mechanisms would also be discussed. Broadly, the students would be exposed to the working of various institutions, offices and political debates ensuing from the operation of the Indian constitution in the last five decades.

2. COMPETENCY

Thepurpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Follow policies, processes, duties, rights and federal structure of Indian constitution as responsible citizens and engineer of the country.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) List salient features and characteristics of the constitution of India.
b) Follow fundamental responsibilities, privileges, rights and duties as responsible citizen and engineer of the country.
c) Differentiate between state and central administrative setup of the country.
d) Explain major constitutional amendment procedures and emergency provisions in the country
e) Explain judicial setup and electoral process of the country.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	-	-	0	-	-	50*	-	50

(*): the marks distribution total internal assessment 50 marks

5. SUGGESTED PRACTICAL EXERCISES -Not applicable

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED-Not applicable

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs andPrOs.More could be added to fulfil the development of this course t competency.

a) Work as a leader/a team member.
b) Follow constitutional duties and responsibilities
c) Follow ethical practices.
d) Practice environmental friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Constitution and Preamble	1a. Explain the meaningof preamble of the constitution. 1b. List the salient features of constitution. 1c. List the characteristics of constitution.	1.1 Meaning of the constitution of India 1.2 Historical perspective of the Constitution of India 1.3 Salient features and characteristics of the Constitution of India 1.4 Preamble to the Constitution of India

Unit – II Fundamental Rights and Directive Principles	2a. Enlist the fundamental rights. 2b. Identify fundamental duties. 2c. Follow fundamental responsibilities as an engineer. 2d. Differentiate between fundamental rights and directive principles. 2e. Identify fundamental duties and responsibilities applicable to a practicing engineer.	2.1 Fundamental Rights under Part-III (Details of exercise of rights and Limitations) 2.2 Fundamental duties and their significance 2.3 Relevance of Directive Principles of State Policy under part-IV.
Unit– III Federal Structure	3a. Draw the structure of governance in India. 3b. Differentiate between state and central administrative setup of the country.	3.1 Federal structure and distribution of legislative and financial powers between the Union and the States 3.2 Union Executive-President, Prime minister, Parliament and the Supreme Court of India, 3.3 State Executive - Governor, Chief Minister, State Legislator, and high Court 3.4 Local Administration - District Administration, Municipal Corporation, Zila Panchayat
Unit– IV Governance and Amendments	4a. Enlist the constitutional amendments 4b. Infer the purposes of various amendments.	4.1 Amendment of the Constitutional Powers and Procedure 4.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st. 4.3Emergency provisions
Unit– V Judicial System and Election Commission&National Green Tribunal	5a. Perform judicial review for societal welfare 5b. Abide by the judicial provisions. 5c. Adopt the electoral procedures with respect to citizenship. 5d. Abide by greening laws 5e. Identify the topics/subtopics in a given engineering corse where greening laws are affecting significantly.	5.1 The Indian Judicial System 5.2 Judicial Review 5.3 Election Commission 5.4 National Green Tribunal

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit	Unit Title	Teachin	Distribution of Theory Marks

No.		g Hours	R Level	U Level	A Level	Total Marks
I	Constitution and Preamble	04	04	04	0	08
II	Fundamental Rights and Directive Principles	08	03	02	10	15
III	Federal Structure	07	02	03	06	11
IV	Governance and Amendments	05	02	02	04	08
V	Judicial System and Election Commission	04	02	02	04	08
Total		**28**	**13**	**13**	**24**	**50**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of theUOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may varyslightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct following activities in group and prepare reports of about 5 pages for each activity. They also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare a report on Mock court hearing
b) Visit to courts
c) Arrange Mock Parliament.
d) Visit to Local Bodies
e) Visit to Courts.
f) Visit to Legal Service Authority
g) Design games and simulation
h) Group discussions on current print articles
i) Prepare college/posters on current constitutional issues.
j) Learning through cases

- **A.K. Gopalan Case (1950):weblink** *https://indiankanoon.org/doc/1857950/*
- **Shankari Prasad Case (1951):weblink***https://indiankanoon.org/doc/1706770/*
- Berubari Union case (1960) :weblinkhttps://indiankanoon.org/doc/1120103/
- Golaknath case (1967) :weblinkhttps://indiankanoon.org/doc/120358/
- Kesavananda Bharati case(1973):weblinkhttps://indiankanoon.org/doc/257876/
- Indira Nehru Gandhi v. Raj Narain case (1975):weblinkhttps://indiankanoon.org/doc/936707/
- Maneka Gandhi case (1978):weblink https://indiankanoon.org/doc/1766147/
- Minerva Mills case (1980): weblink https://indiankanoon.org/doc/1939993/
- Indra Sawhney and Union of India (1992):weblinkhttps://indiankanoon.org/doc/1969682/
- Samatha and State of Andhra Pradesh (1997): weblink https://indiankanoon.org/doc/1969682/

- Aruna Shanbaug Case (2011) : weblinkhttps://indiankanoon.org/doc/235821/
- Justice K.S.Puttaswamy(Retd) ... vs Union Of India And Ors.: Right To Privacy (2017)weblinkhttps://indiankanoon.org/doc/1857950/
- L Chandra Kumar Case (1997):weblink https://indiankanoon.org/doc/1152518/
- Habeas Corpus Case (1976): weblink https://indiankanoon.org/doc/1735815/
- Romesh Thapar Case (1950): weblink https://indiankanoon.org/doc/456839/
- M.C. Mehta And Anr vs Union of India &Ors on 20 December, 1986 Bhpal Gas Tragedy:weblinkhttps://indiankanoon.org/doc/1486949/
- M.C. Mehta vs Union Of India &Ors on 30 December, 1996 Taj Mahal:weblink https://indiankanoon.org/doc/1964392/
- M.C. Mehta vs Union Of India on 15 November, 2019 Delhi Pollution: weblink ttps://indiankanoon.org/doc/174204561/
- Samit Mehta v. Union of India &Ors.;National Green weblink:https://www.casemine.com/judgement/in/5b17d5604a932678010063da

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessedusing different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

- Not Applicable

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	The Constitution of India	P.M. Bakshi	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105
2	Introduction to Indian Constitution	D.D. Basu	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3	Introduction to Constitution of India	B. K. Sharma	PHI, New Delhi, 6th edition, 2011, ISBN:8120344197
4	The Constitution of India	B.L. Fadia	Sahitya Bhawan, Agra, 2017, ISBN:8193413768

S. No.	Title of Book	Author	Publication with place, year and ISBN
5	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008, ISBN:0198063555
6	The Constitutional Law of India	Durga Das Basu	LexisNexis Butterworths Wadhwa, Nagpur 978-81-8038-426-4
7	Indian Constitution	Avtar Singh	Central Law Publication, Prayagraj. Uttar Pradesh 2019. 978-9386456861
8	The Constitution of India	NaushirwanJhabwala	C. Jamnadas&Company. Ahmedabad. 2016.978-9789364572

14. SOFTWARE/LEARNING WEBSITES

a) http://www.legislative.gov.in/constitution-of-india
b) https://en.wikipedia.org/wiki/Constitution_of_India
c) https://www.india.gov.in/my-government/constitution-india
d) https://eci.gov.in/about/about-eci/the-setup-r1/
e) https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india
f) https://main.sci.gov.in/constitution
g) https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf
h) https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf
i) https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india--e.htm
j) https://constitutionnet.org/vl/item/basic-structure-indian-constitution

15. PO-COMPETENCY-CO MAPPING

1	Indian Constitution (Course Code: 4300016)						
	POs and PSOs						
Competency and Course Outcomes	**PO 1 Basic and Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation andTesting**	**PO 5 Engineering practices for society, sustainability and environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency ***Follow policies, processes, duties, rights and federal structure of Indian constitution as responsible citizens***							

and engineer of the country.							
Course Outcomes CO a) List salient features and characteristics of the constitution of India.	-	1	1	-	2	1	2
CO b) Follow fundamental responsibilities, privileges, rights and duties as responsible citizen and engineer of the country.	-	1	1	-	2	1	2
CO c) Differentiate between state and central administrative setup of the country.	-	1	1	-	2	1	2
CO d) Explain major constitutional amendment procedures and emergency provisions in the country.	-	1	1	-	2	1	2
CO e) Explain judicial setup and electoral process of the country.	-	1	1	-	2	1	2

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr PeenaThanky Lecturer [English] BOS Member	RCTechnical Institute, Ahmedabad	94094 11256	drpeena@gmail.com

2	Dr. Yatharth Vaidya Lecturer [English] BOS Member	Government Polytechnic, Rajkot	8980291650	yatharthvaidya@gmail.com
3	Dr J U Nanavaty Expert	Formal principal Sheth M N Law college Patan.	9898115448	junanavaty@gmail.com

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr. Roli Pradhan, Assistant Professor	Department of Management Education	09893205011	rpradhan@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -II

Course Title: Applied Mathematics
(Course Code: 4320001)

Diploma programmes in which this course is offered	Semester in which offered
Chemical Engineering, Civil Engineering, Marine Engineering, Mechanical Engineering, Mining Engineering	Second

1. RATIONALE

This course is an extension of the course based on Mathematics of first semester namely Applied Mathematics. The course is designed to inculcate its applications in relevant branch of engineering and technology using the techniques of Differentiation, Integration, Differential equations, Matrix theory and Statistics. Calculus is a branch of Mathematics that calculates how matter, particles and heavenly bodies actually move. With calculus, we can find how the changing conditions of a system affect us, we can control a system. Derivatives are useful to find maxima and minima of the function, velocity and acceleration and also useful for many engineering optimization problems. Definite integrals are a powerful tool to help us realize and model the world around us. Differential equations are widely applied to model natural phenomena, engineering systems and many other situations. Matrix analysis is a valuable tool used in nearly all the engineering sciences. Statistics can be defined as a type of mathematical analysis which involves the method of collecting and analyzing data and then summing up the data into a numerical form for a given set of factual data or real-world observations. This course further develops the skills and understanding of mathematical concepts which underpin the investigative tools used for modeling and analysis in a wide range of applications in engineering.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Solve broad-based technology problems using the principles of Applied mathematics.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Demonstrate the ability to Crack engineering related problems based on Matrices.
b) Demonstrate the ability to solve engineering related problems based on applications of differentiation.
c) Demonstrate the ability to solve engineering related problems based on applications of integration.
d) Develop the ability to apply differential equations to significant applied problems.
e) Solve applied problems using the concept of mean.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	1	-	4	30*	70	-	-	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL/TUTORIALS EXERCISES (During Tutorial Hours)

The following practical outcomes (PrOs)/Tutorials are the sub-components of the COs. *Some of the **PrOs/Tutorials** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)/Tutorials	Unit No.	Approx. Hrs. required
1	Solve simple problems using the concept of algebraic operations of matrices.	I	1
2	Use the concept of adjoint of a matrix to find the inverse of a matrix.	I	1
3	Solve system of linear equations using matrices. Use suitable software to demonstrate the geometric meaning of solution of system of linear equations.	I	1
4	Solve examples related to 1^{st} rule of derivative, working rules.	II	1
5	Solve examples of derivative related to Chain Rule, Implicit functions.	II	1
6	Solve the examples derivative of Parametric functions and second order derivative of simple functions.	II	1
7	Use concept of derivative to solve the problems related to velocity, acceleration and Maxima-Minima of given simple functions. Use suitable graphical software to visualize the concept of maxima-minima of function.	II	1
8	Solve examples of integration using working rules, standard forms of integration and method of substitution.	III	1
9	Use the concept of integration by parts to solve related problems. Solve problems related to definite integral using properties.	III	1
10	Apply the concept of definite integration to find area and volume.	III	1

S. No.	Practical Outcomes (PrOs)/Tutorials	Unit No.	Approx. Hrs. required
11	Solve problems of the order, degree of differential equations and Variable Separable method.	IV	1
12	Apply the concept of linear differential equations to solve given differential equation. Explain the various applications of differential equations in engineering and real life.	IV	1
13	Solve examples Mean for the given data.	V	1
14	Solve examples of Mean deviation and Standard deviation for the given data.	V	1
			14 Hrs.

Note

*i. More **Practical Exercises/Tutorials** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises/Tutorials** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs/Tutorials	Weightage in %
	Geometric Thinking: Comprehend geometric concepts to interpret solutions by applying apt results to solve well defined Engineering problems.	
1	Solve problems based on derivative/integration and interpret geometrically the obtained solution.	40
2	Solve problems involving area and volume through integrals and interpret geometrically.	30
3	Frequency curves its interpretation.	20
4	Interpret the result and conclude.	10
Total		**100**
S. No.	**Sample Performance Indicators for the PrOs/Tutorials**	**Weightage in %**
	Algebraic Thinking: Create, interpret, use, and analyze expressions, equations, and inequalities in a variety of contexts.	
1	Represent, interpret, and solve variable expressions, equations, and inequalities.	40
2	Write expressions in equivalent forms to solve problems.	40
3	Interpret the result and conclude.	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer System &LCD Projector	3,5,6,10,12,13, 14
2	Scientific Calculator (Display type: Natural Display Algebraic input logic: Natural V.P.A.M. Significant function: 10+2.	5,9,11

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Realize importance of green Mathematics.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher
to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Matrices**	1a. Solve simple problems using the concept of algebraic operations of matrices. 1b. Apply the concept of adjoint of a matrix to find the inverse of a matrix. 1c. Investigate the solution of system of linear equations using matrices.	1.1 Concept of Matrix 1.2 Types of Matrices 1.3 Addition, Subtraction and multiplication by scalar of matrices 1.4 Product of two matrices 1.5 Adjoint and Inverse of a matrix of order 2X2 and 3X3. 1.6 Solution of Simultaneous linear equations of two variables.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Matrices	09	4	6	6	16

Unit – II **Differentiation and its Applications**	2a. Apply the working rules and standard forms of differentiation to find the derivative of simple functions. 2b. Invoke the concept of Chain Rule to find the derivative of simple functions. 2c. Find the derivative of given Implicit and Parametric functions. 2d. Apply the standard forms and rules of derivative to find the second order derivative of simple functions. 2e. Apply the concept and rules of derivative to solve the problems related to velocity, acceleration and Maxima-Minima of given simple functions.	2.1. Concept and Definition of Differentiation 2.2. Working rules : Sum, Product, Division 2.3. Chain Rule 2.4. Derivative of Implicit functions 2.5. Derivative of Parametric functions 2.6. Logarithmic Differentiation 2.7. Successive Differentiation up to second order 2.8. Applications: Velocity, Acceleration, Maxima & Minima of given simple functions.
Unit– III **Integration and its Applications**	3a. Apply the working rules and standard forms of integration to find the integral of simple functions. 3b. Find the integral of simple functions using the method of substitution and integration by parts. 3c. Solve given problems related to definite integral using properties. 3d. Apply the rules and standard forms of integration to solve the problems related to area and volume.	3.1 Concept and Definition of Integration. 3.2 Working rules and Integral of standard functions. 3.3 Method of substitution. 3.4 Integration by parts. 3.5 Definite Integral and its properties. 3.6 Applications: Area and volume. (Simple problems)
Unit– IV **Differential Equations**	4a. Find the order and degree of given differential equations. 4b. Solve Differential Equations related to Variable Separable method. 4c. Solve given linear differential equations.	4.1 Concept and Definition, Order and Degree of differential equation. 4.2 Solution of DE of first degree and first order by Variable Separable method. 4.3 Solution of linear Differential equation.
Unit– V **Statistics**	5a. Find Mean for the given data. 5b. Calculate Mean deviation for the given data. 5c. Calculate Standard deviation for the given data.	5.1 Mean for ungrouped and grouped data. 5.2 Mean deviation and Standard deviation about Mean for ungrouped and grouped data.

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Differentiation and its Applications	10	4	6	6	16
III	Integration and its Applications	10	4	4	6	14
IV	Differential Equations	06	2	4	6	12
V	Statistics	07	2	4	6	12
Total		**42**	**16**	**24**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Identify engineering problems based on real world problems relevant to content of the unit and solve these problems in the light of free tutorials available on the internet.
b) Explore the opportunity to visit Science city, ISRO or nearby Science centers.
c) Explore the opportunity to visit Mathematics Lab Virtually.
d) Prepare charts showing formulas of differentiation.
e) Prepare charts showing formulas of integrations.
f) Use Graphing calculator to plot the graph of solutions explaining Engineering applications.
g) Communicate mathematical thinking coherently and clearly to other students, peers, and others.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Explore the possibility for understanding the Biosphere through Mathematics.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Charts:** Prepare the Charts of formulae for Matrix, Differentiation, Integration.
b) **Charts:** Compare last weather conditions with current weather to predict future weather through chart.
c) **Models:** Prepare the cardboard models based on real world applications of derivatives.
d) **Presentation/Seminar:** Prepare a presentation/seminar on any relevant topic of interdisciplinary nature.
e) **History of Mathematics**: Prepare a write up on the Historical path of Calculus.
f) **Solution of system of linear equations:** Form the system of linear equations up to three variables for the given electrical circuit using matrices solve it.
g) **Maxima and Minima:** Find a real-world problem related to finding area/volume, form the corresponding function and find maxima/minima. For example, maximize the volume of a box made of a rectangle tin sheet by cutting off squares of same size from each corner and folding up.
h) Slope of tangent: Find the slope of tangent for the given curves at a given point using derivative and visualize the location using suitable software.
i) Area/Volume: Find the area of a given closed region or volume of revolution for a given function using integration and visualize using suitable software.
j) Solution of Differential equation: Form differential equations for real-world problems and plot the graph using suitable software with geometrical interpretation.
k) Statistics: Collect the data of world of work and find mean, mean deviation and standard deviation for that data.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Elementary Engineering Mathematics	B. S. Grewal	Khanna Publishers,15th Edition. ISBN: 978-81-7409-257-1
2	Engineering Mathematics	Croft, Anthony	Pearson Education, New Delhi, 2014.

S. No.	Title of Book	Author	Publication with place, year and ISBN
	(Third edition).		ISBN 978-81-317-2605-1
3	Calculus and Its Applications	Marvin L. Bittinger David J. Ellenbogen Scott A. Surgent	Addison-Wesley 10th Edition ISBN-13: 978-0-321-69433-1
4	Calculus and Analytic Geometry	G. B. Thomas, R. L. Finney	Addison Wesley, 9th Edition, 1995. ISBN 978-8174906168
5	Understanding Engineering Mathematics	John Bird	Routledge; 1st edition ISBN 978-0415662840
6	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5
7	Elementary Mathematical Statistics	S. C. Gupta and V. K. Gupta	Sultan Chand and Sons, Educational Publisher, New Delhi ISBN: 978-8180547003

14. SOFTWARE/LEARNING WEBSITES

a) https://www.youtube.com/channel/UCLJVrQyPYsseCf78QWCDsvA/featured (YouTube Channel of DTEGUJ)
b) https://www.geogebra.org/?lang=en
c) https://nios.ac.in/online-course-material/sr-secondary-courses/mathematics-(311).aspx
d) www.dplot.com/ - DPlot
e) www.wolfram.com/mathematica/
f) www.easycalculation.com
g) www.scilab.org/ - SCI Lab
h) https://ncert.nic.in/textbook.php (NCERT Textbooks of Mathematics 11th and 12th Science)
i) https://www.desmos.com/

15. PO-COMPETENCY-CO MAPPING

Semester II	Applied Mathematics (Course Code:4320001)

	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency .	Solve broad-based technology problems using the principles of Applied mathematics.						
Course Outcomes CO a) Demonstrate the ability to Crack engineering related problems based on Matrices	3	1	-	-	-	-	1
CO b) Demonstrate the ability to solve engineering related problems based on applications of differentiation	3	1	1	-	-	-	1
CO c) Demonstrate the ability to solve engineering related problems based on applications of integration	3	1	1	-	-	-	-
CO d)Develop the ability to apply differential equations to significant applied problems	3	1	1	-	-	-	1
CO e) Solve applied problems using the concept of mean	3	1	-	-	-	-	-

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. N. A. Dani Sr. Lecturer	Government Polytechnic, Rajkot	9427184187	nilesh_a_d@yahoo.co.in
2	Dr. Udayan M. Prajapati Head and Associate Professor	St. Xavier College, Ahmedabd	9426383343	Udayan64@yahoo.com
3	Mr. P. N. Joshi Sr. Lecturer	A.V.P.T.I, Rajkot	9924844699	pnj2004@rediffmail.com
4	Dr. J. S. Prajapati Sr. Lecturer	R.C.T.I, Ahmedabad	9426469752	jsprajapati26@gmail.com
5	Dr. Sachin J. Gajjar Lecturer	Government Polytechnic, Gandhinagar	9925362754	gjr.sachin@gmail.com
6	Dr. Nirav H. Shah Lecturer	Government Polytechnic, Jamnagar	9327632570	Nirav.hs@gmail.com

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr. Deepak Singh Associate Professor (Mathematics) Former Head, DAS	Department of Applied Science Education, NITTTR, Bhopal	9826991961	dsingh@nitttrbpl.ac.in

CAD/CAM

3RD Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Metrology and Instrumentation
(Course Code: 1336501)

Diploma programme in which this course is offered	Semester in which offered
CAD/CAM Mechanical Engineering	3rd Semester

1. RATIONALE

The students of the CAD/CAM mechanical engineering programme are basically concerned with manufacturing of various machine, components in shops as per given drawing. Today the industrial processing and manufacturing techniques have become complex and complicated, so their control is very much difficult by visual inspection only. Hence accurate and precise measurements by precision measuring instruments are the basic need of the industries. This course of Metrology and Instrumentation provides practical exposure, skills and self-confidence in the students so that they can operate those precision measuring instruments accurately in the benefit of manufacturing industries.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Select and operate appropriate precision measuring instruments for the measurement of given manufacturing product/component.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

CO-1	Measure the given mechanical elements and assemblies using appropriate linear and angular measuring instruments.
CO-2	Measure geometrical tolerances and surface roughness of given components.
CO-3	Measure important dimensions of different types of gears and threads.
CO-4	Use appropriate limit gauges, transducers and sensors for given applications.
CO-5	Use appropriate temperature and pressure measuring devices for given application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). These PrOs need to be attained to achieve the Cos.

Sr. No.	Practical Exercises (Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1	**Preparatory Activity:** a. S.I. basic, supplementary and derived units and their conversions. Convert given length, area and volume from one unit to another. (From mm to cm and m, from mm to inch, from m to yard and foot, from mm^2 to $inch^2$ and vice- versa, mm^3 to $inch^3$ and vice-versa, etc.). b. Convert given degree to radian and vice-versa. c. Various drafting, surface finish and geometrical symbols. d. Define axis, axes, center, angles, plane and solid angle.	I	02
2	**Linear And Angular Measurement:** Each student will select and bring at least such five mechanical components which will have use of instruments specified below. Same are to be approved by teacher. After approval, student will: a. Sketch each component. b. Sketch and label main parts of instruments to be used. c. Calculate least count of the instrument/s to be used. d. Measure and record applicable dimensions of each component using: i. Vernier caliper. ii. Inside & Outside micrometer. iii. Telescopic gauge iv. Height gauge/depth gauge. v. Slip gauges (Calibration of vernier caliper and micrometer) vi. Bevel protector and sine bar.	I	08
3	**Measurement of geometrical tolerances:** Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking various geometrical tolerances like: a) Straightness b) Flatness	II	04

Sr. No.	Practical Exercises (Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
	c) Squareness, perpendicularity and parallity d) Roundness, Cylindricity, Concentricity, Runout and Ovality.		
4	**Surface Roughness:** a. Tabulate machining processes, and roughness values (Ra, mm), roughness grade number and roughness symbol. b. Demonstrate various surfaces having different roughness values. c. For given component, sketch the component, judge the roughness of surfaces and show surface roughness symbols on applicable surfaces. d. Measure surface roughness value of given machined surface.	III	02
5	**Gear Measurement:** a. Sketch gear tooth nomenclature. b. Sketch gear tooth vernier and label each part. c. Calculate chordal thickness and height of given gear. d. Determine tooth height. e. Measure and compare chordal thickness of given spurs gear using gear tooth vernier.	IV	02
6	**Thread Measurement:** For given external threaded part: a. Draw nomenclature for ISO screw threads (Internal and external both). b. Explain and derive best wire size. c. Sketch the part and show the dimensions to be measured. d. Sketch the set up and instruments used to measure/derive major diameter, minor diameter and effective diameter using two wire and three wire methods. e. Measure the pitch. f. Use threaded ring gauge. g. Record observations.	IV	03
7	**Limit Gauges:** a. Demonstrate use of various limit gauges. b. Select appropriate limit gauge for given dimension/part and check the dimension with gauge. c. Record your observations.	V	02
8	**Demonstration of Transducers and Sensors:** a. Demonstrate electrical (LVDT type, resistance type, capacitance type, inductance type and piezo-electric.) transducers and various sensors. b. Sketch each demonstrated transducers and sensors and tabulate specifications, range, resolution and applications of each.	V	02
9	**Temperature Measurement and Pressure Measurement:** **Temperature Measurement:** a. Sketch the set up and constructional sketch of thermocouple used to measure temperature. b. Measure the temperature of hot body/hot liquid with thermocouple.	VI	03

Sr. No.	Practical Exercises (Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
	c. Record the observation. **Pressure Measurement:** a. Sketch the set up and constructional sketch of pressure gauge used to measure pressure. b. Measure the pressure with pressure gauge. c. Record the observation.		
		Total	28

Note

a. It is compulsory to prepare log book of exercises. It is also required to get each exercise/practical's recorded in logbook, checked and duly dated signed by faculty.
b. Term work report content of each experience should also include following.
    1. Reports.
    2. Student activities.
c. For 25 marks of ESE, students are to be assessed for competencies achieved. They should be given following tasks. (i and any one from ii, iii and iv.)
    1. Measure the linear/angular dimensions and geometrical tolerances of given part/assembly.
    2. Measure important dimensions of different types of gears/threads.
    3. Use appropriate limit gauge for given components.
    4. Explain working of transducers and sensors.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the Cos and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Knowledge of concept and Selection of instrument	25
2	Standard operating procedure	15
3	Measurement skill and data record	20
4	Result and Troubleshooting	25
5	Workplace safety and Ethical practice	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Criteria	Rating Scale			
	Excellent (4)	**Good (3)**	**Fair (2)**	**Poor (1)**
Knowledge of concept and Selection of instrument	Student has excellent knowledge of concept and precisely select appropriate instrument for high accuracy.	Student has good knowledge of concept and able to select appropriate instrument.	Student has fair knowledge of concept and managed to select instrument for measurement.	Student has poor knowledge of concept and unable to select appropriate instrument.
Standard operating procedure	Student always Follow all the standard Procedure with utmost precaution and in logical order.	Student Follow all the standard Procedure with precaution and in logical order.	Student Follow all the standard Procedure with some precaution.	Student not completely Follow all the standard Procedure.
Measurement skill and data record	Student demonstrate excellent measurement skill by taking all measurement very accurately and note it down in lab manual.	Student demonstrate good measurement skill by taking all measurement and note it down in lab manual.	Student demonstrate fair measurement skill by taking some measurement and note it down in lab manual.	Student demonstrate poor measurement skill by not taking measurement accurately and has poor record of data keeping.
Result and Troubleshooting	Student get very accurate result & has ability to detect and correct the error.	Student get accurate result & has managed to detect and correct the error.	Student get result within tolerance range & has managed to detect and correct the error with little help.	Student get result which is not accurate nor in tolerance range. Student has not able to detect error.
Workplace safety and Ethical practice	Student display excellent punctuality & always follow and also encourage others to follow all safety norms ethically during measurement.	Student display good punctuality and always follow all safety norms ethically during measurement.	Student display fair punctuality and follow safety norms during measurement.	Student is not punctual nor follow safety norms during measurement.

6. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	Practical No.
1	1. Surface plate, 500 x 500 mm. 2. Vernier calliper, 0 to 200 mm, least count 0.02 mm. 3. Vernier calliper, 0 to 200 mm, least count 0.01 mm, digital. 4. Inside micrometers, least count 0.01 mm, 50-75 mm. 5. Micrometer, least count 0.01 mm, 0-25mm, 25-50 mm, 50-75 mm. 6. Outside micrometer, least count 0.001 mm, 0-250 mm. 7. Telescopic gauge- 10-100 mm. 8. Height gauge- 300 mm with least count 0.02 mm. 9. Depth gauge- 200 mm with least count 0.02 mm. 10. Bevel protector with least count 5'. 11. Slip gauge box (Preferably M112/1) 12. Sine bar- 100 mm, 200 mm.	2
2	1. Straight edge, 500 mm. 2. Feeler gauge, radius gauge, thread pitch gauge. 3. Dial indicators magnetic stand. 4. Dial indicators, least count 0.01 mm. 5. V blocks.	3
3	1. Samples of various surface textures and different surface roughness. 2. Microprocessor- stylus-probe based surface roughness testing machine. 3. Microscope to compare various textures and surface roughness.	4
4	1. Gear tooth vernier. 2. Profile Projector 3. Set of best wire to measure thread dimensions. 4. Thread Micrometers	5 & 6
5	Set of limit gauges- sorted sizes, plug gauges, thread ring gauges and Snap gauges.	7
6	1. LVDT type, resistance type, capacitance type, inductance type and piezo-electric type transducers. 2. Sensors, position, proximate, velocity, force/strain	8
7	1. Thermometers. 2. Various types of thermocouples.	9

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain instruments and equipment.
e) Practice environment friendly methods and processes. (Environment related).

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

I. 'Valuing Level' in 1st year
II. 'Organization Level' in 2nd year.
III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Linear and angular measurement**	1a. Distinguish between accuracy, precision and error.	1.1 Inspection, quality and quality control-definitions and differences. 1.2 Define accuracy, precision and error. 1.3 Surface plates-types, important features, standards/important sizes, applications and precautions in use.
	1b. Determine least count of given measuring instrument. 1c. Select suitable linear measuring instrument and measure the linear dimension of given component.	1.4 Principle of vernier scale and least count. 1.5 Types, constructional sketch, major parts and their functions, least count, measuring methods and measurement illustration (for e.g., 12.48mm) of: i. Vernier caliper. ii. Micrometer. iii. Telescopic gauge. iv. Height gauge. v. Depth gauge.
	1d. Describe the procedure for wring the slip gauge and set given dimension.	1.6 Slip gauge-types, applications, and wringing method.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	1e. Select suitable angular measuring instrument. 1f. Describe the measurement procedure for the angular dimension of given component.	1.7 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of: I. Bevel Protector. II. Sine bar. III. Angle gauges. IV. Spirit level. V. Clinometers. VI. Auto collimator. 1.8 Calibration – concept and need.
Unit – II **Measurement of geometrical tolerances**	2a. Explain working of dial indicators. 2b. Select the measuring method and describe the measurement procedure for geometrical tolerance of given part/assembly.	2.1 Dial indicators/gauge-types, constructional sketch and applications. 2.2 Definition, symbol and measuring methods of: I. Straightness. II. ii. Flatness. III. Squareness. IV. Parallism. V. Perpendicularity. VI. Roundness. VII. Concentricity. VIII. Cylindricity. IX. Run out and ovality.
Unit – III **Measurement of surface roughness**	3a. Define various terminology used for surface roughness. 3b. Explain working of direct instrument methods.	3.1 Terminology used in connection with surface finish. 3.2 Comparison methods to inspect surface finish-concept and applications. 3.3 Direct instrument measurement methods-types and concepts. 3.4 Construction, working and applications of Talysurf surface roughness tester and Tomlinson tester.
	3c. Determine surface roughness of given data.	3.5 Centre line average and Root Mean Square systems of surface texture evaluation-terminology used, concept, equations and numerical examples. 3.6 Indication of various surface roughness characteristics with surface roughness symbols-interpretation.
Unit – IV **Gear and thread measurement**	4a. Define various terms used for gear nomenclature. 4b. Use gear tooth vernier to measure gear tooth thickness.	4.1 Types of gears. 4.2 Forms of gear teeth-types and concept. 4.3 Gear tooth Terminology. 4.4 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of gear tooth vernier. 4.5 Derivation and numerical example to measure gear tooth thickness using: I. Gear tooth vernier. II. Constant chord method. III. Base tangent method.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4c. Explain working of profile projector. 4d. Define various terms used for thread nomenclature. 4e. Determine best wire size. 4f. Use two and three wire methods to determine effective diameter of thread. 4g. Describe method for measuring the pitch of given thread.	4.6 Gear tooth profile measurement. 4.7 Threads-classification, elements, specifications and forms. 4.8 Measurement of major and minor diameters. 4.9 Three and two wire method of measuring effective diameter of external thread-concept, terminology used, best wire size, derivation of equation and numerical example. 4.10 Thread micrometer-sketch, method to use and determination of dimension. 4.11 Pitch measurement methods.
Unit – V **Limit gauges, Transducers and sensors**	5a. Select and check the given dimension using limit gauge.	5.1 Limit gauges-classification, sketch and applications. 5.2 Comparators-concept, types and applications.
	5b. Define static characteristics of instruments.	5.3 Instrumentation-introduction, performance characteristics. 5.4 Static characteristics of instruments.
	5c. Explain various transducers and sensors.	5.5 Transducers-concept, classifications, physical quantities which can be measured, advantages and disadvantages. 5.6 Electrical transducers-types, working principles and applications of: I. Linear Variable Differential Transducers (LVDT). II. Resistance type. III. Capacitance type. IV. Inductance type. V. Piezo-electric type. 5.7 Sensors- classification and applications. 5.8 Use of transducers and sensors as a safety measures.
Unit – VI **Temperature and Pressure measurement**	6a. Select and describe the method for using appropriate temperature measuring device to measure temperature of given hot body.	6.1 Introduction. 6.2 Classification, working principle, construction, working, advantages, limitations and applications of temperature measuring devices: I. Mercury in glass thermometer. II. Bimetallic thermometer. III. Resistance thermometer. IV. Thermistor. V. Thermocouple. VI. Radiation pyrometers. VII. Optical pyrometers.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	6b. Select and describe the method for using appropriate pressure measuring device to measure pressure.	6.3 Pressure measurement scales. 6.4 Types and applications of manometers (only list and applications). 6.5 Working principle, construction, working, advantages, limitations and applications of pressure measuring devices: I. Bellows type pressure gauge. II. Diaphragm type pressure gauge. III. Bourdon tube pressure gauge. IV. Dead weight piston gauge. 6.6 Concept of transducer-based pressure measuring devices resistance type, capacitance type and inductance type. 6.7 Use of Temperature and Pressure measurement as a safety measures.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Linear and angular measurement	10	06	08	06	20
II	Measurement of geometrical tolerances	06	02	03	03	08
III	Measurement of surface roughness	06	02	03	03	08
IV	Gear and Thread measurement	08	04	08	04	16
V	Limit gauges, transducers and sensors	08	02	06	04	12
VI	Temperature and Pressure measurement	04	02	04	00	06
	Total	**42**	**18**	**32**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the COs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Visit the workshop and identify the machined components which require geometrical tolerances.
b) Visit any industry/tool room and observe the working of inspection and testing department and also prepare the report.
c) Calibrate any one instrument having error in laboratory.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed byteachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular*** activities.
f) Guide students on how to address issues on environment and sustainability.
g) For this course teacher may use one or combine of any strategies from below for better teaching learning experience.
   - Demonstration of actual instrument.
   - Videos of measuring methods.
   - Perform virtual lab experiments.
   - Industrial visits.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Perform a Virtual lab experiment of any one from Linear measuring instrument/Angular measuring instrument/Temperature measurement/Pressure measurement/gear and thread measurement and prepare an observation table for the same.

b) Select a readymade mechanical component/product/assembly from college workshop/industry/market of distinct dimensions, prepare a drawing of it, select and

measure it with various available precision measuring instruments and note it down in drawing. (Select items with at least 5-6 dimensions and try to cover many varieties of instruments like linear, angular, indirect, analog, digital etc.)

c) Prepare a poster/PPT/Animation of any precision measuring instrument containing working principle, least count, construction, reading method, types etc.

d) Do an industrial visit of nearby manufacturing industries/calibration lab and prepare a detail report on list of instruments with its types, range and least count used in the particular industries.

e) Select a mechanical part, measure same dimensions with different instrument also having different least count and observe the change in readings.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Mechanical measurements and instrumentation	R.K.Rajput	KATSON
2	Engineering Metrology and Measurements	N.V. RAGHAVENDRA & L. KRISHNAMURTHY	OXFORD University press
3	Mechanical Measurement	Sirohi R.S., Radha Krishnan H.C.	New Age International
4	Practical Engineering Metrology	K.W.B.Sdarp	Pitman
5	Engineering Metrology	R.K.Jain	Khanna Publications.
6	Metrology & Measurement	Anand Bewoor & Vinay Kulkarn	Tata McGrawHill
7	Industrial Instrumentation & Control	S K Singh	Tata McGrawHill
8	Mechanical Measurement	Beckwith & Buck	Narosa publishing House
9	Mechanical Measurement and Control	D.S.Kumar	Metropolitan Book Pub.
10	Mechatronics	W.Bolten	PEARSON
11	Gear Metrology	C.A.Scoks	

14. SOFTWARE/LEARNING WEBSITES

MOOCS

- https://swayam.gov.in/ (SWAYAM Portal)
- Reference videos from IIT Kanpur MOOC on Engineering Metrology (Gear Metrology).
  - i. https://youtu.be/7ZteZ5UTW6E (Part-1)
  - ii. https://youtu.be/GzMPsjMQKGY (Part-2)
- Reference videos from IIT Roorkee MOOC on Inspection and Quality control in Manufacturing (Gear Measurement).
  1. https://youtu.be/X8KPNVZhvmo

Vertual Labs

- https://www.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4 (OLABS-Vernier Caliper).
- http://www.amrita.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4 (Vernier Caliper).
- https://amrita.olabs.edu.in/?sub=1&brch=5&sim=156&cnt=4 (Micrometer).

- https://kcgcollege.ac.in/Virtual-Lab/Mechanical/Exp-2/index.html (measurement of Major, Minor and Effective diameter of external screw thread using Floating Carriage micrometer).

You tube links

- https://www.youtube.com/watch?v=xgQYvEELbfc (Vernier Caliper).
- https://www.youtube.com/watch?v=FNdkYIVJ3Vc (Vernier Caliper).
- https://www.youtube.com/watch?v=O8vMFFYNIfo (Micrometer)
- https://www.youtube.com/watch?v=h98HPVuWjLA (depth micrometer)
- https://www.youtube.com/watch?v=SmXfGan_NXQ (telescopic gauge)
- https://www.youtube.com/watch?v=eVpoJzLJa0U(surface roughness)
- https://www.youtube.com/watch?v=3Od7vnoMwGg(surface roughness)
- https://www.youtube.com/watch?v=XnLiTPGE6pk (three wire thread measurement)
- https://www.youtube.com/watch?v=Gdvtw0pTAOs (thread pitch)
- https://www.youtube.com/watch?v=qMgXGedDffw (dial indicator)
- http://www.youtube.com/watch?v=lc4dsNvm2Ks (principle of mechanical measurement).
- http://www.youtube.com/watch?v=nv3GuJArjNU (Transducers).
- http://www.youtube.com/watch?v=iMIzApq1CQ0 (pressure measurement).
- http://www.youtube.com/watch?v=JKuoQ5FV2c8 (temperature measurement).
- http://www.youtube.com/watch?v=GNOI_7ftbQ0(temperature measurement).
- http://www.youtube.com/watch?v=QItuf6lNvmI (Capacitive sensors)
- http://www.youtube.com/watch?v=inLkCOwVgyM (force sensors).
- http://www.youtube.com/watch?v=0MP_9n08urA(force sensors).
- http://www.youtube.com/watch?v=zAddvPHfKnw (force sensors)
- http://www.youtube.com/watch?v=_fQSMVf3hdM (calibration).
- http://www.youtube.com/watch?v=ZymDMUuVuyY (geometrical Tolerance).
- http://www.youtube.com/watch?v=5eaSkU6Ecik (flatness measurement).
- http://www.youtube.com/watch?v=1JNCe9fwRUw (Measuring Perpendicularity)
- http://www.youtube.com/watch?v=eJ8a0k8kQIE (Roundness and cylindricity).
- https://youtu.be/jTfUFQ-sbas (Types of Gear in Hindi).
- https://youtu.be/bH3v2bGvLyM (Types of Gear in English).
- https://youtu.be/8AS15R_Q52o (Gear teeth form in Hindi).
- https://youtu.be/ococqpOzbt8 (Gear Tooth Terminology in Hindi).
- https://youtu.be/8hkmFClpwPU (Gear Tooth Terminology in English).
- https://youtu.be/fdz8x5Rgswo (Gear Tooth Terminology in English).
- https://youtu.be/LDhZJ5Ya5YI (Line of action and pressure angle in English).
- https://youtu.be/3L5ZlG8p9Co (measurement of gear tooth thickness in English).
- https://youtu.be/suWlbCsIomg (measurement of gear tooth thickness in Hindi).
- https://youtu.be/FR8Jxr-b3ds (Gear Tooth Vernier Caliper).
- https://youtu.be/Ws98uEZA1MY (Constant chord method in English).
- https://youtu.be/ZKx7jQYj0jk (Constant chord method in Hindi).
- https://youtu.be/_P2q9w49j_w (David brown base tangent comparator method in English)
- https://youtu.be/lyo2POzjslY (David brown gear tooth form testing).
- https://youtu.be/RuAnfLllaDY (Tool room microscope as projection method for small gear).
- https://youtu.be/DYUsqEzV5pY (Parkinson's gear tester in Hindi/English).
- https://youtu.be/qCSCR5RSiPI (Parkinson's gear tester in English).

15. PO-COMPETENCY-CO MAPPING

Semester III	Metrology and Instrumentation (Course Code: - 1336501)						
	POS						
Competency & Course Outcomes	PO1 Basic and Discipline specific knowledge	PO2 Problem analysis	PO3 Design/ development of solutions	PO4 Engineering Tools, Experimentation and Testing	PO5 Engineering practices for society, sustainability and environment	PO6 Project Management	PO7 Life-long learning
Competency	**Select and operate appropriate precision measuring instruments for the measurement of given manufacturing product/component.**						
CO1-Measure the given mechanical elements and assemblies using appropriate linear and angular measuring instruments.	3	-	-	3	-	2	2
CO2-Measure geometrical tolerances and surface roughness of given components.	3	-	-	3	-	1	2
CO3-Measure important dimensions of different types of gears and threads.	3	-	-	3	-	2	2
CO4-Use appropriate limit gauges, transducers and sensors for given applications.	2	-	-	3	2	2	2
CO5-Use appropriate temperature and pressure measuring devices for given application.	3	-	-	3	2	1	2

*Legend: '**3**'for high, '**2**'for medium, **'1'**for low and **'-'**for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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1.	Dr. Hemang J. Parekh Lecturer in Mechanical Engg.	Government Polytechnic Jamnagar	9426481731	parekhhemang080@gmail.com
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BOS Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -III

Course Title: Manufacturing Engineering Process-II
(Course Code: 1336502)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	3rd Semester

1. RATIONALE

This subject of Manufacturing Engineering Processes provides knowledge and embeds skill to students to develop different products using various machining process. Manufacturing processes are the most important element in any engineering industry. Mechanical Engineer is a key person for shop floor activities related to manufacturing. He/she should have knowledge and associated skill of machining processes to produce quality products at optimum cost. This course will make student familiar with fundamentals of cutting mechanics, kinematics, constructional features and selection criterion for various basic machine tools and automates with some basic exposure to conventional work holding devices and cutting tools and tool holders used on the same machines. Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Describe mechanics of cutting, calculate cutting parameters &its effects
CO-2	Demonstrate working of basic machine tools with kinematics.
CO-3	Select appropriate grinding processes, grinding machine, grinding wheels.
C0-4	Select tool and tool holder.
CO-5	Identify the machine tool, able to operate machine tool and select cutting parameters for given job.
CO-6	Produce the job as per given manufacturing drawing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25*	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken

during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Preparatory Activity:** **a.** For given work piece and tool material; select, set and observe cutting speed, feed and depth of cut on lathe machine. Also define these terms. **b.** Calculate metal removal rate (MRR) for above case. **c.** Calculate revolution per minute (RPM) for lathe, milling cutter and drill spindle based on given data.	1	04
2	**Effect of Various Input Variables on Output variables during machining processes:** Demonstrate type of chips, surface finishes and tool life for varying cutting parameters for different work piece material and tool material. Tabulate the observations.	1	02
3	**Turning Job:** Prepare a job on center lathe as per the given drawing. (Including plain turning, step turning, taper turning, threading, knurling, grooving, Etc.) Student will also prepare report including: **a.** Drawing of the job. **b.** Operation sequences including details of cutting parameters used. **c.** Sketch of cutting tools used. **d.** Specification of machines used.	2	08
4	**Milling Job:** Prepare a simple job using milling operations including use of indexing head (Excluding gear tooth cutting). Student will also prepare report including: **a.** Drawing of the job(like hexagon, pentagon) **b.** Operation sequences including details of cutting parameters used. **c.** Specification of machines used. **d.** Machine settings for indexing.	4	06
5	**Shaping and Drilling Job:** Prepare a job having plain surfaces on shaping machine with minimum two holes as per given drawing. Student will also prepare report including: **a.** Drawing of the job. (may use same job of Milling Job) **b.** Operation sequences including details of cutting parameters used. **c.** Specification of machines used.	3 & 5	04

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	**Grinding Process** Prepare a job on Grinding machine (surface or cylindrical) as per the given drawing. (Suggestion: use same job as prepared in 3&4 for grinding operation of flat and cylindrical surface). Student will also prepare report including: **a.** Drawing of the job. **b.** Specification of machines used. **c.** Grinding wheel used.	7	02
7	**Industrial Visit:** Visit a nearby machine shop and prepare a two page report comprises of list of machine tools including automates, its technical specification, machining parameters for various operations being performed, cutting tools and work holding devices used, observation of skill and safety criteria.	All	00
8	**Mini Project and Presentation:** For a given product (different for each student) prepare complete report in suggested format including selection of raw material type & section, sequence of various Machining operations, selection of machine, machining parameters, work holding device, tool , etc. For each machining operation. Each student will also present the outcome.	All	02
		Total	**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. Care must be taken in assigning and assessing study report as it is a Second-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify machine tools & their equipment's (Knowledge)	10
2	Able to operate, set the machine and select machining parameters. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No	Equipment Name with Broad Specifications	PrO. No.
1.	Hacksaw machine.	2 to 5
2.	Lathe with standard and special accessories.	2
3.	Milling machines-Vertical /horizontal with standard accessories and indexing/dividing head.	3
4.	Column drilling or Radial Drilling machine	4
5.	Shaper machine.	5
6.	Tool and cutter grinder	2 to 5
7.	HSS cutting tool and their tool holders	2 to 5
8.	Carbide inserts and their tool holders	6
9.	Drill bit and their tool holder	4
10.	Surface grinding machine	7
11.	Cylindrical grinding machine	7

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-I **Introduction and mechanics of cutting**	1a. Explain mechanics of cutting.	1.1 Introduction of Machining Process used in industries & Safety 1.2 Mechanics of cutting action 1.3 Forces acting on tool and chip, tool dynamometer 1.4 Orthogonal and oblique cutting. (Without derivation).
	1b. Explain the effect of varying cutting parameters.	1.5 Chip formation, types of chips. 1.6 Concept cutting parameter

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		1.7 Effect of cutting parameters on surface finish, tool life, economy, and mass production. 1.8 Cutting fluid- Properties, application
Unit-II **Basic machine tools Lathe Machine**	2a. Explain classification, working principles, construction and operation of lathe 2b. Describe mechanism & motion transmission in lathe. 2c. Explain work holding& Tool holding devices for lathe	2.1 Define and classify basic machine tools. 2.2 Lathe machine. i. Working principle (using block diagram). ii. Detailed specifications. 2.3 All geared head stock center lathe. i. Constructional features. ii. constructional sketch, working, and application iii. Operations performed. iv. Work holding devices- (3 jaw chuck, 4 jaw chuck, face plate, centers). v. Thread cutting setting-concept methods and simple numerical. vi. Tapper turning Method 2.4 Metal removal rate (MRR) – concept and method to calculate on lathe.
Unit-III **Basic machine tools Milling Machine**	3a. Explain classification, working principles, construction and operation of milling machine. 3b. Describe mechanism & motion transmission in milling machine. 3c. Select appropriate Milling cutter for required milling operation.	3.1 Milling machine. i. Types.(Horizontal/Vertical) ii. Working principle (using block diagram). iii. Detailed sample specifications. 3.2 Construction & Operation. i. Constructional features. ii. constructional sketch, working, and use. iii. Operations performed. iv. Up milling and down milling 3.3 Milling cutters-types and applications. 3.4 Work &tool holding devices-constructional sketch, working and applications. 3.5 Simple indexing methods with simple numerical.
Unit-VI **Basic machine tools Drilling Machine**	4a. Explain classification, working principles, construction and operation of drilling machines.	4.1 Drilling machine. i. Types. ii. Working principle (using block diagram). iii. Detailed specifications.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	4b. Select work & Tool holding devices for drilling machines.	4.2 Radial drilling machining. i. Constructional features. ii. Operations performed. iii. Work holding devices- constructional sketch, working and application iv. Tool holding and setting methods. 4.3 Metal removal rate (MRR) – concept and method to calculate on drilling machine.
Unit-V **Basic machine tools Shaper**	5a. Explain types, working principles, construction and operations of shaping, Select work & Tool holding devices for shaping	5.1 Shaping machine i. Working principle (using block diagram). ii. Constructional features and detailed specifications. iii. Quick return mechanisms- kinematic sketch, working and advantages. iv. Operations performed. v. Work holding & tool holding devices.
Unit-VI **Cutting tools and tool holders**	6.a Select cutting tool material 6.b Select cutting tool for different operation to perform 6.c Interpret carbide insert and tool holder designation system. 6.d Explain tool angles of cutting tools and their importance. 6.e Explain factors affecting tool life.	6.1 Various cutting tool materials, their compositions and properties. 6.2 Cutting tools and its types. i. Various types Single point cutting tool. ii. Plain milling cutter. iii. Side and face milling cutter. iv. Twist drill. 6.3 Carbide inserts: i. Types of carbide Inserts ii. Needs and benefits of carbide inserts iii. ISO designation of carbide inserts iv. Mounting and replacement methods of carbide insert. 6.4 Tool Nomenclature and tool geometry i. Single point cutting tool ii. Plain milling cutter iii.Twist drill 6.5 Tool life, Tool wear and Machinability i. Definition ii. Methods for calculation with example
Unit-VII **Grinding processes.**	7.a Explain grinding process and its type 7.b Describe constructional features and working of various grinding machines 7.c Select appropriate finishing operation and grinding machine as per production drawing of the component.	7.1 Describe grinding Process i. Definition ii. Basic Working Principle 7.2 Grinding Machine i. Classification and construction of grinding Machines (Surface, cylindrical, Centre less, tool & cutter grinding machine) ii. Basic Detail specification iii. Grinding Operations

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	7.d Select proper grinding wheels for various grinding process	7.3 Honing, lapping and super finishing process i. Constructional & Working Principle ii. Difference between honing, lapping and super finishing 7.4 Grinding wheel i. Abrasive grain ii. Bonding material iii. Nomenclature of grinding wheel iv. Selection and application of grinding wheel 7.5 Terms Associated with grinding wheel i. Loading, Glazing, Trueing, Dressing ii. Self-sharpening action of grinding wheel

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction and mechanics of cutting	**4**	**3**	**3**	**2**	**8**
2	Basic machine tools-Lathe Machine	**8**	**3**	**4**	**7**	**14**
3	Basic machine tools- Milling Machine	**8**	**3**	**3**	**6**	**12**
4	Basic machine tools-Drilling Machine	**4**	**2**	**2**	**4**	**8**
5	Basic machine tools-Shaper	**6**	**2**	**3**	**3**	**8**
6	Cutting tools and tool holders	**6**	**2**	**5**	**3**	**10**
7	Grinding processes	**6**	**2**	**3**	**5**	**10**
Total		**42**	**17**	**23**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Select two industrial components (approved by teacher) and list various machine tools and operations used to produce these components.
b) Prepare a list of surrounded items which are prepared by machining processes.
c) Collect/download at least four different machine tool catalogues and make report of that with price.
d) List various machine tools (min. 5 machine) currently using in market for different operation to perform.
e) Identify the process use for re-sharpening different types of tools and prepare report for minimum 3 tools

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) To acquire knowledge of basic machine, tool and their operation arrange two or more **industrial visit** of production industry. After visit student must be submit their industrial visit report.
c) Guide student(s) in undertaking micro-projects.
d) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
e) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
f) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a small useful product like various machining parts assembly/v-block/ cutting tools/work holding devices/small laboratory equipment/set-up utilizing laboratory resources.
b) Using Drafting software, prepare machining products drawing with tolerances, quality measure.
c) Survey/Visit nearby vendor lathe, drilling, milling and shaper etc. machining process and prepare report on products manufacture.
d) Maintenance of available infrastructure related to.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Machining and Machine Tools	A.B. Chattopadhyay	Wiley
2	Fundamentals of Machining Processes	Hassan Abdel-Gawad El-Hofy	CRC Press ISBN-13978-0849372889
3	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Company(P) Limited
4	Production Technology (Manufacturing Process)	Dr. P C Sharma	S Chand
5	All about Machine Tools	HEINRICH GERLING	New Age International Private Limited
6	Production Technology	R. K. Jain and S. C. Gupta	Khanna Publishers
7	Elements of Workshop Technology Volume No. II Machine Tools	Hajra Choudhary, Bose S. K., Roy Nirjhar	Media promotors and publishers pvt. Limited
8	Production Technology	HMT	Tata Mcgraw-Hill Publishing Co.

14. SOFTWARE/LEARNING WEBSITES

i. http://nptel.iitm.ac.in/video.php?subjectId=112105126 (Introduction ME-II)
ii. https://archive.nptel.ac.in/courses/112/105/112105233/ (Metal cutting)
iii. https://www.youtube.com/watch?v=wvYQdi68074 (lathe machine)
iv. http://www.youtube.com/watch?v=H0AyVUfl8-k&list=PLEFE7D1579523C45D(lathe operation)
v. http://www.youtube.com/watch?v=81Fdif5e85c (Tool geometry)
vi. http://www.youtube.com/watch?v=THVgkBnjLq0 (Milling Machine)
vii. https://www.youtube.com/watch?v=mF6G9QyNq1I (shaper Machine)
viii. https://youtu.be/Rf90Jbbcr3M (Milling Machine)
ix. https://www.youtube.com/watch?v=0BiLkExp12A (Radial Drilling Machine)
x. http://www.youtube.com/watch?v=Mn9jpqI8rao (single point cutting tool geometry)
xi. http://www.youtube.com/watch?v=XXUHZxweBcw&list=PLD07DE61CB871A0CB(milling machine)
xii. https://nptel.ac.in/courses/110106146 (Future of Manufacturing process)
xiii. https://www.youtube.com/watch?v=gcWj4OcteTk (surface grinding)
xiv. https://nptel.ac.in/courses/112103250 (Abrasive machining)
xv. https://www.youtube.com/watch?v=IXYZLxNd-a8 (centre less grinding)
xvi. https://www.youtube.com/watch?v=GNLQ81WOytU (Grinding wheel)
xvii. https://www.youtube.com/watch?v=Fc_zbYeXAlU (Cylindrical grinding)

15. PO-COMPETENCY-CO MAPPING

Semester III	Manufacturing Engineering Processes-II (3336502)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long Learning
Competency	**Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**						
CO 1. Describe mechanics of cutting, calculate cutting parameters &its effects	**3**	**2**	**2**	--	--	--	--
CO 2. Demonstrate working of basic machine tools with kinematics.	**3**	--	--	**2**	--	--	--
CO 3. Select appropriate grinding processes, grinding machine, grinding wheels.	**3**	--	--	**3**	--	--	--
CO 4. Select tool and tool holder.	**3**	--	--	**2**	--	--	**2**
CO 5. Identify the machine tool, able to operate and select cutting parameters for given job.	**3**	**2**	**2**	**2**	--	--	**3**
CO 6. Make the job as per given manufacturing drawing.	**3**	--	--	**3**	**2**	**2**	**3**

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
1.	S. M. Tank, Lecturer in Mechanical Engineering.	RCTI, AHMEDABAD	9825631840	Suresh.a1987@gmail.com
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BOS Resource Persons

Sr. No.	Name and Designation	Department	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Computer Programming for Mechanical Engineering
(Course Code: 1336503)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	3rdSemester

1. **RATIONALE**

This course intends to develop programming skills in the students, using a popular structured programming language `C'. The students will learn step by step procedure (i.e. Flowchart & Algorithm) of any program development process. The programming skills thus acquired using `C' language can be used for acquiring necessary programming skill to work with advance level programming languages which in turn will be helping in developing programs for the scientific, research and business purposes.

2. **COMPETENCY**

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences.

- Develop structured, modular and memory efficient programs in 'C'.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Develop flowchart and algorithm for the solution of assigned problems.
b) Interpret the basic principles and the general structure of C Programming.
c) Develop C Programs using operators and decision statements.
d) Develop C Programs using control structures.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (CI+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
CI	T	P	C	CA	ESE	CA	ESE	
0	0	2	1	0	0	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate the attainment of COs holistically, as there is no theory ESE.

*Legends: **CI**– Classroom Instructions; **T** – Tutorial/Teacher Guided Theory Practice;*
***P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs.*Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
1	Develop flowchart and algorithm for thesolution of assigned problems.	02
2	Study the general structure of C Program and develop a C program to print your name, address and contact details.	04
3	DevelopC Programs to define, change and print different types of variables and constants	04
4	Develop C Programs to perform operations on value using different operators	04
5	Develop C Programs to perform actions using If-Else and Switch statements	04
6	Develop C Programs to perform actions using While loop	04
7	Develop C Programs to perform actions using For loop	04
8	Develop C Programs to define, change and print arrays	02
	Total	28

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Correctness of algorithm/program	30
2	Readability and documentation of the algorithm/flowchart of input and output displayed (messaging and formatting)	10
3	Code efficiency	20
4	Debugging ability	20
5	Program execution/answer to sample questions	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer with basic configuration with Windows OS or Unix OS	All
2	Software tool: C Compiler	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Follow safety practices.
b) Maintain tools and equipment.
c) Work as a leader/a team member.
d) Follow ethical practices.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare small reports (of 1 to 5 pages for each activity). For micro project report should be as per suggested format, for other activities students and teachers together can decide the format of the report. Students should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) Undertake micro-projects in teams.
b) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning.
c) Undertake a market survey of different industry suited programming languages.
d) Website, https://www.codechef.com/learn/c, contains elementary programs. Students are expected to solve those programs.

9. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) Practice, practice and practice - expose students to wide range of problems
d) Diagnosing Essential Missed Learning concepts that will help for students.
e) Guide Students to do Personalized learning so that students can understand the course material at his or her pace.
f) Encourage students to do Group learning by sharing so that teaching can easily be enhanced.
g) With respect to ***Section No. 9***, course teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
h) Guide students on how to address issues on environment and sustainability using the knowledge of this course.

10. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total work load on each student due to the micro-project should be about ***16 (sixteen) student engagement hours*** (i.e., about one hour per week) during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Develop a menu driven C program to perform basic arithmetic operations/mathematical operations like calculators on user input data.
b) Develop a C program for currency conversion.
c) Develop a C program for record keeping of student database.
d) Develop a C program to display a minimum number of currency notes required based on the entered amount. Output will also display the total number of notes required for each currency note. Valid currency notes are 1, 2, 5, 10, 20, 50, 100, 200, 500. E.g. if the user enters 140 then the output will be “3 currency notes are required. 1*100 + 2*20 = 140”.
e) Develop a C program to generate result for student. User enters component wise marks for each subject. After entering the marks, students will know his/her SPI as well as total backlogs.

11. SUGGESTED LEARNING RESOURCES

Sr.No.	Title of Book	Author	Publication
1	Programming in ANSI C	Balaguruswami E.	McGrawHill Education, Latest Edition
2	Programming withANSI and Turbo C	Kamthane Ashok N.	Pearson Education, LatestEdition
3	Let us 'C'	KanetkarYashavant	BPB Publications, Latest Edition

12. SUGGESTED LEARNING WEBSITES

a) https://www.w3schools.com/c/index.php
b) https://www.programiz.com/c-programming
c) https://www.codechef.com/learn/c
d) https://swayam.gov.in/

13. PO-COMPETENCY-CO MAPPING

Semester IV	Computer Programming For Mechanical Engineering (Course Code: 1336503)						
	POs and PSOs						
Competency & Course Outcomes	PO 1 Basic & Discipline Specific Knowledge	PO 2 Problem Analysis	PO 3 Design/ Development of Solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering Practicesfor Society, Sustainability & Environmen	PO 6 Project Management	PO 7 Life-long Learning
Competency **Develop structured, modular and memory efficient programs in 'C'.**							
Course Outcomes							
a) Develop flowchart and algorithm for the solution of assigned problems.	2	2	2	-	-	-	2
b) Interpret the basic principles and the general structure of C Programming.	2	-	-	-	-	-	2

c) Develop C Programs usingoperators and decisionstatements.	-	3	3	3	-	-	2
d) Develop C Programs using control structures.	-	3	3	3	-	-	2

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

14. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. HamirSapramer, HOD Mechanical	Government Polytechnic, Rajkot	9426587197	merhamir@yahoo.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester-III

Course Title: Mechanical Maintenance and Safety

(Course Code: 1336504)

Diploma Programs in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	3rd Semester

1. RATIONALE

In industries, the mechanical engineers/CNC machine operators and supervisors are supposed to manage functioning of equipments/CNC machines. With proper planning, operation and adaption of maintenance schedule, one can manage to run the machines continuesly with good efficiency.

The objective of Mechanical maintenance is **to achieve minimum breakdown and to keep the machine shop in good working condition at the lowest possible cost**. Machines and other facilities should be kept in such a condition which permits them to be used at their optimum (profit making) capacity without any interruption or hindrance. Students need to know about the combination of maintenance with safe conditions for better performance simultaneously. Students must be able to recognize the possible hazards and adverse effects while working for the maintenace work at shopfloor and working sites.

2. EXPECTED COMPETENCY

The importance of this course is closely related to the ability of the student to understand and analyse to find problem solutions for detected faults for shopfloor machines & all kind of CNC apparatus along with automation processes.

The course content should be taught and implemented with the aim to inculcate the safety practice while working on the machines and different types of skills so that students are able to acquire the following competency:

“Use ethics of assembly / dis-assembly in maintenance of various mechanisms, machines, and equipment with safety aspects”

3. COURSE OUTCOMES (COs)

The practical exercises, the relevant skills associated with this competency are to be developed in the student to satisfy the following COs:

a) Understand different types unit systems and types of toolings prevailing in the market.

b) Understand ethics of dismentaling and assembling the job with proper usage of tools for different machines and mechanisms
c) Justify the role of maintenance in engineering along with selection of suitable maintenance procedures.
d) Recognise the concept of safety for possible threats/hazards while working

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CA	ESE	CA	50
0	0	2	1	0	0	25	25	

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, PA - Progressive Assessment; ESE - End Semester Examination.

5. SUGGESTED LIST OF EXERCISES/PRACTICALS

Sr No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. Required
1	**Preparatory Activity:** A. Interpret and write various types of units (i.e.,Foot/Pound/Second (FPS) system prevails in the most of the industries till today. So compare it with MKS and SI units and their conversions by table. Also comopare the types of threads i.e., Metrics Vs BSW/BSP) B. Demonstration and report writing of various types of tools (Spanners, allen keys, pliers, Taps & wrenches to get internal small threadings, dies and die holders to get threads on pipes, bearing pullers, flaring tool kit for tubing operations in ACs, Water coolers and Refrigerators …etc,). C. Report writing regarding gauges which are used for pipes, wires, metal sheets etc., along with their impact on cost. Also get list of commercial lubricants and the meanings of their properties to get proper selection	06
2	**Study the types of CNC Manchines and their maintenance**	02

3	**To study and perform the Maintenance of Mechanical Based Equipment/Device/Machine:** Overhauling/Servicing of following are to be done and make the report along with snapshots of students while on the work of that **(Approx. 4-5 students in each group)** 1. Head stock /Tail stock /Carriage of lathe 2. Indexing head/Milling table mechanism / True Chuck 3. Water cooler / Window AC/ Split Ac / Refrigerator of the institute 4. Shutter/Gates / R O system / any other similar auxiliary of the institute	04
4	**To study Fault Tracing and Decision Tree and preparation of detail report:** Develop decision tree to locate/identify the possible fault for following items 1. If your petrol two wheeler vehicle doesn't start 2. If your domestic fluid/water pump doesn't work effectively 3. Jaw of the chuck doesn't rotate 4 Indexing mechanism of milling machine doesn't work properly and get stuck	04
5	**Prepare report on Preventive and periodic Maintenance for any workshops/plants:** (**Approx. 4-5 students in each group)** Collect and Prepare a preventive and periodic maintenance schedule of any institute/nearby workshop having- full fledge machines and mechanisms ie., near by Machine shop.	02
6	**Prepare a report on recognition of threats at work place with sign boards/safety symbols along with causes of Accidents** Causes of Accident Enlist / Designate the neccesary safety symbols required to create awareness among the industrial workers by using sign boards Prepare and display different posters/sign boards for safety symbols (Attach group photo with posters/ banner in the report)	02
7	**Study the report on requirement and usage of safety equipments to prevent any hazards or accident :** i.e., safety helmets, gloves, eye protection/high-visibility goggles, safe clothing**,** safe footwear, and respiratory protective equipment (RPE).	02
8	**Study the impact of cost/time for various assembly methods** (i.e different ways of assembly / dis assembly methods)	02

9	**Mini Project And Presentation** a. Identify mechanical based any one equipment /device / machine at institute level which requires maintenance. b. Prepare general sketch. c. Perform fault tracing and prepare the decision tree. d. Dismantle the job. Write the sequence of dismantling. Also describe the steps. List the tools used for this activity. e. Attend necessary maintenance tasks. Write the tasks performed. f. Assemble, test and if necessary, modify. Write the steps. g. Prepare power point presentation. Presentation for the project. This must include photographs / movies of group while working on project.	04
10	**Industrial visit** Visit of any work unit/workshop where Errectioning, testing, commissioning and installation of CNC machines and other automation instruments can be seen and understood easily OR Visit at any kind of work unit/ workshop where multi tasking assembling and dis assembling can be seen and understood easily.	
	Total Hours	28

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

'Well Equipped machine shop and workshop will be sufficient for demonstration/study type work'

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfill the development of this course competency.

a) Follow ethical practices.

b) Work as a team leader/a team member.

c) Fault finding and ability to resolve it.

8 SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, the following are the suggested student-related ***co-curricular*** activities that can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct the following activities in a group and prepare reports of each activity. They should also collect/record physical evidence for their (student's) portfolio which will be useful for their placement interviews:

a) Charts can be prepared.

b) A short report on any topic given by concerned faculty

c) Small groups of students can be formed for assigned work. Assigned work should be such that it encompasses market survey, Model making, Powerpoint presentation, time management... etc.

9. PO - COMPETENCY - CO MAPPING

Semester III	PLANT MAINTENANCE AND SAFETY						
	POs						
Competency & Course Outcomes -Cos (concerned Units)	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Understand different types unit systems and types of toolings prevailing in the market.	3	1		3			2
Understand ethics of dismentaling and assembling the job with proper usage of tools for different machines and mechanisms	3			2	1	2	2
Justify the role of maintenance in engineering along with selection of suitable maintenance procedures	3	1			1	1	2
Recognise the concept of safety for possible threats /hazards while working relevant safety.	3		2		2	1	3

10. SUPPORT LINKS :

PRACTICAL 1

https://www.amazon.in/Spanners-Wrenches-50-Off-or-more/s?rh=n%3A7355682031%2Cp_n_pct-off-with-tax%3A2665401031
https://www.amazon.in/Abn-Flaring-Tool-Set-Swaging/dp/B07DDPX3RD

https://www.google.com/search?q=sheets/pipes+gauge&rlz=1C1CAFB_enIN861IN861&hl=en-GB&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiJr7Wyxa38AhWjxjgGHUzbCG0Q_AUoAnoECAEQBA&biw=1366&bih=568&dpr=1cold
cold

https://www.google.com/search?q=types+of+lubricants+and+designations&tbm=isch&ved=2ahUKEwiB6KW2xa38AhXHiNgFHQVtCOwQ2-cCegQIABAA&oq=types+of+lubricants+and+designations&gs_lcp=CgNpbWcQDDoICAAQgAQQsQM6CwgAEIAEELEDEIMBOgUIABCABDoECAAQQzoGCAAQBRAeOgQIABAeOgcIABCABBAYUMcNWKFcYJh1aABwAHgAgAGRAogBiTOSAQYwLjMzLjSYAQCgAQGqAQtnd3Mtd2l6LWltZ8ABAQ&sclient=img&ei=4j61Y4HvFceR4t4Phdqh4A4&bih=568&biw=1366&rlz=1C1CAFB_enIN861IN861&hl=en-GB#imgrc=Prv2OYwFhpDDFM

PRACTICAL 6

https://www.google.com/search?q=RECOGNITION+OF+THREATS+WHILE+WORKING+AT+MANUFACTURING+UNIT+%2FPLANT+&tbm=isch&ved=2ahUKEwjQ9e7R3q38AhUdi9gFHQjTDdcQ2-cCegQIABAA&oq=RECOGNITION+OF+THREATS+WHILE+WORKING+AT+MANUFACTURING+UNIT+%2FPLANT+&gs_lcp=CgNpbWcQDDoICAAQgAQQsQM6BAgAEEM6CAgAELEDEIMBOgUIABCABDoLCAAQgAQQsQMQgwE6BAgAEAM6CQgAEIAEEAoQGDoHCAAQgAQQGDoGCAAQCBAeUK0NWLjqAWDO_QFoBXAAeACAAYACiAGMZJIBBjAuNjQuOJgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=U1m1Y5CABJ2W4t4PiKa3uA0&bih=568&biw=1366&rlz=1C1CAFB_enIN861IN861&hl=en-GB

PRACTICAL 7

https://www.google.com/search?q=REQUIREMENT+AND+USAGE+OF+SAFETY+INSTRUMENTS+&tbm=isch&ved=2ahUKEwjH9J_Z4K38AhXbkdgFHatdBRoQ2-cCegQIABAA&oq=REQUIREMENT+AND+USAGE+OF+SAFETY+INSTRUMENTS+&gs_lcp=CgNpbWcQDDoGCAAQBRAeOgYIABAIEB46BggAEAcQHjoECAAQQzoICAAQgAQQsQM6CAgAELEDEIMBOgUIABCABDoHCAAQsQMQQzoLCAAQgAQQsQMQgwE6CQgAEIAEEAoQGDoHCAAQgAQQGFAAWLdqYO6IAWgAcAB4AoAB5AKIAapNkgEIMS40My45LjGYAQCgAQGqAQtnd3Mtd2l6LWltZ7ABAMABAQ&sclient=img&ei=e1u1Y4fLGduj4t4Pq7uV0AE&bih=568&biw=1366&rlz=1C1CAFB_enIN861IN861&hl=en-GB

PRACTICAL 8
https://www.highlandmachine.com/assembly-options-cost-savings/

11. Study Resourses :

Book name	Auther	Publication
Plant equipment and maintenance engineering handbook 1st Edition	Duncan C, Rechardson PE	**Publication Date & Copyright:** 2014 McGraw-Hill Education
Industrial maintenanace management	S K Srivastava	S chand & co
Process equipment malfunctions : Techniques to identify plant problems	Norman P. Lieberman	**Publication Date & Copyright:** 2011 McGraw-Hill Companies, Inc.
Machine Tools (specifucation, Purchase & Installation)	Russel Gamblin	**McGrow-Hill Education ISBN: 978-0-07-181223-8**

12. COURSE CURRICUM DEVELOPMENT COMMITTEE

Sr No	Name and Designation	Institute	Contact No.	Email
1	Prof. G R Khunt Sr.Lecturer in Mech Engg.	R. C. Technical Institute Sola, Ahmedabad.	8128291616	grkhunt@gmail.com
2	Prof. R A Prajapati Lect. in Mech Engg.	Government Polytechnic, Ahmedabad	9429435748	raprajapati27@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Summer Internship-I
(Course Code: 4330001)

Diploma programme in which this course is offered	Semester in which offered
All Branches of Diploma Engineering(Except Automobile, Bio Medical, ICT, Power)	Third

1. RATIONALE

Idea of Embedded Internships- AICTE has made 7-10 weeks summer internships mandatory in the new curriculum which will equip the students with practical understanding and training about industry practices in a suitable industry or organization. To make education holistic, sports, physical activities, values and ethics have been embedded in the curriculum.

We must agree that all Branches of Diploma Engineering are changing rapidly. New technologies are adding fast which effects can be seen in our society. Summer internship is a good option by which students to get flavor of such emerging technology and familiar with industry environment to identify scope and focus of their career development opportunities. Main objective of summer internship is hand-on practice to expose students for thinking about professional career by observing, understanding working mechanism of ongoing work of industry and to obtain various types of skills throughout internship program.

This two week mandatory internship is to equip the students with practical knowledge and provide them exposure to real time industrial environments. Further, in these internships, the option is provided to do internship in Government Agencies/ skill centers/ social sector/ Govt. initiated social schemes/ NGOs etc. The duration of internship will be two weeks. It will be after completion of 2nd Semester and before the commencement of Semester 3rd. Any options from following can be chosen by the students:

1. **Offline internship in industry** - Student is supposed to produce joining letter for starting and relieving letter once the internship is over in case of Offline internship in any industry.
2. **Online internships –** Student can select from any of approved /supported / recommended by the All India Council of Technical education for Internship (like Internshala/ NEAT/ Gujarat Knowledge Society Initiative etc.) or Approved by the state government or University approved
3. **A Mini Project** - On some suitable topic related to respective branch. It can be small fabrication / experimental results/ simulations/ Application development / Design and / or Analysis of System(s) etc. depending on the branch of the student. Preferably a single student should carry out a mini-project.

2. COMPETENCY

The purpose of this course is to help the student to attain flavor of the following industry identified competency through summer internship experiences:

- **Develop multiple types of skills such as planning, communication, collaboration, decision making / Problem solving and management skills along with selected technical knowledge.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Learn and adopt the engineer's role and responsibilities with ethics.
b) Get exposure to the industrial environment for professional activities.
c) Get possible opportunities to learn, understand and sharpen the technical skills required for technical advancement.
d) Develop managerial skills required for professional career.
e) Attain skill for writing technical report and prepare poster for presentation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	0	1	0	0	25	25	50

1. **Offline internship in industry:** CA will be carried out based on submitted progress card by Industry resource person and ESE / Assessment will be carried out by institute resources person.
2. **Online internships:** CA will be carried out based on submitted certificate and ESE/ Assessment will be carried out by institute resources person.
3. **A Mini Project:** CA will be carried out based on project work by institute resources person.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

List of Documents to be prepared for Submission:

- Detail report duly signed and approved by the internal/external mentor
- Presentation softcopy approved by the internal/external mentor
- Poster of summer internship activities approved by the internal/external mentor.

Sample forms for Registration and Evaluation of Summer Internship-I –SI-I are given below:

1) Both forms are mandatory to be filled at the commencement and completion of SI respectively.
2) It is mandatory to file and map SI-I Registration and Evaluation with respective forms of SI-II (Later in Semester 5) so that students get enough exposure of industry / technology. (Mapping doesn't mean same industry/ company/ project-it can be independent/ different also.)
3) Mapping will be done to ease CA and ESE Evaluations.
4) A Seminar / Webinar can be arranged so that students coming from different industry / institute / project background can share experiences and learnings to their peers / all students of the same department.
5) Attached formats for Registration, Completion and Evaluation are suggestive. But, adhering to these formats is anticipated.

Summer Internship-I Registration Form

Note: Students needs to submit this registration form after finalizing mode of internship.

Student Details												
Enrollment Number												
Student Name												
Student Details	Mobile Number :											
	Email Address:											
Branch												
Code of the Institute	Name of the Institute											
Mentor Details (Institute)	Name:											
	Designation:											
	Mobile No:											
	Email Address:											
Industry Details	Name:											
	Address:											
	Email:											
	Phone:											
	Website:											
Mentor Details (Industry)	Name:											
	Designation:											
	Mobile No:											
	Email Address											
Mode of Internship Carried Out	Online / Offline/ Mini Project											
Title of the Project/ Internship carried out												
Nature of Work Carried Out	Web Design / Application development (Web / Mobile), Experimental results/ simulations/ Analysis of System(s) etc… Other please Specify_____											

Student Signature Faculty Signature

Summer Internship-I -Suggested Letter for Completion

[Company or Institute letter head]

No: Date

TO WHOM SO EVER IT MAY CONCERN

This is to certify that, Mr. /Mrs._____

Enrollment No._____ Student of_____

Has successfully completed a two week Internship in the field of_____

From the date:_____ to date:_____.

[90% Attendance is mandatory for completion of Internship]

During the period of his/her summer internship program with us, He / She were exposed to following different processes and were found sincere and hardworking.

1. _____

2. _____

3. _____

4._____

Mentor Signature **Head of Department**

Stamp Stamp

Summer Internship-I -Evaluation Rubrics for Institute

Evaluation Rubrics (Institute)

Enrollment No: _____ Branch: _____

Name of the Students: _____

Date of Evaluation: _____

Internal Evaluation – 25 Marks PA(I) **(To be carried out by the mentor in consultation with Industry) Minimum Passing Marks: 13**					
Parameter	**Excellent**	**Good**	**Average**	**Not up the level of Satisfaction**	**Obtained Marks**
Mark range	**4-5**	**3-4**	**2-3**	**Below 2**	
Knowledge acquisition in specific domain. **5 marks**					
Skill and attitude attainment in specific domain. **5 marks**					
Feedback and suggestions given are incorporated? **5 marks**					
Quality of the prepared report and poster. **5 marks**					
Quality of the presentation. **5 marks**					
Total Marks Obtained Out of 25 PA(I)					

Signature: _____ Institute Resource Examiner Name: _____

Suggested Evaluation Rubrics for Industry

Evaluation Rubrics (Industry)

Enrollment No: _____ Branch: _____

Name of the Students: _____

Date of Evaluation: _____

External Evaluation – 25 Marks ESE(V) **(To be carried out by the Industry Supervisor) Minimum Passing Marks: 13**					
Parameter	**Excellent**	**Good**	**Average**	**Not up the level of Satisfaction**	Obtained Marks
Mark range	**4-5**	**3-4**	**2-3**	**Below 2**	
Student regularity during the Internship period and proactive ness/responsiveness towards the given tasks (**5 Marks)**					
Work Plan, Execution and quality of work in forms of Outcome achieved (**5 Marks)**					
Engineering Tools and Techniques (**5 Marks)**					
Quality of poster design and presentation (**5 Marks)**					
Quality of the report and Skill **(5 Marks)**					
Total Marks Obtained Out of 25 ESE(V)					

Signature: _____ Industry resource/ Examiner Name: _____

Common Note:

1) For Summer Internship / Projects / Seminar etc. Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc. The internal / external assessment is based on the student's performance in viva-voce /work record respectively.
2) In case Industry Supervisor is not available / Institute Mentor/ Faculty can fill up both.

5. AFFECTIVE DOMAIN OUTCOMES

The following affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member as role of Engineer.
b) Practice environmentally friendly methods and processes.
Follow safety precautions and ethical practices.

6. SUGGESTED STUDENT ACTIVITIES

Following are the suggested student-related curricular, **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities and prepare reports and give presentation in front of students and faculty members. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Perform various tasks given by industry resources person during offline internship.
b) Perform various tasks given during online internship.
c) Perform various task required to complete mini project work under guidance of faculty member.
d) Summer Internship program Interns are required to give a presentation before review committee consisting of a group of academic staff members.
e) The review committee gives feedback and suggests possible improvements in the work.
f) At the end of the program all the Summer Internship program Interns make a poster presentation of the work carried out. The poster presentation is open to the public. It is also evaluated by faculty members.
g) A completion certificate will be issued to all Summer Internship program Interns only after the completion of internship tenure.

7. SOFTWARE / LEARNING WEBSITES

An internship is a short term work program usually offered to students by companies and institutes who require staff for assistance at junior levels. Thus for the students undergoing internship a professional learning experience is provided to benefit them in their skills as well as career. It will brush existing skills and provide exposure to new skills. Generally it is provided ay entry level in the industry.

Here is a suggestive list for reference only.

- https://www.internshala.com
- https://swayam.gov.in
- https://nptel.ac.in/
- https://neat.aicte-india.org/
- https://www.edx.org/
- https://www.coursera.org/
- https://www.udemy.com/
- https://www.linkedIn.com
- https://www.stumags.com
- https://www.letsintern.com
- https://www.internship.com
- https://www.glassdoor.com

8. PO-COMPETENCY-CO MAPPING

Semester III	Summer Internship (Course Code:4330001)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	**Use principles of basic electronics to maintain various electronics circuits And equipment**						
CO1) Learn and adopt the engineer's role and responsibilities with ethics.	2	1	1	1	1	1	1
CO2) Get exposure to the industrial environment for professional activities.	1	1	1	1	1	1	1
CO3) Get possible opportunities to learn understand and sharpen the technical skills required for technical advancement.	2	1	2	2	1	1	1
CO4) Develop managerial skills required for professional career.	1	1	2	1	1	1	1
CO5) Attain skill for writing technical report and prepare poster for presentation.	1	1	-	1	1	1	1

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Jiger P. Acharya	GP, Ahmedabad	9429462026	jigeracharya@gmail.com
2	Alpeshkumar R. Thaker	GP, Ahmedabad	9879709675	alpeshrthaker@gmail.com
3	Umang D. Shah	GP, Ahmedabad	9427686364	umang.shah111gp@gmail

BoS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Shri U. V. Buch- BoS Member and Subject in-charge (EC)	G P Ahmedabad	9825346992	uvbuch@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Theory of Machines and Mechanisms
(Course Code: 4331901)

Diploma Programs in which this course is offered	Offered in
Mechanical Engineering, Mechatronics Engineering	Third

1. RATIONALE

No matter how computerized, remote, online, bluetoothicized, internet-based and virtualized the world becomes, Mechanisms will always be important! Modern machines (e.g. Cars, boats, aircraft, space crafts, appliances, air and water handling, machine tools, robots, etc.) are a complicated combination of structures, mechanisms and controls.

In industries, the mechanical engineers/technicians are supposed to manage functioning of equipment with proper planning, operation and maintenance of machines and equipment. Students need to know about the combination of force and movement defines power and a mechanism that **manages power to achieve the desired set of forces and movement**. A mechanism is usually a piece of a larger process, known as a mechanical system or machine. This course includes such necessary knowledge and skill and ultimately becomes key course for mechanical engineering students.

2. EXPECTED COMPETENCY

The importance of this course is closely related to the ability of the student to understand and analyze to find problem solutions for machines and automation processes.

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire the following competency: "Use principle of kinematics and dynamics in operation and maintenance of various mechanisms, machines, and equipment"

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Understand Kinematics and Dynamics of different machines and mechanisms.

b) Understand different types of Cams and their motions along with the drawing ability of Cam profiles for various motions.

c) Justify the role of Flywheel, Governor, Brakes, Bearings and Clutchesalong with selection of suitable drives in Mechanical applications.

d) Appreciate concept of balancing and vibrations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	4	70	30	25	25	150

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit,PA - Progressive Assessment; ESE - End Semester Examination.

5. SUGGESTED LIST OF EXERCISES/PRACTICALS

Sr. No.	Concerned Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. Required
1	ALL	**Preparatory Activity:** a. Interpret and write various course-relatedQuantities, SI units, and their conversions. b. Recall and write scalar and vector quantities. c. Demonstrate various mechanisms.	02
2	II	**Cam Profile:** a. Demonstrate working of any type of cam and followers. b. Prepare one sheet on construction of cam profile for given data (without offset). This should include one problem of knife-edge follower, and roller follower. c. Prepare one sheet on the construction of cam profile for given data (with offset). This should include one problem for knife-edge and another for roller follower.	04
3	III	**Demonstration of Clutches:** To demonstrate the working of plate/cone/centrifugal/diaphragm clutch.	02
4	III	**Demonstration of Brakes:** To demonstrate the working block/band/block & band/ Disc	02
5	III	**Study of Dynamometers:** To demonstrate the working of Rope Brake/Hydraulic/Eddy current dynamometer.	02
6	IV	**Demonstration of Power Transmission Systems:** a. Identify various power transmission systems by observing different machines and equipment used in the Mechanical engineering laboratory/workshop. Examples- IC Engine test rigs, Compressors, Machine tools, Elevators, etc. Sketch at least four mechanisms with labeling on each. b. Demonstrate the working of each.	02
7	V	**Demonstration of Governors:** To demonstrate the working Watt/Porter/Proell governor.	02

8	VI	**Balancing:** Prepare one sheet on balancing using graphical and analytical methods for a given data. This should include a minimum of two problems.	04
9	III, IV and V	**Tutorials:** a. Calculate at least one problem of power loss due to friction in bearings and clutches from given problems/experimental data. b. Solve at least two problems of power transmission systems by a belt drive and gear drive from given problems/ experimental data. c. Calculate and prepare at least one turning moment diagram from given problems/experimental data. d. Calculate the mass of the flywheel from given problems/ experimental data. Note: Teachers will provide the data for tutorial problems well in advance to the students. (Within two weeks of the commencement of the semester) So that the students can complete the numerical problems timely and submit the solutions simultaneously. Teachers will solve the given problem/data in the lab if needed in this duration.	02
10	ALL	**Mini Project and Presentation:** a. Compile information from the internet related to various mechanisms/elements like piston, crank, connecting rod, cam, clutch, brake, flywheel, governor, or animation of mechanism, etc. along with functions of each. b. Select any one mechanism (preferably that which is NOT part of the syllabus) from mechanical laboratory/workshop/real life. Sketch the same. Take a photograph of the same. Also, record the movie of its working. c. Prepare any simple model of a subject-related mechanism. This has to be proposed by the student/sand has to be approved by the teacher. d. Present that detail of selected simple model in abovepoint C with a PowerPoint presentation. This has to include: i. Compile and synchronize the information. ii. Explain the mechanism selected at b above. Use photographs and movie recordings. iii. Explain the working of the model prepared at cabove. iv. Photographs/movies of students working on aproject. e. Present student activities also	06

11	ALL	**Student Activities & Report presentation** a. Select any machine tool's mechanism available in the institute's workshop and perform the following activity: • Measuring dimensions of different links of a given shaper machine/any machine • Sketching • Labelling the sketch b. List the mechanisms which you are using in your day-to-day life. Sketch any three from these and explain in brief. c. Identify the type of clutches used in different automobiles and explain how it works. d. Identify the type of brakes used in different automobiles and bicycles. Explain how it works. e. Write the names of the five mechanical power transmissions you have seen in your daily life. f. Choose any vehicle and tell what kind of brakes it has and give a brief description of how it works. g. Make a note of that 'Is there "friction" in your routine?' and Justify your viewpoint.	-
		Total Hours	28

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Theory of Machine practicals need following Lab Equipment

- Cam Analysis Apparatus.
- Journal Bearing Apparatus.
- Setups to show different modes of transmissions
- Universal Governor apparatus
- Rope Brake and Dynamometer.
- Epicyclic Gear Train Apparatus.
- Working / Wooden / Thermocol Models & Mechanisms of:
    1. Kinematic links and pairs.
    2. Single slider-crank.
    3. Four bar chain.
    4. Types of cams, followers, and cam/follower arrangements.
    5. Friction bearing- all types.
    6. Dynamometers - all types.
    7. Friction clutches - all types.
    8. Friction brakes - all types.
    9. Rope/belt – All types of flat and Vs (ve).
    10. Gear trains - all types. (Simple, compound, reverted, epicyclical).
    11. Balancing machines -Revolving masses.
    12. Steam engine, Internal combustion engine.

13. Governors - all types.
14. Vibration -spring and mass model.
15. Any machine having a flywheel.

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
C) Vision of finding faults in defective machines and different modes of maintenance for shop floor.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level of Revised Bloom's taxonomy that is formulated for development of the COs and competency. If required, more such higher level could be included by the course teacher to focus on attainment of COs and competency.

Unit Nos.	Major Learning Outcomes /Unit Outcomes	Topics and Sub-topics
Unit I **Motions & Mechanisms**	1a. Define various terms related to mechanisms. 1b. Explain different Inversions of Mechanism. 1c. Explain the construction and working of various mechanisms. 1d. Understand various terms and methods related to velocity and acceleration diagrams.	1.1 Theory of machines: Introduction, need, scope and importance in design and analysis, basic terminology that has already been studied in Engineering Mechanics. 1.2 Kinematics of Machines: Definition of Kinematics, Dynamics, Statics, Kinetics, Kinematic link, Kinematic pair, and its types, constrained motion and its types, Kinematic chain and its types, Mechanism, inversion, machine, and structure. 1.3 Inversions of four-bar chain, Single Slider Crank chain and Double Slider Crank Chain. 1.4 Concept of velocity and acceleration of a point on link by relative velocity method in four-bar chain and single slider crank mechanism (without numerical).

Unit– II **Cams and Followers**	2a. Define the terms related to Cam and followers. 2b. Classify Cams and Followers. 2c. Draw cam profile as per the given problems.	2.1 Concept, definition and application of Cams and Followers. 2.2 Classification of Cams and Followers. 2.3 Different follower motions and their displacement diagrams like Uniform velocity, Simple harmonic motion (SHM), Uniform acceleration and retardation. 2.4 Drawing of a profile of radial cam with a knife-edge, roller & flat-faced follower with and without offset with reciprocating motion (Graphical method).
Unit– III **Bearings, Clutches, Brake & Dynamometer**	3a. Differentiate between uniform pressure and uniform wear theories. 3b. Explain construction and working of various thrust bearing 3c. Explain construction and working of various clutches. 3d. Calculate torque and power lost in friction in bearing & clutch. 3e. Differentiate between brake sand dynamometers. 3f. Construction and working of various brakes and dynamometers.	3.1 Concept, definition, basic terminology of friction, types and application of friction. 3.2 Uniform pressure and Uniform wear theories. 3.3 Types of thrust bearing, Torque and Power lost in i) Flat pivot, ii) Conical pivot, v) single collar v) muti-collar bearing and it's numerical. 3.4 Function of Clutch and its application, Construction and working of i) Single plate clutch, ii) multi-plate clutch, iii) Centrifugal Clutch iv) Cone clutch v) Diaphragm clutch. (Simple numerical on single and multi-plate clutch) 3.5 Function of brake and its application, Construction and working of i) block brake ii) band brake iii) Band & block brake iv) internal expanding shoe brake v) disc brake (without numerical). 3.6 Dynamometer- Function, Construction and working of i) Rope Brake, ii) Hydraulic iii) Eddy current.

Unit– IV Power Transmission	4a. Explain the need and modes of power transmission. 4b. Calculate velocity ratio, belt tensions, slip, angle of lap, and power transmitted in belt drives. 4c. Calculate the train ratio for the given gear drives. 4d. Select suitable drives for the given application withjustification.	4.1 Concept need and types of power transmission. 4.2 Types of Drives-Belt, Chain, Rope, Gear and their comparison with applications, advantages & limitations. 4.3 Flat belt, V-belt & its applications, material, angle of lap, belt length. Slip and Creep. Determination of velocity ratio, the ratio of tight side and slack side tension, centrifugal tension and initial tension, condition for maximum power transmission (Numerical on belt drives) 4.4 Rope Drives- types; application; Advantages & limitations of steel ropes 4.5 Chain Drives- Advantages & disadvantages; Selection of chain & sprocket wheels 4.6 Gear Drives- Classification of Gears - Nomenclature of a gear - explanation and applications of spur, helical and bevel gears, worm and worm wheel, rack and pinion; types of gear trains; their selection for different applications. 4.7 Train value & Speed ratio for Simple, Compound, and Riveted gear trains using spur gears (Numerical of gear drive for finding Speed ratio or Train ratio excluding epicyclic gear train).
Unit- V Flywheel and Governors	5a. Construct a Turning moment diagram. 5b. Calculate the energy fluctuation and variation in speed of the Flywheel. 5c. Demonstrate the working of different types of Governors. Differentiate the working of Flywheel and Governor.	5.1 Flywheel- Concept, function and application of flywheel with the help of turning moment diagram for Single cylinder double acting steam engine, Single cylinder 4 -Stroke I.C. Engine, Co-efficient of fluctuation of energy, Co-efficient of fluctuation of speed, Energy stored in a Flywheel and its significance. Simple numerical. 5.2 Governor- Concept, function and application & terminology of Governors. Types, Explanation of Watt, Porter, Proell. 5.3 Comparison between Flywheel and Governor.

Unit- VI Balancing and Vibrations	6a. Calculate balancing mass and its position for masses revolvingin the same plane. 6b. Identify different types of vibration, its causes and remedies.	6.1 Concepts and types of balancing. 6.2 Effects of unbalanced masses. 6.3 Balancing of single rotating mass. Analytical and graphical method for balancing of several masses revolving in the same plane. 6.4 Concept, types and terminology used in vibration, causes of vibrations in machines, their harmful effects and remedies.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hrs.	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I.	Motions & Mechanisms	9	6	8	0	14
II.	Cams and Followers	5	2	0	7	9
III.	Bearings, Clutches, Brake & Dynamometer	11	2	6	8	16
IV.	Power transmission	9	2	5	8	15
V.	Flywheel and Governors	5	2	2	4	8
VI.	Balancing and Vibrations	3	2	2	4	8
	Total	42	16	23	31	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: Above table provides general guidelines to assist students in their learning. For teachers to teach and for question paper designers/setters to formulate test items/questions to assess the attainments. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from the above table.

Recommendation / General Notes:

- If only one mid-sem test is the part of continuous evaluation system, Examiner is free to decide the topics for the exam. But it is recommended to cover atleast 65 % of the CO's / Topics in the mid test exam.
- Ask the questions from each topic as per Bloom's taxonomy weightage marks. Numerical questions are to be asked as per the instructions of the syllabus only. Optional questions must be asked from the same topic / unit with consideration of same Bloom's taxonomy's level (RUA). Each question must be mapped with their UOs (Unit Outcomes) COs (Course outcomes), and Bloom taxonomy in Mid sem exam. A sample is provided here for the convenience of the teacher.

Question No.	Questions	Marks	UOs	COs	BTL
Q-1					

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, the following are the suggested student-related ***co-curricular*** activities that can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct the following activities in a group and prepare reports of each activity. They should also collect/record physical evidence for their (student's) portfolio which will be useful for their placement interviews:

a) Charts can be prepared.
b) A short report on any topic given by concerned faculty
c) Small groups of students can be formed for assigned work. Assigned work should be such that it encompasses market survey, Model making, Powerpoint presentation, time management... etc.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

Unit	Unit Name	Strategies
I	Motions & Mechanisms	Model, Education charts & videos, and Real-life examples. Demonstration of real industrial parts used in different devices, Movies/ Animations.
II	Cam and cam profile	Demonstration of cams, Movies/Animations.
III	Bearings, Clutches, Brakes,and dynamometers	Model, Education charts & videos, and Real-life examples. Demonstration of real industrial parts used in different devices, Movies/ Animations.
IV	Power transmission	Demonstration of real industrial parts, Movies/Animations, and Models of different power transmission elements
V	Flywheel and Governors	Industrial visits, Animations/movies, Models of different types of governors.
VI	Balancing and vibrations	Industrial visits, Animations/movies.

These are sample strategies, which the teacher can use to accelerate the attainment of thevarious outcomes in this course:
Massive open online courses (MOOCs) may be used to teach various topics/sub topics
Guide the student(s) in undertaking mini-projects.

12. SUGGESTED LEARNING RESOURCES

Sr. No.	Author	Title of Books	Publication
1.	Jagdish Lal	Theory of Machines	Metropolitan book New Delhi.
2.	Abdulla Shariff	Theory of Machines	Dhanpatray and Sons, New Delhi
3.	S S Ratan	Theory of Machines	Tata McGraw Hill New Delhi
4	A Ghosh & A K Malik	Theory of Machines	East-West Press (Pvt) Ltd. New Delhi
5.	Thomas Bevan	Theory of Machines	C S B Publishers and distributors
6.	Joseph Edward Shigley	Theory of Machines	McGraw Hill
7.	P L Bellaney	Theory of Machines	Khanna Publications, New Delhi
8.	Sadhu Singh	Theory of Machines	Pearson Education, India
9.	R S Khurmi & J K Gupta	Theory of Machines	S Chand, New Delhi
10.	Gordon R. Pennock & Joseph E. Shigley John J. Uicker	Theory of Machine and Mechanisms	Oxford University Press
11.	Dr. V. P. Singh	Theory of Machines	Dhanpat Rai Publishing Co Pvt Ltd

13. LIST OF SOFTWARE/LEARNING WEBSITES

- https://nptel.ac.in/courses/112106270
- https://nptel.ac.in/courses/112104121
- https://nptel.ac.in/courses/112103108
- https://youtu.be/ASIl3HWTT4U
- https://youtu.be/MAuVDB-G-HQ
- https://youtu.be/ApuBEn2zct8
- https://youtu.be/SJGFX1Nub1A
- https://youtu.be/devo3kdSPQY
- https://youtu.be/HY_PjmHRxuE
- https://youtu.be/6DL0j0eKD8Y
- https://youtu.be/lqo0_StXf4M
- https://youtu.be/m4UmBbS7mfI
- https://youtu.be/uwZGtFRtGoU
- https://youtu.be/zDRc01bD6a8
- https://youtu.be/uW1CvgfJuEg
- https://youtu.be/Ibs10c9FX0M
- https://youtu.be/j6woGQdUPFs
- https://youtu.be/u5nwkm5IbqY
- https://youtu.be/LmYhzHnMH9o

14. PO - COMPETENCY - CO MAPPING

Semester III	THEORY OF MACHINES & MECHANISMS						
	POs						
Competency & Course Outcomes -Cos (concerned Units)	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Understand Kinematics and Dynamics of different machines and mechanisms. (Unit No I)	3	1				1	2
Understand different types of Cams and their motions along with the drawing ability of Cam profiles for various motions. (Unit No II)	3	3				1	3
Justify the role of Flywheel, Governor, Brakes, Bearings and Clutches along with selection of suitable drives in Mechanical applications. (Unit No III, IV & V)	3	3		2		1	3
Appreciate concept of balancing and vibrations. (Unit No VI)	3	3	2	2		1	3

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE GTU Resource Persons:

Sr. No	Name and Designation	Institute	Contact No.	Email
1	Prof. G R Khunt Sr Lecturer in Mech Engg. Dept	R C Technical Institute SOLA, Ahmedabad.	8128291616	grkhunt@gmail.com
2	Dr. Mihir T. Patel Lect. in Mech Engg. Dept.	B & B Institute of Technology, V V Nagar	9426033823	mtpatel@bbit.ac.in

3	Prof. Ravikumar D Gujarati Lect. in Mech Engg. Dept.	Government Polytechnic, Porbandar	9925267725	ravi009.4ever@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (G.T.U.)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Engineering Thermodynamics
(Course Code: 4331902)

Diploma programs in which this course is offered	Semester in which offered
Mechanical Engineering , Mechatronics Engineering, Marine Engineering	Third

1. RATIONALE:

Thermodynamics is a branch of science that deals with energy transformations and are primarily concerned with the two forms of energy heat and work. The energy transformations are governed by the various laws of thermodynamics known as zero, first, second and third laws. These laws were deducted from experimental observations and logical reasoning. Extensive applications of thermodynamics can be found in fields ranging from refrigeration and air-conditioning to aerospace. Its principles are used to design energy converting devices, automobile engines, steam and gas turbines, power plants, compressors, HVAC, alternators, propulsion systems of aircraft and rockets, etc. Thus, every student of Diploma Mechanical Engineering should have a fundamental knowledge of thiscourse. It is a pre-requisite course for many courses of Thermal Engineering in higher semesters.

2. COMPETENCY:

The course should be taught in such a way that it can develop the necessary skills to bridge the gap between theoretical knowledge and its practical application. The students achieve the following competencies after completion of this course:

- **Apply fundamental concepts, laws and principles of thermodynamics on various thermal Devices/systems.**

3. COURSE OUTCOMES (COs)

1. Identify thermodynamic properties and systems by interpreting the basic concepts of thermodynamics.

2. Apply various thermodynamic laws and gas laws to thermal systems.
3. Calculate various parameters of different thermodynamic processes and cycles using P-V and T-s diagrams.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	0	0	100

(*) out of 30 marks under the component of theory CA, 10 marks are allotted for the assessment of the micro-project to facilitate the integration of COs. The remaining 20 marks would be the average of marks of the 2 mid-semester exams to be taken during the semester for assessing the attainment of the cognitive domain. UOs are required for the attainment of the COs.

*Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **E.S.E.** -End Semester Examination.*

5. UNDERPINNING THEORY

The primary underpinning theory is below based on the higher level UOs of the *Revised Bloom's taxonomy* formulated for developing the COs and competency. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit–I Basic Concepts of Thermodynamics	1.a Illustrate various terms related to thermodynamics. 1.b Identify thermodynamic properties with appropriate usages. 1.c Describe a zeroth law of thermodynamics.	1.1 Introduction and applications of Engineering thermodynamics. 1.2 Basic thermodynamic Concepts. - State, System, Boundary and Surroundings. - Types of Systems and boundaries with examples. - Thermodynamic properties, their units and classifications. 1.3 Energy, Heat, Work, Power and its simple numericals. 1.4 Thermodynamic equilibrium. 1.5 Thermodynamic Process and Cycle 1.6 Zeroth law of thermodynamics and its application.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit –II First Law of Thermodynamics	2.a Describe the first law of thermodynamics. 2.b Apply the first law of thermodynamics to real-life situations. 2,c Solve various numerical related to the first law of thermodynamics.	2.1 Law of conservation of energy. 2.2 Heat and work relation with Joule's Experiment. 2.3 Statement of the first law of thermodynamics. 2.4 Application of the firstlaw of thermodynamics: - Closed system (Non-flowProcesses). - Open system (Flow Processes). 2.5 Definition of the flow process, control volume and flow work. 2.6 Steady and unsteady flow processes. 2.7 Steady Flow Energy Equations (SFEE) and its applications in Nozzle, Diffuser, Boiler, Turbine, Compressor, Condenser, and throttling devices. 2.8Simple numerical examples based on the above. 2.9 Identify the applications of First law of thermodynamics for green environment.
Unit–III Second Law of Thermodynamics	3.a Describe the second law of thermodynamics. 3.b Apply the second law of thermodynamics to real-life situations. 3.c Solve various numerical related thermal efficiency &C.O.P.. 3.d Interpret the entropy, its equations with the unit.	3.1 Limitations of the first law of thermodynamics. 3.2 Concept of heat source, heat sink, heat engine, heat pump, refrigerator and simple numerical on thermal efficiency and COP (Coefficient of Performance) respectively. 3.3 Statement of the second law of thermodynamics: - Kelvin Planck Statement - Clausius Statement 3.4 Applications of the second law of thermodynamics.Also identify its applications for green environment. 3.5 Concept of reversibility and irreversibility. List of irreversibility only. 3.6 Definition of Entropy and its T-ds equation. (Without Derivations) 3.7 Statement of the third law of thermodynamics.
Unit-IV Ideal Gases and Thermodynamic Processes	4.a Describe various ideal gas laws. 4.b Derive the relationship of specific heats.	4.1 Concept of Ideal gas. 4.2 Boyle's law, Charle's law and Gay-Lussac law for ideal gases. 4.3 Characteristic gas equation and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4.c Identify various thermodynamic processes. 4.d Calculate the amount of heat transfer, work transfer & internal energy associated with the process. 4.e Plot various thermodynamic processes on P-V and T-S diagrams. 4.f Solve various numerical.	Universal gas constant, Specific heats of gas and their relationship. 4.4 Thermodynamic Processes, its representation on P-V (Pressure-Volume) and T-S (Temperature-Entropy) diagram: - Constant Volume Process - Constant Pressure Process - Constant Temperature Process - Adiabatic Process - Polytropic Process - Throttling Process 4.5 Equations of P-V-T relationship, work transfer, heat transfer and internal energy of the above processes. (Without derivations) 4.6 Simple numerical based on the above.
Unit–V Thermodynamic Cycles	5.a Identify thermodynamic processes in a cycle. 5.b Plot various cycles on P-V and T-s diagram. 5.c Solve various numerical related to power-producing cycles.	5.1 Classifications of thermodynamic cycle. 5.2 Carnot cycle and its representation on P-V and T-s diagram. 5.3 Derivation of thermal efficiency of Carnot cycle and simple numerical based on it. 5.4 Concept of air standard efficiency. 5.5 Otto, Diesel, Dual and Brayton cycle (Without derivation) 5.6 Representation on P-V & T-s diagram, Equation of air standard efficiency (Without derivations) and simple examples. 5.7 Representation of Reversed Carnot cycle and Reversed Brayton cycle on P-V and T-s diagram respectively.

6. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic Concepts of Thermodynamics	8	05	04	04	13
II	First Law of Thermodynamics	09	04	05	06	15
III	Second Law of Thermodynamics	05	02	03	03	8

IV	Ideal Gases and Thermodynamic Processes	10	04	06	07	17
V	Thermodynamic Cycles	10	04	06	07	17
	Total	**42**	**19**	**24**	**27**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note: This specification table gives general guidelines to assist studentsin their learning, and to the teachers, for question paper design and teaching methodology to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U, and A) in the question paper may slightly vary from the above table.

7. SUGGESTED STUDENT ACTIVITIES

Sr.No.	Activity.
1.	Identify and list real situations working on a:Zerothlaw of thermodynamics. b:Firstlawofthermodynamics. c:Secondlawofthermodynamics.
2.	Prepare charts of diesel, dual and gasoline cycles.Tabulate the main points of differences between them.
3.	List out the thermodynamic laws/concepts used in the Solar system. Also, Prepare technical specifications of solar rooftop at your home or nearby areas.
4.	Write the specifications of the domesticrefrigeratoravailableatyourhomeandI.C.Engineofanytwo-wheelers.Also,drawandexplainthe cycle on which domestic Refrigerator and I.C. Engine works.
5.	Presentations on "Smart Thermostat" of home appliances.
6.	Collect/ download product catalogs with the specification of various types of air compressors/ I.C.Engines /Refrigerators used in daily life.
7.	Take any thermal Device/system available in the Institute and identify it based on 1)type of system, 2) type of boundary.
8.	Prepare specification of some thermal devices/systems available in the Institute/surrounding.
9.	Give seminars on various topics learned in the course.
10.	Prepare chart on: (1) Types of system, (2) Temperature scale, (3) Types of process, (4) Types of thermodynamic cycles, and (5) Refrigeration cycle, etc.
	Interpret the relationship between different thermodynamic properties.

8. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (IF ANY)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Basic Concepts of Thermodynamics	o Real-life examples. Demonstration ofrealsystems. Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs).
II	Ideal Gases and Thermodynamic Processes	
III	First Law of Thermodynamics	
IV	Second Law of Thermodynamics	
V	Thermodynamic Cycles	

9. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to them during the semester. The teacher can assign any activity suggested in section 7 of ***"SUGGESTED STUDENT ACTIVITIES"*** according to their convenience. While designing the micro-project, it should be kept in mind that it encompasses most of the COs.It should be the application of the theoretical knowledge into some practical aspect.

10. SUGGESTED LEARNING RESOURCES

Sr. No.	TitleofBooks	Author	Publication& ISBN
1.	Engineering Thermodynamics	Yunus A. Cengel	Tata McGraw Hill 975-1-25-906256-8
2.	Thermodynamics	R.Yadav	CPH ISBN-13: 9788185444031
3.	Thermodynamics for Engineers	M.L.Mathur	Dhanpatrai & sons 81-200-0029-3
4.	Heat Engines	C.S.Shah& N.C.Pandya	Charotar Publi.House 81-85594-49-X
5.	Elements of Heat Engines Vol.I&II	R.C.Patel	AcharyaBookDepot
6.	Thermodynamics	SAAD	Prentice-Hall
7.	EngineeringThermodynamics-2nd Edition	P.K. Nag	Mc-GrawHillEducation 978-0-07-026062-7
8.	Applied Thermodynamics	R.C.Patel	AcharyaBookDepot
9.	Thermodynamics	Gupta	Pearson 9788131717950

10.	Thermodynamics	J.P. Holman	Tata Mc Graw-Hill
11.	Thermodynamics – Theory & Application	Robert Balmer	Jaico publication house
12.	Fundamentals of Thermodynamics	Sonntag, Borgnakke & Van wylen	John Wiley & sons (ASIA) PVT. LTD

11. SOFTWARE/LEARNING WEBSITES

Sr. No.	Software/Website address	Topic covered
1.	CALPHAD software	Thermodynamic modeling
2.	https://lawofthermodynamicsinfo.com/what-is-thermodynamic-system/	Basic of thermodynamics
3.	https://thermo.pressbooks.com/chapter/chapter-4/	Problems based on first law of thermodynamics
4.	https://study.com/academy/lesson/First-law-of-thermodynamics-law-of-conservation-of-energy.htm	First law of thermodynamics
5.	https://vimeo.com/94762428	First law of thermodynamics
6.	https://www.youtube.com/watch?v=OmhXb-miAhw	Thermodynamic cycles
7.	https://nptel.ac.in/courses/112/105/112105123/	All units
8.	http://www.thermofluids.net/	All units
9.	http://www.grc.nasa.gov/WWW/k-12/airplane/thermo.html	Basic concepts
10.	http://www.youtube.com/watch?v=Xb05CaG7TsQ	First law of thermodynamics

11.	http://www.youtube.com/watch?v=aAfBSJObd6Y	Ca rnot cycle
12.	http://www.youtube.com/watch?v=DHUwFuHuCdw	Secondlaw ofthermodynamics and heat engines
13.	http://www.youtube.com/watch?v=GKqG6n6nAmg	Zeroth law of thermodynamics
14.	https://www.youtube.com/watch?v=ty4F30dRdwk	Understanding entropy
15.	https://www.youtube.com/watch?v=WTtxlaeC9PY	Understanding secondlaw of thermodynamics
16.	https://www.youtube.com/watch?v=Jsnv8L7HdEk	Thermodynamic processes

12. PO-COMPETENCY-CO MAPPING

Semester II	**Engineering Thermodynamics (Course Code: 4321901)**						
	POs						
Competency & Course Outcomes	**PO1** (Basic & Discipline specific knowledge)	**PO2** (Problem Analysis)	**PO3**(Design/ development of solutions)	**PO4**(Engineering Tools, Experimentation Testing)	**PO5** (Engineering practices for society, sustainability & environment	**PO6** (Project Management)	**PO7** (Life-long learning)
Competency	Apply fundamental concepts, laws and principles of Thermodynamics on various thermal devices/systems.						
CO.1 Identify thermodynamic properties and systems by interpreting the basic concepts of thermodynamics.	3	-	-	-	-	-	2
CO.2 Apply various thermodynamic	3	2	-	-	1	-	2

laws and gas laws to thermal systems.							
CO.3 Calculate various parameters of different thermodynamic processes and cycles using P-V and T-s diagrams	3	2	1	-	-	-	-

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation ofeach CO with PO.*

13. COURSE CURRICULUM DEVELOPMENT COMMITTEE

o **GTU Resource Persons:**

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Pinkesh R.Shah	Gov. Polytechnic, Ahmedabad	9825472703	pinkeshrshah@gtu.edu.in
2.	Dr. V.K.Patel	R.C.Technical Institute, Ahmedabad	9898712580	vkpatel_1976@rediffmail.com
3.	Ms.Swati Dayal	R.C.Technical Institute, Ahmedabad	9998670720	swatidayal@rediffmail.com
4.	Dr.Rakesh Bumataria	Govt.Polytechnic, Porbandar	9924402808	rakesh.bumataria@gmail.com

BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr.S.H.Sundarani BOS Chairman HOD Mechanica lEngg.	Government Polytechnic Ahmedabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel BOS Member HOD Mechanical Engg.	B & B Institute of Technology VV Nagar	9825523982	rakeshgtu@gmail.com
3.	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Instituteof Technology Bardoli	7567421337	Asshah97@yahoo.in

CAD/CAM

4TH Semester

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Semester – IV

Course Title: Essence of Indian knowledge and Tradition
(Course Code: 4340001)

Diploma programme in which this course is offered	Semester in which offered
All branches of Diploma Engineering	4th Semester

1. RATIONALE:

National education Policy 2020, has given ample emphasis on Indian Knowledge system. The significance of teaching of Indian knowledge and Tradition is very much required as for centuries this great tradition had been trampled under the feet of invaders. Even after Independence, Indian Knowledge System had been neglected and only Western parameters have been considered as standard.

The essence of Indian culture has been carried through centuries only because of its scientific and humanitarian approach. It is the need of the hour that young students learn the significance of the contribution made by Indian Knowledge Systems and contribute to the world with pride and confidence even in the field of Science and technology which had been mastered centuries ago but was perished by invaders. This course will provide an opportunity to the students the hidden secrets of the great heritage of knowledge that existed thousands of years ago in Indian Tradition.

2. COMPETENCY:

1) Study of IKS will enable students to respect and relish the greatness of our tradition. The awareness of IKS will make them feel proud about their own culture.
2) The knowledge of Indian knowledge will enable and empower them with the first hand knowledge of India's great heritage, culture and traditions.
3) This will create a scope and awareness amongst the foreigners regarding India and its contribution to the world.

3. COURSE OUTCOMES

1. Students will attain awareness regarding the significance of IKS
2. The syllabus will enhance their confidence in Indian traditional knowledge system and enable them to perceive at the problems with Indian perspective
3. This will also enable them to analyze the issues on their own and enable them for critical thinking.
4. The knowledge about the ancient Indian Scientific traditions will generate more confidence in themselves.
5. This will lead them to make research and innovative thinking which can result in global contribution at later stage.

4.TEACHING AND EXAMINATION SCHEMES

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	25	25	150

5.PRACTICAL / PROJECT :

The student can visit any historical / monumental sights like Adalaj step well or Rani Ki Vav – Patan and study about architectural skills of Indians in past.

Topics:-

1. **Ancient Indian Astronomy :**

- **Development of Astronomy**:
  A) Consideration of Purnima and Amavasya
  B) Beginning of The New Year- Vasant Ritu- (Vernal Equinox)
  C) Ancient Indian Calender
  D) Science Behind "Adhikmaas"
  E) Uttarayan and Dakshinayan

- **Knowledge about Constellations / planets / distance between planets etc.**

A) Saptarushi – seven Seers- Significant Knowledge of star and constellations
B) Knowledge of Speed of Light – Rigveda(1.50.04)
C) Distance between Earth and Sun (Hanuman Chalisa)

- **Advances in Mathematics and Geometry in Ancient India**

A) Sulbha- Sutra (Kalpa Sutra) composed by Baudhayana, Manava, Apastamba and Katyayana

B) Contribution of Ancient Rushis to Mathematics

A)Bodhayana's value of pie
B) Lilavati
C) Bhaskaracharya
D) Arya Bhatt.

2. **Town Planning in Ancient India**

A)Roads in Ancient India – Uttarpath by Chandra Gupta
B)Ancient Indian Trade Routs/ Waterways
C)Ship- Building In Ancient India
D)Temple Architecture
-Nagar Style/ Dravida style/ Vesara style

3. **Atomic Theory of by Kanada**

A) Concept of Seven Padartha and Nine Dravyas
B) Theory of Gurutva
C) Characteristics of Atom

4. **Metallurgical Discoveries in Ancient India**

- Lime a Mortar
- Bronze
- Gold & Silver /\
- Glass / Iron
- Nagarjuna's Contribution in making Alloys

5. **Vimanshastra - Airbourne Vehicles.**

A) References of Vimana- Flying Machines in Rigveda, Mahabharat and Ramayana
B) BhardwajSutra- Chapter-1 Rasyagnoadhikari

6.REFERENCE BOOKS:

1)History of Science, Arts & Technology By Dr. Shripad Dattatrya Kulkarni, Bhishma Prakashan, Mumbai -1998.

2)Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana, PHI Learning Pvt. Ltd., Delhi
3)Town Planning in Ancient India by Binode Bihari Dutt, Thacker, Spink & Co.
4) ભારતનો વૈજ્ઞાનિક વારસો લેખક-જે . જે . રાવલ યુનિવર્સિટી ગ્રંથ નિર્માણ બોર્ડ, ગુજરાત રાજ્ય

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)
Semester – IV

Course Title: Contributor Personality Development
(Course Code: 4340002)

Diploma programme in which this course is offered	Semester in which offered
All branches of Diploma Engineering	4th Semester

Type of course: Work-Personality Development

For Year: Pre-final year for all Diploma programs

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their I-Can attitude and self-confidence for their career.
- Improve their ability to engage positively to handle the challenges in career and workplaces.
- Build long-term and sustainable view of success and career that will help them make sustainable choices in a volatile and changing world of work.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Awaken their aspiration to develop as Contributors in their organizations and society.

The program is focused on building foundational career values and the self-esteem of students to contribute in today's world of work.

The Contributor Program syllabus has been evolved and fine-tuned over several years, to –

a) address the changing needs and contemporary challenges being faced by industry and what employers today are looking for in the people they hire.
b) working extensively with universities and students and an appreciation of their challenges and concerns.
c) guided by the higher ideas and principles of Practical Vedanta in work.

OVERALL TEACHING AND EXAMINATION SCHEME
FOR ALL DIPLOMA COURSES

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	25	25	150

L- Lecture; T- Tutorial/ Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
-	**30**	**30**	**10**	-	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note:
It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

Note:
1. This subject is compulsory.
2. It will carry 2 credits.

COURSE FORMAT

Class Sessions:

- Students will have to attend 3 hours of discovery-based sessions, to build new models of thinking & capacities for every module. [i.e., total 18 hours of classroom sessions in the semester]
- They will work closely with their peers to discuss and understand these new models of thinking.
- Their learning will be facilitated by trained college faculty.
- They also go through standard end-of-module, live assessments in class via a Student App, for continuous assessment of learning, which will be used for the progressive assessment component.

Project work:

- Students will have to complete projects as part of Practical work. They have one project corresponding to each module. These projects help them apply contributor thinking into their careers and life. These also help them build their confidence to communicate, ability to do systematic research and present their thinking effectively.
- For the successful completion of projects:
    - Students will be given orientation to the project and systematic guidelines on how to conduct the project by their trained college faculty in a project orientation session.
    - The projects will be done in teams and will require research. It may also need field work.
    - Student teams present their projects in the classroom in project presentation sessions.

COURSE CONTENT:

MODULE		WHAT IS COVERED	Total Hrs.
1	Part 1: Developing self-efficacy and basic inner strength	**Who is a Contributor?** Students build a vision of who they can become as a 'Contributor' in their career. They gain clarity on expectations from the future workforce, and importance of being a contributor. This enables students to transform their expectation of themselves in their career and future work.	3 hrs Lab Sessions (discovery-based facilitator led)

2		**The 'creator approach' to life & challenges** In a "caged approach", we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator approach" to challenges and situations. This helps them take ownership & responsibility to shape destiny, build a new future, find answers to challenges; and stop being complainers.	Same as above
3		**Develop yourself to succeed: The I CAN Approach** Students learn to develop an "I CAN" attitude to everything. This is the base that helps them develop a Growth Identity & builds their self-esteem step by step; making them ready to deal with the dynamic demands of the future workplace.	Same as above
4	Part 2: Building ability to make more effective career choices	**Achieving Sustainable Success in their career** Students discover how to achieve sustainable or lasting success, by making themselves success worthy. Where their focus shifts to building one's "engine of success" rather than being focused on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. This helps them make better choices in life, that leads to steady success & long-term career fulfillment in an uncertain world.	Same as above
5		**Career Development Pathways open to us** In this topic, students explore a range of diverse "career development models" and the possibilities for contribution that each opens up for them. This helps them open up hidden opportunities that such an environment offers. And free themselves from a herd mentality when making career	Same as above

		choices.	
6		**Unleashing our Power to Contribute** In this topic, students learn how to expand the contribution possible in any role they play. This helps them take charge of their own career growth & discover their power to contribute in any role or job.	Same as above
Project work		Project Assignments are given corresponding to each of the six topics. These projects require research and field work beyond the classroom that students are expected to do.	Beyond classroom, with student presentations in the class

Reference resources:

A. Basic reference for both students and teachers –

1. Student Resources for study comprising of key ideas learnt in the classroom in each topic and additional references to videos, articles etc. from the internet for continued exploration. These resources are made available via the Student App.
2. In-class Assessment Quizzes for each of the 6 modules that students do via the Student App.
3. Structured classroom presentations that teachers use to conduct classes systematically. This is provided via a digital delivery platform (only for teachers).
4. Guides and preparation material to help teachers prepare for the classroom sessions. This is also provided via the digital delivery platform.
5. Project Guides and support materials provided via the digital delivery platform and the Student App.

These will be made available by Illumine (www.illumine.in), Knowledge Partner for the Contributor Program.

B. Advanced reference for teachers –

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Awaken the Contributor Within (Contributor Ethic), Srinivas V.; Illumine Ideas, 2019
3. Becoming a Contributor Teacher (Contributor Ethic), Srinivas V.; Illumine Ideas, 2018
4. Reclaiming our intentionality: from “victims” to “creators of our destiny” (Design of Life), Srinivas V.; Illumine Ideas, 2016.
5. Examining our motives of work: can we ask more out of ourselves? (Design of Life), Srinivas V.; Illumine Ideas, 2016.
6. Building a Contributor Ethic in Organizations, Srinivas V.; Illumine Ideas, 2019.
7. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
8. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan

9. Karma Yoga, Swami Vivekananda; Advaita Ashrama
10. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
11. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
12. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
13. Why not? how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
14. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
15. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
16. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of class sessions		
CO-1	Students are able to recognize the work ideal of a Contributor in terms of their motives for working and approach to work. They appreciate the value and importance of becoming Contributors in today's context.	10-12%
CO-2	Students are able to recognize & appreciate a "caged" approach as distinct from a "creator" approach in the way people deal with challenges and situations; and learn ways to develop a creator approach.	10-12%
CO-3	Students are able to recognize an "I Can" approach or way of thinking in situations. They learn how to apply this thinking to systematically develop themselves and their self-confidence in any area they choose.	10-12%
CO-4	Students are able to widen their understanding of success, that will help them make more sustainable career choices.	10-12%
CO-5	Students are able to recognize & appreciate different career development pathways and their value; to open up different career possibilities for themselves.	10-12%
CO-6	Students are able to recognize that any role has the potential for contribution. And they learn how to systematically expand the contributions and impact they can make in any role.	10-12%
Outcome of practical /project sessions		
	Students learn to apply the new thinking in the real world context	30%

EXAMINATION PATTERN:

End Semester Examination Pattern:

1.0 The final examination will cover all six modules included in the course content.

2.0 The examination is largely understanding and application oriented. Thus, a thorough appreciation of the key concepts of the course to recognize contributor thinking and application of the concepts in everyday life & work context, will help students to do well in the examination.

3.0 The examination paper will have ~30 questions and is to be completed in 1 ½ hours.

4.0 All questions are compulsory.

5.0 Pattern of questions –

- There are four sections in the question paper.
- All questions are in multiple-choice format (MCQ).
- The questions are in the form of scenarios / situations giving options. The student is expected to choose one option out of the given options.

6.0 The total number of marks is **70 marks**. The No. of questions and maximum marks per section is given below:

Section	Type of questions & No. of questions	Marking scheme
Section A	Case with 4 MCQs (with 2 or 3 options each). Student has to choose only one option.	2 questions x 3 marks each 2 questions x 2 marks each Max. marks = 10 marks Min. marks = zero
Section B	10 MCQs (with two valid options each). Student has to choose only one option.	10 questions x 2 marks each Max. marks = 20 marks Min. marks = zero
Section C	5 MCQs (with 3 or 4 options each). Student has to prioritize/ rank the statements & choose only one option that is closest to their ranking or priority-combination.	5 questions x 2 marks each Max. marks = 10 marks Min. marks = zero
Section D	10 MCQs (with 3 options each). Student has to choose only one option.	10 questions x 3 marks each Max. marks = 30 marks Min. marks = 10 marks

Sample Question Paper Pattern:

Section A

Instructions: This section has a scenario. Read carefully before answering the subsequent questions. There are 4 questions in this section. All questions are compulsory. Each question has 3 or 2 options. Choose ONLY ONE option which you consider the most appropriate option. Read carefully before answering.

Maximum Marks: 10

E-retailer Flipkart has announced that it will use the services of Dabbawalas of Mumbai for delivering goods to customers.

The Dabbawalas have been in the profession of transporting lunch boxes with absolute accuracy for more than 120 years. Their unique delivery system has been smooth, and reliable under all conditions. Their business involves no paper or administrative team. This helps in keeping the costs down.

However the Dabbawalas are not technology savvy which can be a problem for Flipkart.

1. The biggest advantage of this partnership is that… *[3 marks]*

a] …it will reduce Flipkart's cost of delivery significantly.
b] …it is an unusual and beneficial partnership for all concerned.
c] …it will give Dabbawalas additional income.

2. Suppose a partnership fails, your learning from it would be… *[2 marks]*
   a] These things happen, don't think about it but go forward.
   b] I need to think through more carefully whom to partner with and how we work together.

Section B

Instructions: There are 10 questions in this section. All questions are compulsory. Each question has 2 statements. Select ONLY ONE statement you feel is closest to your thinking and mark it on the answer sheet given to you.

[10 Qs x 2 marks = max. marks 20]

3. An astronomer made a discovery of a new planet at a unique location in the galaxy after several years of work. This helped prove and support an already well-established theory in Physics. Will the astronomer be called a Contributor?
   a] No, not a contributor, as finally his work led to nothing substantial (the theory was already well established).
   b] Yes, he is a Contributor because he continued for long and didn't give up so that he could make a discovery.

4. a] "I won the 'Best Athlete Award' last year. I should practice well enough to win it again this year."
   b] "I won the 'Best Athlete Award' last year. For this year's sports day, I should practice to improve my stamina and speed."

Section C

Instructions: This section will have 5 questions. All questions are compulsory. Each question has some statements with a unique number (e.g. 1, 2, 3, 4) and 3 or 4 options (e.g. a, b, c, d). Each option is either a combination of statements or a specific order of the statements. Choose ONLY ONE option closest to your thinking and mark it on the answer sheet given to you.

[5 Qs x 2 marks = max. marks 10]

5. What makes a project successful? *(Rank in the order of most likely to least likely option)*
   1. An inspiring team leader who can delegate jobs to his team.
   2. Hardworking team members who complete the tasks which are assigned to them.
   3. A team who believes the project should be successful.
   4. People who think like a 'team'.

   a] 4-3-2-1 b] 2-1-4-3 c] 2-1-3-4 d] 4-3-1-2

6. What are the different I CANs required to crack a job interview?
    1. I CAN learn to articulate my thoughts in a better manner
    2. I CAN overcome the fear of others judging me
    3. I CAN train myself to build my stamina
    4. I CAN think calmly to answer difficult questions

    a] 1, 2, 3 b] 1, 2, 4 c] 1, 3, 4 d] 2, 3, 4

Section D

Instructions: There are 10 questions in this section. All questions are compulsory. Each question has 3 options. Select ONLY ONE option you feel is the most appropriate and mark it on the answer sheet given to you.

[10 Qs x 3 marks = max. marks 30]

7. Which is a Contribution to Self, that a football player can make in his role?
    a] Asking for personalized attention from the coach and better opportunities to prove himself in the team.
    b] Improving his dribbling and passing techniques and his ability to work in smooth co-ordination with other players
    c] Winning more matches and increasing the number of goals scored by him in different matches.

8. Vaibhav, a mechanical engineering student, guides his classmates in completing their lab and group project work, gives regular updates on the progress to the teacher and works with everyone so that the journals of the entire class are submitted in time for external evaluation. What roles is Vaibhav playing in his college/class?
    a] Student leader, friend, role model
    b] Student, classmate, class representative
    c] Student, mentor, coordinator, representative of the class, assisting the teacher

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Semester – IV

Course Title: Integrated Personality Development Course
(Course Code: 4340003)

Diploma programme in which this course is offered	Semester in which offered
All branches of Diploma Engineering	4th Semester

1. TYPE OF COURSE

Value-based holistic personality development course for university students.

2. RATIONALE

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

3. COURSE OUTCOMES

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India’s glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

4. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	25	25	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.

5. COURSE-CONTENT:

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module & Subject	Subject Description	Hours
IPDC-1 (First Phase/Semester)			
Intro-duction	The Need for Values	Students will learn about the need for values as part of their holistic development to become successful in their many roles - as ambitious students, reliable employees, caring family members, and considerate citizens.	2
1	**Module:** Remaking Yourself **Subject :** Restructuring Yourself	Students learn how self-improvement enables them to secure a bright future for themselves. They will learn 6 powerful thought-processes that can develop their physical, intellectual, emotional, and spiritual quotients.	2
2	**Module:** Remaking Yourself **Subject :** Power of Habit	Students will undergo a study of how habits work, the habits of successful professionals, and the practical techniques that can be used to develop good habits in their life.	2
3	**Module:** Learning from Legends **Subject :** Tendulkar & Tata	Students will learn from the inspirational lives of India's two legends, Sachin Tendulkar and Ratan Tata. They will implement these lessons through relatable case studies.	2
4	**Module:** From House to Home **Subject :** Listening & Understanding	Active listening is an essential part of academic progress and communications. Students will learn to listen with their eyes, ears, mind, and heart.	2
5	**Module:** Facing Failures **Subject :** Welcoming	This lecture enables students to revisit the way in which they approach challenges. Through the study of successful figures	2

	Challenges	such as Disney, Lincoln and Bachchan, students will learn to face difficulties through a positive perspective.	
6	**Module:** Facing Failures **Subject :** Significance of Failures	Failure is a student's daily source of fear, negativity, and depression. Students will be given the constructive skills to understand failure as formative learning experiences.	2
7	**Module:** My India My Pride **Subject :** Glorious Past - Part 1	India's ancient Rishis, scholars, and intellectuals have made tremendous contributions to the world, they developed an advanced, sophisticated culture and civilization which began thousands of years ago. Students will learn the importance of studying India's glorious past so that they could develop a strong passion and pride for our nation.	2
8	**Module:** My India My Pride **Subject :** Glorious Past - Part 2	Our ancient concepts can be used to seek revolutionary ideas and to generate inspiration. Students will develop a deeper interest in India's Glorious Past – by appreciating the need to read about it, research it, write about it, and share it.	2
9	**Module:** Learning from Legends **Subject :** A.P.J. Abdul Kalam	Dr Kalam's inspirational life displayed legendary qualities which apply to students (1) Dare to Dream (2) Work Hard (3) Get Good Guidance (4) Humility (5) Use Your Talents for the Benefit of Others	2
10	**Module:** Soft Skills **Subject :** Networking & Leadership	Students are taught the means of building a professional network and developing a leadership attitude.	2
11	**Module:** Soft Skills **Subject :** Project Management	Students will learn the secrets of project management through the Akshardham case study. They will then practice these skills through an activity relevant to student life.	2
12	**Module:** Remaking Yourself **Subject :** Handling Social Media	Students will learn how social media can become addictive and they will imbibe simple methods to take back control.	2
13	**Module:** Facing Failures **Subject :** Power of Faith	Students will learn about the power and necessity of faith in our daily lives.	2
14	**Module:** From House to Home **Subject :** Bonding the Family	Students will understand the importance of strong family relationships. They will learn how to overcome the generation gap and connect with their family more.	2

15	**Module:** Selfless Service **Subject :** Seva	Students will learn that performing seva is beneficial to one's health, wellbeing, and happiness. It also benefits and inspires others.	2

6. COURSE MATERIAL / MAIN COURSE WORKBOOK:

Workbook will be designed and presented by IPDC Team. These official workbooks would be the course-material for study of IPDC. These workbooks will solve the purpose of study, submission, viva and exams for students.

IPDC Workbook-1 (*published by Swaminarayan Aksharpith)*

7. IPDC REFERENCES:

These are the reference material for the IPDC lectures. This is not compulsory reading for the students as the essential information is contained in the workbook.

Module No.	Module	References
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013

3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011 2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010
7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020] 3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester-IV

Course Title: Estimating, Costing and Engineering Contracting

(Course Code: 4341901)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

This course is designed to develop the ability in the students to evaluate materials, consumables and process costs in the monetary units. Hence, it will help to increase the productivity of the organization and conservation of valuable resources. This course will also help in developing the skills required in the process of decision making and to plan, use, monitor and control resources optimally and economically. This will also be helpful in budgeting and contracting.

2. COMPETENCY

The theory should be taught in such a manner that students are able to acquire different learning objectives in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

3. COURSE OUTCOMES (COs)

CO-1	Understand the concept of estimation, costing and depreciation.
CO-2	Apply break even analysis to get optimum production level.
CO-3	Estimate cost for various conventional manufacturing processes.
CO-4	Estimate the cost of special process plant.
CO-5	Prepare budgets and engineering contracts related to mechanical domain.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30	70	00	00	100

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T****– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES: N.A.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: N.A.

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course

competency.

a) Work as a leader/a team member.
b) Follow safety practices and Follow ethical practices
c) Practice environment friendly methods and processes. (Environment related)

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction	1a. Explain terminology and importance of ECC in industries. 1b. Explain the methods of costing 1c. Calculate elements of cost 1d. Find depreciation	1. Introduction of Estimation, Costing and contracting and their importance in industries. 2. Methods of costing (Explain actual examples for these methods) A. Specific order costing - Job costing - Contract costing - Batch costing B. Continuous operation costing - Process costing - Service costing - Operation costing - Unit costing 3. Calculation of catalogue price, selling price and various over heads (**Only** numerical). 4. Depreciation methods (1) Straight line method (2) Sinking fund method (**Only** numerical)
Unit – II Break even analysis	2a. Construct break even chart and find various parameters. 2b. Determine break even quantity for given data	1. Calculation of Break-even Quantity analytically and graphically (**Only** real time examples). 2. Safety Margin and it's importance. 3. Assumptions and Limitations of BEA.
Unit - III Costing in forging and casting	3a. Estimate material cost 3b. Estimate cost for a forging component 3c. Estimate cost for a casting component	1. Calculate volume of shapes of various combinations of cylinder, square, prism and sphere. 2. Calculate mass and material cost of given component (shape of component should be combination of above basic shapes like I-section, T-section, L-section, etc.). 3. List and calculate various forging losses for given data. 4. Estimate forging cost (for given data) 5. Estimate pattern making cost (for given data) 6. For a given component, Estimate casting

		cost including all losses.
Unit – IV Costing in Fabrication shop	4a. Estimate material and welding cost for a given component 4b. Estimate sheet metal work cost	1. Estimation of fabrication cost of real time object like safety grill (e.g. windows, doors, etc.), gate, various shades, etc. (Sizes are given) 2. Estimate Solar Roof Top costing for various capacities. It includes, cost of welding, framing, solar panel, labour, taxes, subsidies, etc. 3. Estimate **ONLY** material cost in sheet metal work for various jobs. (Concept of development of solid surfaces to be used. Consider regular shapes like cylinder and prism only) (**ONLY** numerical to be covered in this chapter)
Unit – V Costing in Production shop	5a. Calculate machining cost in lathe, drilling, milling, shaping and grinding machines	1. Calculate cost of various lathe operations like turning, facing, knurling etc. 2. Calculate cost of various drilling operations like drilling, boring, reaming, etc. 3. Calculate cost of shaping, grinding and milling operations. (**ONLY** numerical to be covered in this chapter)
Unit – VI Costing of various processes	6a. Identify various elements to estimate the process cost 6b. Estimate the cost of various processes	1. Estimate the cost of furniture work for given data. 2. Calculate running cost of power plant. 3. Calculate running cost of refrigerator, air conditioners, lift, cold storage, DG set, etc. (**ONLY** numerical to be covered in this chapter)
Unit VII Budget and Contracting	4a. Explain various Terminologies of budget. 4b. Prepare simple budget. 4c. Interpret parameters of given budget. 4d. Explain various terminologies of Contracting 4e. Prepare contract document 4f. Interpret given contract terms and conditions. 4g. Prepare data for tendering	1. Define budget. Objectives and advantages of budget. 2. Explain industrial budget with actual example. 3. Discuss Rail budget, Financial budget of State/country. 4. Budgetary control and it's advantages. 5. Explain actual contracts. e.g. Housekeeping contract, Labour contract, Security contract, Annual Maintenance contract like CCTV, Lift, Diesel Generator set, water purifier, vehicle, computer system, etc. 6. Explain Tendering process and E-tendering

	process.	with real time example. 7. Explain about GeM (Government E Market). How to become seller or buyer on GeM.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory marks			
			R Level	U Level	A Level	Marks
1	Introduction	4	4	6	0	10
2	Break even analysis	3	0	4	4	8
3	Costing in forging and casting	5	0	6	6	12
4	Costing in Fabrication shop	5	4	2	6	12
5	Costing in Production shop	5	2	4	6	12
6	Costing of various processes	3	0	2	6	8
7	Budget and Contracting	3	4	0	4	8
	Total	**28**	**14**	**24**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom learning, following are the suggested student- related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Do market survey and find prevailing hourly rates of CNC, Hacksaw cutter, lathe, milling, drilling, grinding and shaping machines and price of these machines.
b) Do market survey and find prevailing hourly rates of renting diesel generating sets. Specify output (HP or kW).
c) Do market survey and find prevailing rates of commonly used engineering materials like MS, brass, copper, stainless steel, Aluminum, etc.
d) Calculate cutting fluid cost. e.g. cost of lubricating oil, coolant, packaging oil, etc.
e) Calculate cutting tool cost. e.g. cost of drill, tips, carbide cutter, reamer, honing stick, etc.
f) Do market survey and find prevailing rates of boiler, furnace, condenser, evaporator etc.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and

provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS:

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

13. SUGGESTED LEARNING RESOURCES

Sr.	Title of Book	Author	Publication with place,year & ISBN
1	Mechanical estimating and costing	Banga and Sharma	Khanna Publishers. New Delhi.
2	Learning package in ECC	NITTTR, Bhopal	NITTTR, Bhopal
3	Mechanical estimating and costing	Shrimali and Jain	Khanna Publishers, New Delhi.

14. SOFTWARE/LEARNING WEBSITES

Refer following links to learn this subject in Gujarati Language.

(a) https://www.youtube.com/c/MechanicalEnggSubjectsGTU
(b) https://youtu.be/7F1n5OgnK4I
(c) https://youtu.be/btrxpgk4F-Q
(d) https://youtu.be/aTnDZF_C-XM
(e) https://youtu.be/hnfkUh3iYb4

15. PO-COMPETENCY-CO MAPPING

Semester IV		Estimating, Costing and Engineering Contracting (Course Code: 4341901) POs						
Competency & Course Outcomes		PO1 Basic & discipline specific knowledge	PO2 Problem Analysis	PO3 Design/Development of solution	PO4 Engineering tools, experimentation and testing	PO5 Engineering Practices for society	PO6 Project Management	PO7 Life long learning
Competency	Students are able to evaluate materials, consumables and process costs for increasing the productivity of the organization and conservation of valuable resources.							
CO-1	Understand the concept of estimation, costing and depreciation.	**2**	-	-	-	-	-	**2**
CO-2	Apply break even analysis to get optimum production level.	**3**	**3**	-	-	-	**1**	**2**
CO-3	Estimate cost for various conventional manufacturing processes.	**3**	-	**2**	-	-	**2**	**2**
CO-4	Estimate the cost of special process plant.	**2**	**1**	**2**	-	-	-	**1**
CO-5	Prepare budgets and engineering contracts related to mechanical domain	**3**	-	-	-	**2**	**2**	**2**

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S S Sonigra Lect. Mech. Engg.	Government Polytechnic, Jamnagar.	9427322129	sssonigra@gmail.com
2.	Dr. H K Trivedi Lect. Mech. Engg.	Sir Bhavsinhji Polytechnic Institute, Bhavnagar	9428408407	hetalktrivedi@gmail.com
3.	Smt. J R Patel	Government Polytechnic, Himmatnagar.	9824063572	jigishapreksha@gmail.com

BOS Resource Persons

Sr.	Name and Designation	Department	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS (Chairman HOD Mechanical Engg.)	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. R. D. Patel (BOS Member, HOD Mechanical Engg.)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah (BOS Member, Principal)	B. V. Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-IV

Course Title: Fluid Mechanics and Hydraulic Machinery
(Course Code: 4341903)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

The main objective of this course is to understand the fundamentals of fluid mechanics, such as fluid and flow properties, fluid behavior at rest and in motion, and fundamental equations like mass, momentum, and energy conservation of the fluid flow, thereby developing an understanding of fluid dynamics in a variety of fields. Applications of these fundamental equations have been highlighted for flow measurements. Hydraulic machinery is essential in converting hydraulic energy to mechanical energy and vice-versa. Hydraulic turbines are used to meet our day-to-day power demands. Also, different types of pumps are essential equipment in all industries. It also tried understanding hydraulic devices generally used in industries through the course.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Select, operate and maintain fluid machinery based on fluid laws and characteristics.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify fluid properties and their effect on the flow system.
CO-2	Apply various laws of fluid mechanics to various real-life applications.
CO-3	Estimate various flow losses to select suitable pipe as per the given situation.
CO-4	Select a hydraulic machine for a particular application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Demonstrate various fluid properties.	I	02
02	Measure pressure using pressure measurement devices.	II	02
03	Verify Bernoulli's theorem.	II	02
04	Measure fluid flow by Venturi meter and orifice meter.	II	04
05	Determine the hydraulic coefficients(Cc,Cv & Cd) of an orifice.	II	02
06	Measure fluid flow using Notch.	II	02
07	Estimate Reynold's number using the given test rig.	III	02
08	Determine major and minor head losses through a pipe.	III	04
09	Perform a test on the centrifugal pump test rig.	IV	02
10	Perform a test on the reciprocating pump test rig.	IV	02
11	Perform a test on a hydraulic turbine test rig.	IV	02
12	Demonstrate the use of different hydraulic devices.	IV	02
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data (which and why) before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1& 12)		
1	Knowledge	30
2	Quality of Report	30

3	Participation	20
4	Punctuality	20
Total		**100**
Experimentation/performance type PrOs (PrOs Number: 2,3,4,5,6,7,8,9,10 & 11)		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number 1 &12)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Students give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale).	A few required elements (labelling/ notations) are missing.	Several require elements (content in paragraph, labels, figures, tables) are missing.
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Experimentation/performance type PrOs (PrOs number 2,3,4,5,6,7,8,9,10 & 11)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Procedure	30%	Student	Student follow	Student follow all	Student follow

follows		follow all the procedure with precaution in a logical order.	all the procedure with some precaution in a logical order.	the procedure without precaution in a logical order.	all the procedure without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Conclusion/ Summary	10%	Student concept is mostly clear.	Student concept is partly clear.	Student concept is somewhat clear.	Student concept is not clear.
Quality of Report	10%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale).	A few required elements (labelling/ notations) are missing.	Several require elements (content in paragraph, labels, figures, tables) are missing.
Punctuality	10%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Different manometers.	02
2.	Hydraulic test rig compressing facility to verify Bernoulli's theorem, venturi meter, orifice meter, orifice, and major & minor losses through pipes.	03, 04, 05, 06, 07, 08
3.	Centrifugal pump test rig.	9
4.	Reciprocating pump test rig.	10
5.	Hydraulic prime mover test rig.	11
6.	Working model of hydraulic devices.	12

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the COs mentioned above and PrOs. More could be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I Fluid and Fluid Properties	1.a Explain the effect of fluid properties on a flow system	1.1 Concept and classification of fluid. 1.2 Properties of fluid i. Density ii. Specific weight iii. Specific volume iv. Specific gravity v. Viscosity vi. Surface tension vii. Cohesion & Adhesion viii. Capillarity ix. Bulk modulus of elasticity x. Vapor Pressure 1.3 Simple numerical examples.
Unit-II Fluid Mechanics and Flow Measurement	2.a Explain Fluid Pressure and use the appropriate pressure measuring device. 2.b Identify the type of fluid flow patterns. 2.c Describe and use continuity equations for one-dimensional fluid flow situations. 2.d Explain and apply fluid equations in simple industrial situations. 2.e Select and use flow measuring devices based on a given	2.1 Fluid pressure, Pressure head 2.2 Concept of vacuum, gauge, atmospheric, and absolute pressure. 2.3 Pascal's law and its applications. 2.4 Classification of pressure measuring devices. 2.5 Working and application of pressure measuring devices: i. Simple manometers (Piezometer, U tube manometer and single column manometer) ii. Differential manometers (U tube and inverted) 2.6 Fluid energy and its types. 2.7 Fluid flow

	situation.	i. Continuity, momentum, and energy equation. ii. Flow patterns. iii. Types of fluid flow. 2.8 Bernoulli's theorem. (Without derivation) and its assumption, limitations, and application. 2.9 Flow measurement: Construction, working, and application of Pitot tube, Orifice, Venturimeter, and Orifice meter. 2.10 Hydraulic co-efficients and its measurement. 2.11 Concept of Notch and Weir (without derivation and numerical). 2.12 Concept of Impact of jet and its application (without derivation and numerical). 2.13 Simple numerical problems on all above.
Unit-III Flow Through Pipes	3.a Understand various losses. 3.b Explain the water hammer and surge tank. 3.c Select the appropriate pipe based on a given situation.	3.1 Introduction to pipe and pipe flow. 3.2 Major and minor losses. 3.3 Reynold's experiment, friction factor, Darcy's and Chezy's equations (without derivation), Moody's chart 3.4 Water hammer and cavitation, its cause, effect, and remedies. 3.5 Simple numerical examples.
Unit-IV Hydraulic Machines	4.a Explain the construction and working of hydraulic pumps. 4.b Estimate performance parameters of a given centrifugal and reciprocating pump. 4.c Explain the construction and working of the hydraulic turbine. 4.d Explain the construction, working, and application of hydraulic devices.	4.1 Concept, classification, and application of pumps. 4.2 Construction, working, and application of centrifugal pump. i. Types of impeller and casings. ii. Multistage. iii. Priming. iv. Minimum suction depth. 4.3 Construction, working, and application of reciprocating pump. i. Single acting pump ii. Double acting pump iii. Air vessel 4.4 Numerical on a reciprocating and centrifugal pump. 4.5 Concept of gear pump and vane pump. 4.6 Layout and features of a hydroelectric power plant. 4.7 Classification, construction, working principle, and applications of turbines:

		i. Pelton turbine ii. Francis turbine iii. Kaplan turbine 4.8 Types, construction, and working of draft tubes. 4.9 Concept of hydraulic devices. 4.10 Construction, working, and application of: i. Hydraulic press ii. Hydraulic accumulator iii. Hydraulic ram iv. Hydraulic coupling v. Hydraulic intensifier.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fluid and Fluid Properties	03	3	4	-	7
II	Fluid Mechanics and Flow Measurement	10	6	8	7	21
III	Flow Through Pipes	04	3	4	7	14
IV	Hydraulic Machines	11	8	6	14	28
Total		**28**	**20**	**22**	**28**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Prepare a chart/presentation to select particular pressure measuring device for a particular application.
2.	Prepare a chart/presentation for a selection criterion for flow-measuring devices.
3.	Prepare a chart/presentation for a selection criterion for pipes and pipe sizes.
4.	Prepare a chart/presentation to select a particular pump for a particular application.
5.	Prepare a chart/presentation to select a particular hydraulic pump for a particular application.
6.	Prepare a tabulated summary of the types of pipes available in the market. (Summary includes type, specification, size range, material, rate, and applications).
7.	Identify any one hydraulic pump and one prime mover available in the market in a group of five students with detailed specifications and current prices.
8.	Visit a nearby related industry and prepare a summary of hydro-pneumatic devices used and their specifications.
9.	Select at least three problems on the manometer and prepare a report containing their solutions.

10.	Select at least three problems on the manometer and prepare a report containing their solutions.
11.	Select at least three problems regarding the continuity equation and prepare a report containing their solutions.
12.	Select at least three problems regarding Bernoulli's equation, and p prepare a report containing their solutions.
13.	Select at least five problems regarding discharge measurement and prepare a report containing their solutions.
14.	Select at least three problems to determine major and minor losses and prepare a report containing their solutions.
15.	Select at least two problems to type of flow (Based on Reynold's number) and prepare a report containing their solutions.
16.	Select at least three problems to determine major and minor losses and prepare a report containing their solutions.
17.	Select at least two problems to determine the power/efficiency of the Reciprocating and Centrifugal pump and prepare a report containing their solutions.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Fluid Mechanics and Hydraulic Machinery being a fundamental subject, teachers are expected to lay considerable stress on understanding the basic concepts, principles, and applications. For this purpose, teachers are expected to give simple problems in the classroom and provide tutorial exercises to develop the necessary knowledge for comprehending the basic concepts and principles. As far as possible, teaching the subject is supplemented by demonstrations and practical work in the laboratory.

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Fluid and Fluid Properties	
II	Fluid Mechanics and Flow Measurement	o Real-life examples, Demonstration of natural systems, Movies/Animations, Numericals, Massive Open Online Courses (MOOCs).
III	Flow Through Pipes	o Real-life examples, Demonstration of natural systems, Movies/Animations, Numericals, Massive Open Online Courses (MOOCs).
IV	Hydraulic Machines	o Real-life examples, Demonstration of natural systems, Movies/Animations, Numericals, Massive Open Online Courses (MOOCs).

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-projects are group-based (groups of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more COs which are, in fact, an integration of PrOs, UOs, and ADOs. Each student must maintain a dated work diary consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the

COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty could add similar micro-projects in any form (chart/presentation/report/model):

1. Compare the following liquids concerning their density (for the same mass, compare the volume) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
2. Arrange the situations of H_2O at atmospheric pressure in ascending order (with reason) concerning their density.

   (a) Ice at -10℃, (b) Water at 30℃, (c) Water at 100℃, (d) Dry and saturated Steam at 100℃
3. Arrange the situations of H_2O at an atmospheric temperature in ascending order (with reason) concerning their density.

   (a) Water at atmospheric pressure, (b) Water at 10 bar, (c) Water at 40 bar
4. Compare the following liquids concerning their viscosity (for the same temperature, compare the velocity) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
5. Calculate the water weight when your home's water tank is completely filled with water.
6. Calculate the water pressure at different Discharge points (different floors) based on the equation $p = \rho gh$ and explain the phenomena variation of pressure at different floors.
7. Observe the working of a Hydraulic Jack at any garage and relate it with Pascal's law.
8. Measure the fluid pressure of the suction and discharge pipe of the pump and convert it into absolute pressure.
9. Observe the discharge water condition from a pipe at the time of car washing with a nozzle and without a nozzle and explain the difference considering Bernoulli's equation.
10. Observe discharge water condition from a pipe at fully and partially opened cock/valve/tap and explain the difference considering the continuity equation.
11. Draw a line diagram of the water supply & distribution line of your hydraulic lab and indicate the source of major and minor losses in it.
12. Visit the manufacturer's website for hydraulic pumps, collect the catalog, and select a suitable pump for your home application.
13. Calculate the major loss occurring in your hydraulic lab's water supply and distribution lines.
14. Indicate all sources of minor losses occurring in your hydraulic lab's water supply and distribution lines and give possible solutions to minimize these losses.
15. Prepare a demonstration model of the hydroelectric power plant.
16. Prepare a demonstration model of the hydraulic devices.
17. Gather information on prime movers of different hydroelectric power plants in Gujarat.
18. Select a pump for a coolant recirculation in a lathe machine, garage pump for car washing, Bore well pump, pump at a service station, pump used in water coolers, or pump in a purified water filter system with justification.
19. Download/collect a catalogue of pump manufacturers like Kirloskar, Shakti, Jyoti, Lubi, KSB, Havells, etc., and compare their parameters.

20. Prepare a display chart of types of pipes based on material. size and applications.
21. Observe pressure gauges used by roadside tire workers, blood pressure measurement by doctors., and pressure gauges mounted on a turbine test rig and write a report on it.
22. Visit nearby shops to identify different PVC and GI pipe fittings. Collect manufacturing catalogues related to the same.
23. Prepare any non-Newtonian fluid and compare its characteristics with Newtonian fluid.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	A Textbook of Fluid Mechanics & Hydraulic Machines	Dr. R.K.Bansal	Lakhsmi publication (P) Ltd
2	Hydraulic & Hydraulic Machines	R.C. Patel & A.D. Pandya	Acharya Book Depot
3	Fundamental of Fluid Mechanics (in SI units)	Dr. D.S. Kumar	Katson Pub. house
4	Fluid Mechanics, Fundamentals, and Applications	Yunus A. Cengel, John M. Cimbala	MC-Graw Hill, Higher Education
5	Hydraulics and Fluid Mechanics, Including Hydraulics Machines	Dr. P. N. Patel, Dr. S. M. Seth	Rajsons Publications Pvt., Ltd.
6	Fluid Mechanics and Hydraulic Machines	R. K. Rajput	S. Chand & Company Ltd.

14. SOFTWARE/LEARNING WEBSITES

1. https://nptel.ac.in/courses/112105206
2. https://nptel.ac.in/courses/112104117
3. https://nptel.ac.in/courses/112103249
4. https://www.classcentral.com/course/youtube-fluid-mechanics-concept-derivation-videos-53034
5. https://fmc-nitk.vlabs.ac.in/fluid-machinery/exp/centrifugal-pump/index.html
6. https://me.iitp.ac.in/Virtual-Fluid-Laboratory/
7. https://eerc03-iiith.vlabs.ac.in/List%20of%20experiments.html
8. https://fm-nitk.vlabs.ac.in/List%20of%20experiments.html

15. PO-COMPETENCY-CO MAPPING

Semester IV	Fluid Mechanics and Hydraulic Machinery (4341903)						
	POs						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ developmentof solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Select, operate and maintain fluid machinery based on fluid laws and characteristics.						
CO-1: Identify fluid properties and their effect on the flow system.	3	-	-	-	-	-	3
CO-2: Apply various laws of fluid mechanics to various real-life applications.	2	3	2	3	-	-	3
CO-3: Estimate various flow losses to select suitable pipe as per the given situation.	2	3	-	2	2	-	2
CO-4: Select a hydraulic machine for a particular application.	2	3	-	3	3	-	2

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE(GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. Nisha Pandya	Government Polytechnic, Himatnagar	9426352574	nishacryo8@gmail.com
2.	Prof. (Dr.) Mihir Patel	B. & B. Institute of Technology, Vallabh Vidyanagar	9426033823	mihireagle@yahoo.co.in
3.	Prof. (Dr) Rakesh Bumataria	Government Polytechnic, Porbandar	9924402808	rakesh.bumataria@gmail.com
4.	Prof. Sumeet Kotak	Government Polytechnic, Jamnagar	9033906004	sumeetp.kotak@gmail.com

17 BOS Resource Persons

Sr. No.	Name and Designation	Department	Contact No.	Email
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2.	Dr. Rakesh D. Patel (BOS Member, HOD Mechanical Engg.)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
IV – Semester

Course Title: **Manufacturing Engineering Processes-III**
(Course Code: 4346501)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering (CAD-CAM)	four

1. RATIONALE

This subject of Manufacturing Engineering Processes -III provides knowledge and embeds skill to students to develop different products using various machining process, rapid prototyping, and non-conventional machining process. Manufacturing processes are the most important element in any engineering industry. Large numbers of industrial parts have features like teeth, threads, slots, splines, surfaces etc. Quality of these parts depends on parameters aspects such as accuracy of profile, dimension & surface finish controls. Correct selection of process & its parameters on such machines; plays a vital role in obtaining required quality product at optimum cost. This course will make student familiar with fundamentals of cutting mechanics, kinematics, constructional features and selection criterion for various basic machine tools, rapid prototyping and advance machining process Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different type of skills so that students are able to acquire at least following competencies:

- **Produce the part as per given drawing/specifications by adopting conventional machine tools and/or non-conventional machining processes using optimum process parameters, safe working procedures, suitable work & tool holding devices and appropriate cutting tools.**
- **Plan and supervise manufacturing operations at a shop floor of machine tools based manufacturing industries.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify effect of machining parameter on quality of products.
CO-2	Produce the job with appropriate process, cutting tools, machine tools and cutting parameters for given work piece like gear, mechanical job with thread.
CO-3	Expose the students to different types of Rapid prototyping processes, materials used in RP systems.
C0-4	Select appropriate non – conventional machining method for different machining operations.
CO-5	Outline the role of computer and automation in manufacturing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25*	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T**– Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Preparatory Activity** (Includes Home Assignments)**:** Demonstrate various cutting parameters, carbide inserts with ISO designation system and explain the steps to calculate cutting speeds. Student will prepare the report on following. a. Tabulate various cutting tools materials with main elements, properties and applications. b. Calculate RPM for lathe, milling cutter and drill spindle strokes/minute for shaping/planning; based on given data. Use equations. Each student should be given different data for diameters and cutting speeds.	1 & 2	04
2	**Kinematics and motion transmission systems:** Demonstrate motion and power transmission path, transmission systems, work mounting systems, tool mounting systems and tool holders/holding. System of lathe, gear hobbing, gear milling, gear shaping, threading on lathe, drilling machine. **a.** Sketch and label main elements of machine kinematics. **b.** Write specification of Machine **c.** Sketch cutting tools with nomenclature, Sketch tool holders.	2, 4	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	**Produce job with various machining methods:** **a.** Sketch the production drawing of the part. Part should include plain/taper turning, step turning, cylindrical/surface grinding, etc. **b.** Outline the processes. **c.** Calculate/select, set, observe and record the cutting parameters for each process. **d.** List the cutting tools you have used. Also state specifications of each. **e.** List the work holding devices you have used. Also state specifications of each. **f.** Produce the part.	1, 2, 4	08
4	**Gear cutting:** Prepare a simple spur gear using milling operations including use of indexing head .Student will also prepare report including: **a.** Drawing of the job Gear. **b.** State equations to find module, pitch circle diameter, outside diameter, circular pitch and number of teeth. **c.** Produce spur gear on milling machine using indexing head. Calculate/select, set, observe and record the cutting parameters. **d.** List the cutting tools and work holding device you have used. Also state specifications of each.	2	06
5	**Thread cutting:** Prepare a job having threaded surfaces on lathe machine **a.** Sketch the production drawing of the part. **b.** Prepare a multi start/square threaded bolt and nut. Calculate/select, set, observe and record the cutting parameters for the process. **c.** List the cutting tools you have used. Also state specifications of each. **d.** List the work holding devices you have used. Also state specifications of each.	4	04
6	**Rapid prototyping machine(3D printer) (Demonstration)** To study the part builds mechanism of a Rapid prototyping machine. **a.** To develop CAD models using 3D Scanner/Software for 3D printer. **b.** To select a specific material for the given application. **c.** To produce a simple product using 3D printing or Additive Manufacturing (AM)	3	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	**Presentation:** **a.** Teacher will assign any one topic to each batch student from Unit number V &VI. Each student will have different topic. **b.** Using power point presentation, each student will present the topic. Presentation must include related Videos/images. **c.** Present the topic and submit the report of same.	1,3,6	02
8	**Technical visit/participation:** Visit manufacturing related industries (one must be having non-conventional manufacturing facilities) and prepare industry wise technical report. Hint: Before visit, faculty will remind student regarding portion of subject content (especially practice) not covered within institution premises (due to non-availability of resources). Faculty will also direct student's attention towards all possibility/scope available at the industries to be visited. Student will observe and record all such details like Specifications, Operating procedure, Selection of operational parameters, Details about tool/work holders used, Machine setting, Product details being manufactured for each method/machine like gear forming/generating, honing/lapping/buffing machine, Non-conventional machine, Jig boring machine, Broaching machine etc.	All	
		Total	**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. Care must be taken in assigning and assessing study report as it is a third-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify machine tools & their equipment's (Knowledge)	10
2	Able to operate, set the machine and select machining parameters. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Hacksaw machine.	3 to 6
2.	Lathe with standard and special accessories.	3
3.	Milling machines-Vertical /horizontal with standard accessories and indexing/dividing head.	4
4.	Column drilling or Radial Drilling machine	4
5.	Shaper machine.	4
6.	Rapid Prototyping Machine	6
7.	HSS cutting tool and their tool holders	3 to 5
8.	Carbide inserts and their tool holders	4 ,5
9.	Drill bit and their tool holder	4

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I. Introduction to Manufacturing Engineering-III.	1a. Importance of Manufacturing engineering III	1.1 Introduction of process used in Industries like Gear manufacturing, thread production, Rapid Prototyping, Computer integrated manufacturing. Non-conventional and advance Methods of machining.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	1b. Machine shop supervisor skill. 1c. the effect of different machining parameters on quality and cost of product.	1.2 Need of attitude, knowledge & skill required for shop floor supervision in Machine tools based industries for quality and cost effective production. 1.3 Importance of processes and required parameters (like material removal rate, cutting power, cutting time, cutting speed, feed, depth of cut, number of cuts, tool signature, tool life etc) on quality and cost of product.,
Unit– II **Gear manufacturing and finishing processes.**	2a. List types of gears 2b. Assimilate the Gear manufacturing & finishing processes. 2c. Describe constructional features and working of various gear manufacturing machines. 2d. Select appropriate gear manufacturing machine as per the given situation.	2.1 Types of gears and application, nomenclature of spur gear. 2.2 Gear generating and forming processes-concept, differences and applications. 2.3 Classification, constructional features, working and application of gear milling, gear hobbing and gear shaping machines. 2.4 Nomenclature and sketch of gear hob and gear shaping cutter.
	2e. Select gear cutting parameters for given materials and work- piece 2f. Gear finishing process	2.5 Gear Cutting parameters for commonly used materials and work-piece. 2.6 Gear finishing methods, requirement of gear finishing.
Unit– III **Rapid Prototyping**	3a. Explain Introduction, classification, application of rapid prototyping.	3.1 Fundamentals of Rapid Prototyping, advantages and limitations. 3.2 Classification of Rapid prototyping methods 3.3 Applications of rapid prototyping methods
	3b. Rapid prototyping methods, working principle, detail of process	3.4 Working principle, process detail of Stereo lithography apparatus, selective laser sintering, laminate object manufacturing & fused deposition modeling (3D printing).

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– IV **Thread production Methods.**	4a. Explain thread production processes.	4.1 Thread nomenclature and important terminologies used in threads. 4.2 Various threads production processes like turning, rolling, grinding, taping, etc. their applications, advantages and limitations.
	4b. Describe constructional features and working of Various thread production machines. 4c. Select appropriate thread production machine as per the given situation. 4d. Explain different steps for producing thread on thread production machine.	4.3 Constructional features including coolant and lubrication systems, motion and power transmission path, working and application of various threads production machines/ processes like lathe, rolling, grinding, taping, etc. 4.4 Thread cutting parameters for commonly used materials and work-piece. 4.5 Tool mounting methods on thread production processes.
Unit-V **Computer integrated Manufacturing (CIM)**	5a. Concept and scope of Computer integrated Manufacturing (CIM) 5b. Role of management in CIM 5c. Role Manufacturing engineers in CIM 5d.introduction to automation	5.1 Introduction to CIM Concepts & scope of CIM, 5.2 Nature & type of manufacturing system. 5.3 Evolution, Benefits of CIM. 5.4 Role of management in CIM, Expert system & participate management. 5.5 Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel. 5.6 Introduction Automation in production system. Types of automation(fixed automation, programmable automation, flexible automation and integrated automation), Reasons for automation
Unit-VI **Non-conventional and advance methods of Machining.**	6.a Overview and requirement of Non- conventional Machining methods. 6.b Explain working principles and working parameters of non-conventional machining methods. 6.c Selection of nonconventional machining methods	6.1 Need of nonconventional machining and comparison between conventional & non-conventional machining methods. 6.2 Classification, working principles, application and working parameters of following non-conventional machining methods: i. Electro chemical machining (ECM). ii. Electro discharge machining (EDM) including wire cut and dies sinking. iii. Ultrasonic machining (USM).

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		iv. Laser beam machining (LBM). v. Abrasive jet machining (AJM). vi. Plasma arc machining (PAM) vii. Water jet machining (WJM) 6.3 Criterion for selection of non-Conventional machining methods. 6.4 Introduction and application of MEMS.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Introduction to Manufacturing Engineering- III.**	**4**	**1**	**3**	**0**	**4**
2	**Gear manufacturing and finishing processes.**	**8**	**4**	**6**	**4**	**14**
3	**Rapid Prototyping**	**8**	**4**	**6**	**4**	**14**
4	**Thread production Methods.**	**6**	**2**	**4**	**4**	**10**
5	**Computer integrated Manufacturing (CIM)**	**6**	**4**	**5**	**3**	**12**
6	**Non-conventional and advance methods of Machining.**	**10**	**5**	**6**	**5**	**16**
Total		**42**	**20**	**30**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

1. Prepare a report on at least one industrial component/product with its complete technical details covering the points like design criterion, features included with Dimensional/Geometric constraints, manufacturing resource requirements, challenges in controlling its quality and cost, etc.
2. Prepare report on product manufactured by rapid prototyping.
3. Collect the technical details about all production facilities available at nearby industry/industries.
4. Visit or participate in the technical events, exhibition, conference, seminar etc.
5. Collect/download at least four different machine tool catalogues including at least one special purpose, non-conventional or advance machine.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) To acquire knowledge of basic machine, tool and their operation arrange two or more **industrial visit** of production industry. After visit student must be submit their industrial visit report.
c) Guide student(s) in undertaking micro-projects.
d) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
e) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
f) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed six.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a small useful product like various machining parts assembly/gear box/rapid prototyping model/useful thread assembly /small laboratory equipment/set-up utilizing laboratory resources.
b) Prepare a model for types of gear / types of different thread.
c) Design and manufacture various die or Jigs studied in Tool engineering subject
d) Prepare a report on product manufactured with various non-conventional process (design, machining methods, specification, parameters..)
e) Using Drafting software, prepare machining products drawing with tolerances, quality measure with operation sheets for manufacturing.

f) Survey nearby vendor for rapid prototyping, non-conventional machining, and gear and thread manufacturing etc. machining process and prepare report on products manufacture to reduce rejection, quality improvement, production rate etc..

g) Maintenance of available infrastructure related to Machining.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Production Technology (Manufacturing Process)	Dr. P C Sharma	S Chand
2	Elements of Workshop Technology Volume No. II Machine Tools	Hajra Choudhary, Bose S. K., Roy Nirjhar	Media promotors and publishers pvt. Limited
3	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Company(P) Limited
4	Machine tools technology	G. S. Kandasami	Khanna publisher
5	Fundamentals of Metal Machining and Machine Tools	W. A. Knight and Geoffrey Boothroyd	CRC Press
6	Modern Machining Processes	P. C. Pandey	Tata McGraw Hill, New Delhi
7	M.E.M.S.: Fundamental Technology and Application	VikasChoudhary, Krzysztof Iniewski	CRC Press
8	Production Technology	R. K. Jain and S. C. Gupta	Khanna Publishers
9	Production Technology	HMT	Tata Mcgraw-Hill Publishing Co.
10	All about Machine Tools	HEINRICH GERLING	New Age International Private Limited
11	Computer integrated manufacturing	S. Kant Vajpayee	Prentice Hall of India

14. SOFTWARE/LEARNING WEBSITES

1. https://nptel.ac.in/courses/112/105/112105126/
2. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-32.pdf
3. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-31.pdf
4. https://nptel.ac.in/courses/112/104/112104028/
5. https://archive.nptel.ac.in/courses/112/104/112104289/
6. https://www.me.iitb.ac.in/~ramesh/courses/ME338/non_trad.pdf
7. http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf
8. http://www.youtube.com/watch?v=bmooEZyivxo
9. http://www.youtube.com/watch?v=mWy9awGv6so
10. http://www.youtube.com/watch?v=mKES5Fyz9l0
11. http://www.youtube.com/watch?v=BgGXQUeYNKw
12. ihttp://www.youtube.com/watch?v=eaeEn1Gs4aQ
13. http://www.youtube.com/watch?v=49GpJ7yhecg
14. http://www.youtube.com/watch?v=XfYXelZ4IaY

15. http://www.youtube.com/watch?v=SNWF_4jQ2pU
16. http://www.youtube.com/watch?v=pI1QGpmKqow
17. https://www.youtube.com/watch?v=NkC8TNts4B4
18. https://www.youtube.com/watch?v=KJj8CfnC0Ek
19. https://onlinecourses.nptel.ac.in/noc21_me115/p

15. PO-COMPETENCY-CO MAPPING

Semester IV	Manufacturing Engineering Processes-III (4346501)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long Learning
Competency	**Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**						
CO 1. Identify effect of machining parameter on quality of products.	3	2					
CO 2. Produce the job with appropriate process, cutting tools, machine tools and cutting parameters for given work piece like gear, mechanical job with thread.	3			2	3	2	2
CO 3. Expose the students to different types of Rapid prototyping processes, materials used in RP systems.	3	2		2	2		
CO 4. Select appropriate non – conventional machining method for different machining operations.	3			3	2		2
CO 5. Explain the knowledge about role of computer and automation in manufacturing.	3			2		2	

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
1.	Prof. S. M. Tank	R.C.T.I. Ahmedabad	9825631840	Suresh.a1987@gmail.com
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BOS Resource Persons

Sr.No	Name and Designation	Department	Contact No.	Email
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2.	Dr. Hamir Sapramer	HOD Mech. Engg. G.P. Rajkot	9426587197	merhamir@yahoo.com
3.	Dr. Rakesh D. Patel	HOD Mech. Engg. B.B.I.T., V. V. Nagar	9825523982	rakeshgtu@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-IV

Course Title: Thermal Engineering
(Course Code: 4346502)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	4th Semester

1. RATIONALE

This course will provide the basic knowledge of Thermal engineering required for a mechanical engineer. It would develop basic knowledge and skills related to boilers, boiler mounting and accessories, steam turbines, condensers, cooling towers, air compressors, heat transfer, internal combustion engines. refrigeration and air conditioning. This course essentially provides adequate knowledge in the field of thermal engineering required for the mechanical engineer specializing in CAD/CAM.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Understand basic concepts of thermal engineering and the working of boilers & its accessories, condensers, cooling towers, internal combustion engines, refrigeration and air conditioners. To understand heat transfer phenomena and air compressors.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify the various features of boilers, mountings and accessories, turbines, condensers and cooling towers.
CO-2	Explain the operational aspects of different internal combustion engines
CO-3	Understand the working of Air compressor.
CO-4	Describe the working principle of refrigeration and air conditioning systems.
CO-5	Appreciate the importance of different parameters for various mode of heat transfer.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Functional study of steam boilers, along with their mountings and accessories.	I	04
02	Functional study of various turbines, condensers and cooling towers. *	I	04
03	Operational study of Internal Combustion engines and their parts. *	II	04
04	Demonstration of reciprocating air compressor and its parts. *	III	04
05	Operational study of refrigeration and air conditioning System and its components. *	IV	04
06	Demonstration of various tools for refrigeration and air conditioning tubing operation.	IV	04
07	Functional study of various types of heat exchangers. *	V	04
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Third-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	20%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Models of various steam boilers, mountings and accessories, turbines, condensers and cooling towers.	1,2
2.	Models (cut section) of 4-stroke Petrol engine, 4-stroke Diesel engine, 2-stroke Petrol engine, 2-stroke Diesel engine, Carburetor, Spark plug, Fuel Injector, Fuel pump, MPFI system.	3
4.	Models (cut section) of reciprocating centrifugal and axial type air compressor.	4

5.	Models of VCRS, compressor, condenser, expansion devices, evaporator.	5
7.	Thermometer and Psychometer.	5
8.	Refrigeration and air conditioning tubing operation kit.	6
9.	Models of various heat exchangers like double pipe heat exchanger, shell and tube type heat exchanger, plate type heat exchanger etc.	7

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices.

d. Maintain tools and equipment.

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Thermal Energy Systems	1.a Explain the construction and working of boilers. 1.b Function and location of boiler mountings and accessories. 1.c Explain the construction and working principle of a Steam turbine. 1.d Describe the working of jet & surface condensers. 1.e Describe the working of cooling towers.	1.1 Steam boiler Concept, definition as per Indian Boilers Regulation (IBR), Classifications and Applications. 1.2 Construction and working of steam boilers. i. Cochran boiler ii. Babcock and Wilcox boiler iii. Packaged boiler iv. Fluidized bed combustion boiler 1.3 Function & Location of different boiler mountings like Water level indicator, Pressure gauge, Safety valve and Fusible plug. 1.4 Function & Location of different boiler accessories like Economizer, Air preheater and Superheater

		1.5 Steam turbine i. Concept & classifications ii. Construction and working of impulse and reaction turbine 1.6 Steam condensers Construction and working of Jet condensers and surface condensers. 1.7 Cooling Towers i. Concept & classification ii. Construction and working of natural draft and mechanical draft cooling towers.
Unit – II Internal Combustion Engines	2.a Describe ICEs with classification. 2.b Explain various components and terminology used in ICEs. 2.c Describe the working principle, construction and working of the ICEs. 2.d Explain needs and types of alternate fuels & their applications.	2.1. IC Engine - Concept & working principle - Major components & Its functions - Terminology - Classifications 2.2. P-V and T-S diagram of otto and diesel cycle (without derivation). 2.3. Construction and working of four Stroke petrol and diesel engine 2.4. Construction and working of two stroke petrol and diesel engine 2.5. Alternative fuels Alcohols, Hydrogen, LPG, Biogas, CNG, Biofuel
Unit-III Air Compressors	3.a Explain the principle, construction and working of air compressors. 3.b Explain various components used in air compressors.	3.1. Concepts, classification and applications. 3.2. Construction and working of Reciprocating air compressor (single stage & multi-stage) 3.3. Construction and working of dynamic (centrifugal & axial) air compressor

Unit-IV Refrigeration and Air-Conditioning	4.a 4.b 4.c 4.d 4.e	Describe the processes and components of VCRS with functions of each component. Plot the various VCRS processes on P-H diagram List characteristics of refrigerants used for VCRSs. Plot and interpret various air conditioning processes on psychometric chart. Explain working of various air-conditioners.	4.1 Concept of refrigerators and heat pumps 4.2 Reverse Carnot cycle and Bell column cycle (Without COP derivation) 4.3 Construction and working of Vapor Compression Refrigeration Cycle, P-V, T-S and P-h diagram 4.4 Application of VCRS Domestic refrigerator, Ice plant, Water cooler 4.5 Refrigerant - Types and Properties of refrigerants - Eco friendly refrigerants 4.6 Air conditioning - Properties of air - Psychometric chart - Psychometric processes - Construction and working of window and split air conditioner
Unit-V Heat Transfer	5.a 5.b 5.c	Describe modes of heat transfer. Determination of heat transfer through cylinder and wall. Calculate the overall heat transfer coefficient and LMTD.	5.1.Various modes of heat transfer. 5.2.Conduction heat transfer- Fourier's law-explanation (Without derivation), thermal conductivity, heat transfer through a plain wall, composite wall and cylinder (Simple numerical) 5.3.Convection heat transfer, coefficient of convection, newton's law of convection (simple numerical), Free and force convection 5.4.Radiation heat transfer, Black body concept, emissivity, reflectivity, absorptivity, Stefan and Boltzmann's law. 5.5.Heat exchanger: - Concept, classification and application - Logarithmic Mean Temperature Difference (LMTD) (Without derivation) (simple numerical)

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Thermal Energy Systems	09	7	4	3	14
II	Internal Combustion Engines	08	6	8	-	14
III	Air Compressors	05	3	5	-	08
IV	Refrigeration and Air-Conditioning	10	6	6	4	16
V	Heat Transfer and Heat Exchangers	10	5	6	7	18
Total		**42**	**29**	**27**	**14**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Visit of any power plant/ industry where various items like boiler, air compressors, heat exchanger, cooling tower, condenser etc. can be shown to students.
2.	Prepare a model of simple heat exchanger in modelling software.
3.	Enlist IC Engine specifications which is available in your laboratory.
4.	Visit any automobile service center in the nearby area.
5.	Enlist specifications of VCRS system which is available in your laboratory.
6.	Enlist specifications of air compressor which is available in your laboratory.
7.	Identify and enlist at least ten devices that require heat transfer and prevention of heat transfer. Also, state the mode of heat transfer and methods used to prevent heat transfer.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Boilers, Boiler mountings and accessories, Steam Turbines, Steam Condensers and Cooling Towers	o Real-life examples, Demonstration of natural systems, Movies/Animations. o Numericals, Massive Open Online Courses (MOOCs).
II	Internal Combustion Engines	
III	Air Compressors	
IV	Refrigeration and Air-Conditioning	
V	Heat Transfer and Heat Exchangers	

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned at the beginning of the semester. The number of studentsin the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass at least COs with in

integration of PrOs, UOs, and ADOs. The duration of the micro project should be about **4-5** ***(four to five) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model/animation):

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model):

1. Prepare a lay out of thermal power plant using software like open office draw, Microsoft visio, RFflow etc.
2. Thermal analysis of simple heat exchanger using analysis software like ANSYS, Autodesk Inventor Nastran etc.
3. Prepare a lay out of refrigeration and air conditioning system using software like open office draw, Microsoft visio, RFflow etc.
4. Thermal analysis of composite wall taking different materials in analysis software like ANSYS, Autodesk Inventor Nastran etc. (Faculty can assign different shape and material to group of students.). Also compare result of analysis with theoretical result.
5. Prepare a tabulated summary of the types of air compressors available in the market. (Summary includes type, specification, rate, and applications).
6. Prepare a tabulated summary of the types of four-stroke Petrol and diesel engines used in a vehicle which are available in the market. (Summary includes number of cylinders, capacity, types of cooling system, types of ignition system, types of governing system, types of fuel supply system etc).
7. Prepare a chart of possible minor fault and remedies while driving two wheelers and four wheels.
8. Prepare a chart of installation and maintenance of A.C. at home or office.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Thermodynamics: An Engineering Approach	Yunush A. Cengel Michael A. Boles	Tata Mcgraw- Hill.
2.	A Course In Power Plant Engineering	Arora and Domkundwar	DhanpatRai Publication
3.	A Textbook of Power Plant Engineering	R K Rajput	Laxmi. Publications
4.	Heat Engines	Pandya and Shah	Charotar Publishing House.
5.	Thermodynamics and Heat power Engineering	Mathur and Mehta	Tata Mcgraw- Hill.
6.	Thermal Engineering	R K Rajput	Laxmi. Publications

7.	A Text book of Thermal Engineering	R S Khurmi & J.K. Gupta	S Chand & Co.
8.	Thermal engineering	P.L.Ballaney	Khanna Publication
9.	Thermal Science and Engineering	Dr. D.S.Kumar	S.K.Kataria & Sons.
10.	IC Engine	Mathur and Sharma	DhanpatRai Publication
11.	Refrigeration and air conditioning	Arora & Domkundwar	Khanna publication.
12.	A Text Book of Refrigeration and Air Conditioning	R S Khurmi	Eurasia Publishing House
13.	Refrigeration & Air-Conditioning	R.K.Rajput	S.K.Kataria & Sons.
14.	Heat and mass transfer	R K Rajput	S. Chand & Co.
15.	Heat and mass transfer	D S Kumar	S K Kataria & Sons

14. SOFTWARE/LEARNING WEBSITES

1. https://www.youtube.com/watch?v=EGFDqqX_Iek&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=7
2. https://www.youtube.com/watch?v=h1Yt4ibYXfA&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=12
3. https://www.youtube.com/watch?v=DuLFDzQVTU4&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=16
4. http://nptel.ac.in/courses/112105128/
5. http://www.youtube.com/playlist?list=PLE2DA184A2E479885
6. http://www.kolpak.com/asset/?id=tuqvr
7. https://www.kwangu.com/work/psychrometric.htm
8. http://people.tamu.edu/~i-choudhury/psych.html
9. https://www.youtube.com/playlist?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC
10. http://vlabs.iitkgp.ernet.in/rtvlas/exp1/index.html#
11. https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=709&cnt=4
12. https://vlab.amrita.edu/index.php?sub=1&brch=194
13. https://www.spiraxsarco.com/resources-and-design-tools/steam-tables/superheated-steam-region

15. PO-COMPETENCY-CO MAPPING

Semester IV	Thermal Engineering (4346502)						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ developmentof solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Apply basic concepts, laws, and principles of thermal engineering to operate and maintain the equipment and machines working on thermal systems.						
CO-1: Identify the various features of boilers, mountings and accessories, turbines, condensers and cooling towers.	2	-	-	-	2	-	3
CO-2: Explain the operational aspects of different internal combustion engines.	2	2	-	-	2	-	3
CO-3: Understand the working of Air compressor.	2	2	-	-	2	-	2
CO-4: Describe the working principle of refrigeration and air conditioning systems	2	2	-	-	2	-	3
CO-5: Appreciate the importance of different parameters for various mode of heat transfer.	3	2	2	-	2	2	2

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU RESOURCE PERSONS)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. (Dr.) J.M.Bhatt	G. P. Junagadh	9428573088	jaydeepbhatt54@gmail.com
2.	Prof. A.N.Khudaiwala	G. P. Porbandar	9998550143	khudaiwala_ashish@gtu.edu.in

BOS RESOURCE PERSONS

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S. H. Sundarani	HOD Mech. Engg. G.P. A'bad	9227200147	gpasiraj@gmail.com
2.	Dr. Hamir Sapramer	HOD Mech. Engg. G.P. Rajkot	9426587197	merhamir@yahoo.com
3.	Dr. Rakesh D. Patel	HOD Mech. Engg. B.B.I.T.	9825523982	rakeshgtu@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
IV – Semester

Course Title: Computer Aided Drafting-II
(Course Code: 4346503)

Diploma programmer in which this course is offered	Category	Semester in which offered
Mechanical Engineering(CAD/CAM)	Program Core	Fourth

1. RATIONALE

Mechanical engineers are responsible for designing and manufacturing a wide range of products, from small components to complex machines. In order to do this effectively, they need to be able to create and interpret 3D models of engineering parts and assemblies.

Parametric solid modeling software is a powerful tool that allows engineers to create and modify 3D models quickly and easily. Parametric software uses constraints to link geometric features together, so that when one feature is changed, the other features are updated automatically. This makes it easy to make changes to designs without having to start from scratch.

In addition to its power and flexibility, parametric solid modeling software is also widely used in industry. This means that students who learn to use this software will be well-prepared for jobs in the mechanical engineering field.

The course will teach students the fundamentals of parametric solid modeling using any popular parametric solid modeling software. Students will learn how to create and modify 3D models of engineering parts and assemblies, create engineering drawings from parametric models, and perform simple animations of assembly and analysis of parts for mechanical and thermal stress.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

1. Proficiency in Parametric Modeling Software
2. Engineering Drawing and Analysis Skills

3. COURSE OUTCOMES

The practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

1. Apply parametric modeling techniques to create 3D mechanical components using industry-standard software.
2. Apply parametric modeling techniques to create simple assemblies using industry-standard software.
3. Generate precise engineering drawings and comprehensive documentation from parametric models.
4. Analyze parametric models of mechanical assembly to ensure movement integrity through animation simulations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (COs). All PrOs are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Faculty can utilize any parametric 3D modeling software accessible at their institution to supplement the teaching and learning process for this course. However, pursuant to the Memorandum of Understanding (MoU) between Autodesk and AICTE, parametric software like Fusion 360 and Inventor can be made available to faculty members and students, granting them access to the design software to enhance their learning experience.

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required	CO
1	Create and modify 3D models of mechanical components using parametric modeling software. Select Mechanical Components: Students will select four mechanical components to model. The components should be complex enough to challenge students, but not so complex that they are impossible to model and draw. Create 3D Models: Using the parametric modeling software, students will create 3D models of the selected mechanical components. The models should be accurate and detailed.	12	CO1

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required	CO
	Students will submit the completed models in relevant file format. Modify 3D Models: Students will modify the 3D models to incorporate design changes. The modifications should be significant enough to demonstrate the power of parametric modeling.		
2	Create and modify 3D models of mechanical assemblies using parametric modeling software. Select Mechanical assembly: A group of 4-5 Students will select a mechanical assembly having 6 to 10 parts to model. The assembly should be complex enough to challenge students, but not so complex that they are impossible to model. Create 3D assembly: Using the parametric modeling software, a group of students will create 3D models of the selected mechanical assembly. The model should be accurate and detailed, and should include all dimensions and tolerances. Students will submit the completed assembly in relevant file format. Modify 3D Models: Students will modify the 3D models to incorporate design changes. The modifications should be significant enough to demonstrate the power of parametric modeling.	12	CO2
3	Generate engineering drawings and documentation from parametric models. Using parametric software's drawing generation tools students will create orthographic production drawings of the 3D models prepared in practical number 1 and 2. The drawings should include all dimensions, tolerances, notes, a title block, and other necessary annotations. Students will submit the completed drawings in PDF format.	08	CO3
4	Employ simulation tools in parametric software to analyze the kinematic motion of a mechanical assembly. Use Simulation tools of your parametric software to analyze the kinematic motion of an assembly designed in practical number two. The simulation should show how the various parts interact with each other. Students will submit the completed task in relevant file format.	08	CO4
5	**Mini Project** The mini project should aim to develop and showcase the students' proficiency in parametric modeling software and engineering drawing and analysis skills. The project should involve creating and analyzing 3D models of mechanical	16	ALL

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required	CO
	components or assemblies. **Project Selection Criteria**: ● Relevance to Course Objectives: The project should directly address the course objectives of developing proficiency in parametric modeling software and engineering drawing and analysis skills. ● Complexity and Challenge: The project should be of a suitable complexity level that challenges students to apply their knowledge and skills effectively without being overwhelming. ● Practical Application: The project should have real-world relevance and demonstrate the practical application of parametric modeling software and engineering drawing and analysis skills. ● Creativity and Innovation: The project should encourage creativity and innovation in design solutions, allowing students to explore their problem-solving abilities. ● Individual or Group Work: The project to be undertaken as a group project, fostering collaboration and teamwork skills.		
		56	

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1.	Lab Records and regularity	15
2.	Question answer / understanding steps of exercise	15
3.	Execution of exercise	30
4.	Printout/Result	10
5.	Viva voice	30
Total		**100**

6. MAJOREQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Computer system with latest configuration.	All
2.	Laser printer - plotter A2 size.	All
3.	Related software. (Any parametric modeling software like Pro-E, SolidEdge, SolidWorks; Autodesk Inventor, Fusion-360). (Refer this MoU for free usage of parametric software at your institute)	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical and electronics equipment.
c) Maintain tools and equipment.
d) Realize the importance of E-waste management. (Environment related).

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year.
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (3 to 5 UOs at different levels)	Topics and Sub-topics
Unit-I Introduction to Parametric Solid Modeling	• Define parametric design and explain its benefits. • Apply the key concepts of parametric design, such as features, constraints, and parameters.	• Understanding parametric design principles. • Introduction to 3D modeling terminology and concepts. • Exploring the history and development of parametric

Unit	Unit Outcomes (UOs) (3 to 5 UOs at different levels)	Topics and Sub-topics
	● Create and edit basic 3D models using parametric software. ● Navigate the user interface of a popular parametric modeling software package (e.g., SolidWorks, Autodesk Inventor, or PTC Creo). ● Configure settings and preferences for efficient modeling.	modeling. ● Differentiating between parametric and non-parametric modeling. ● Familiarization with any one or more popular parametric modeling software (e.g., SolidWorks, Autodesk Inventor, PTC Creo etc). ● Navigating the software's user interface. ● Configuring settings and preferences for efficient modeling.
Unit-II Creating and Modifying 3D Models of Engineering Parts	● Create and modify 3D models of engineering parts using parametric features, constraints, and parameters. ● Apply advanced parametric modeling techniques to create complex engineering parts	● Overview of essential tools and commands for creating parametric solid models ● Building and editing 3D geometry using parametric techniques. ● Sketching and constraining 2D profiles for 3D features. ● Applying geometric and dimensional constraints. ● Working with extrusions, revolve, sweeps, and other modeling operations. ● Exploring advanced modeling techniques like patterns, shells, and loft.
Unit-III Creating and Modifying 3D Models of Engineering Assemblies	● Create and modify 3D models of engineering assemblies using parametric software. ● Apply parametric assembly techniques to create assemblies with multiple parts. ● Use parametric mates to constrain the movement of parts in an assembly.	● Managing Assembly Files and Folders. ● Configuring Assembly Settings for Efficient Modeling ● Exploring Parametric Assembly Techniques. ● Understanding Parametric Mates, constraints and relations.
Unit-IV Creating and Modifying Engineering Drawings from Parametric Models.	● Create assembly drawings, detail drawings, and section drawings. ● Dimension and annotate engineering drawings according to engineering standards. ● Update engineering drawings automatically when the parametric model is modified.	● Creating assembly drawings using parametric software. ● Creating detail drawings using parametric software ● Creating section drawings using parametric software. ● Dimensioning and annotating engineering drawings.

Unit	Unit Outcomes (UOs) (3 to 5 UOs at different levels)	Topics and Sub-topics
	● Generate engineering drawings in multiple formats, such as PDF, DWG, and DXF.	● Updating engineering drawings automatically ● Generating engineering drawings in multiple formats.
Unit-V Simple Animations of Engineering Assemblies.	● Create simple animations of engineering assemblies using parametric software to simulate their movement and performance.	● Using parametric software to create simple animations of engineering assemblies ● Animating the movement of parts in an assembly ● Analyzing the performance of an assembly using animation

SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Not applicable						

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

9. SUGGESTED STUDENT ACTIVITIES

Other than the laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in groups and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Undertake micro-projects in team/individually.
b) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc. to further enhance their learning.
c) Select at least four mechanical components and get them approved by the teacher. Measure and model these parts and present them in a report with dimensions. (For Ex. No 01).
d) Select at least one simple mechanical assembly in a group of 5-6 students, each made up of minimum 6-10 components. Get them approved by the teacher. Prepare the solid model of the assembly and present it in a report with dimensions. (For Ex.No.02).
e) Bring Actual assembly from workshop/industry, measure dimensions, sketch it and make 3D production drawing for the same. (For Ex.No. 03)
f) Prepare Charts that classify recycling processes for electronic waste and plastics.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.

b) Guide student(s) in undertaking micro-projects.

About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature may be given to the students for ***self-learning***, but to be assessed using different assessment methods.

Guide students on addressing the issues on environment and sustainability using the knowledge of this course.

c) Guide students for keeping the drawings in digital form and reduce use of paper.

11. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5).

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- Design and model a custom part for a specific industry, such as a manufacturing part, a medical device, or a consumer product.
- Create a parametric model of a real-world object / assembly i.e., piston crankshaft, Cam and follower, knuckle joint, cotter joint, gear train, tail stock etc.
- Use parametric solid modeling software to design and simulate a manufacturing process, such as injection molding or CNC machining.
- Research and compare different parametric solid modeling software packages.
- Create a video tutorial on parametric solid modeling.
- Develop a web community or web application that allows users to design and share parametric models.
- Build a physical prototype of a parametric model using a 3D printer or CNC machine.
- Use parametric solid modeling software to design and animate various mechanisms used in study of theory of machine.
- Deliver expert lectures on parametric solid modeling for other students.

12. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Design with SolidWorks	David C. Planchard	SDC Publications ISBN: 9781630574680
2	Mastering SolidWorks	Matt Lombard	Publisher: John Wiley & Sons Inc ISBN: 9781119300588
3	Creo Parametric 9.0	Cadartifex Sandeep	Publisher: Cadartifex ISBN: 9789394074026
4	Autodesk Inventor	James D. Bethune	Publisher: Pearson Education ISBN: 9780131190733
5	Parametric Modeling with Fusion 360	Randy Shih	SDC Publications ISBN: 9781630570552

13. SOFTWARE/LEARNING WEBSITES

Autodesk Inventor

- Autodesk Inventor Learning Center: https://www.youtube.com/watch?v=iCnVZrzz1VI
- Autodesk Inventor Documentation: https://www.autodesk.com/support/technical/product/inventor
- Autodesk Inventor Tutorials: https://www.youtube.com/watch?v=KKbwf2a53bA

Dassault Systèmes SolidWorks

- SolidWorks Tutorials: https://www.youtube.com/watch?v=E69EqFY2qMc
- SolidWorks Tutorials: https://www.youtube.com/watch?v=CiBwrjUeB8U
- SolidWorks Help Center: https://www.solidworks.com/support/home

PTC Creo Parametric

- PTC Learning Community: https://community.ptc.com/
- PTC Creo Parametric Tutorials: https://support.ptc.com/help/creo/creo_pma/r10.0/usascii/tutorials_pma/pma_tutorials.html
- PTC Creo Parametric Documentation: https://support.ptc.com/images/cs/articles/2018/05/1525425932uNM3/tkuse.pdf

Fusion 360

- Autodesk Fusion 360 Learning Center: https://help.autodesk.com/view/fusion360/ENU/courses/
- Fusion 360 Tutorials: https://www.youtube.com/watch?v=qvrHuaHhqHI
- Fusion 360 Help Center: https://help.autodesk.com/view/fusion360/ENU

14. PO-COMPETENCY-CO MAPPING

Semester IV	Computer Aided Drafting-II (Course Code: 4346503)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Managemen t**	**PO 7 Life-long learning**
Competency 1. Proficiency in Parametric Modeling Software	3	2	3	3	2	2	2
2. Engineering Drawing and Analysis Skills	2	2	2	2	2	2	3
CO1 - Apply parametric modeling techniques to create 3D mechanical components using industry-standard software.	3	2	2	3			2
CO2 - Apply parametric modeling techniques to create simple assemblies using industry-standard software.	3	2	2	3		2	2
CO3 - Generate precise engineering drawings and comprehensive documentation from parametric models.	3		2	3	2	3	2
CO4 - Analyze parametric models of mechanical assembly to ensure movement integrity through animation simulations.	2	3		2			

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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