

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, Transportation Engineering (All branches except CACD & DM)	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				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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/calculus1openstax/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 <i>Solve broad-based technology problems using the principles of mathematics.</i>	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
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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				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 <ul style="list-style-type: none"> • Syntax (Sub-Verb Agreement) • Diction (choice and use of words) • Control of the basic grammatical patterns 	20
4	Style <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 Communication	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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Types of letters, • Formats of Letters • Qualities of a good letter <ul style="list-style-type: none"> • Sample letters such as: <ul style="list-style-type: none"> - 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 <ul style="list-style-type: none"> • Basics of Speaking • Importance of public speaking • Characteristics of good speech 5.2 Samples for Practice: <ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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, 4 th Edition 1956 ISBN : 0521093694
9	Ed. English Pronouncing Dictionary	James Hartman & et al.	Cambridge: Cambridge University Press.17 th Edition 2006 ISBN : 0521680867
10	Effective Communication Skills	Kulbhusan 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/ 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 reading, writing, speaking, listening skills to communicate effectively in English						
<u>Course Outcomes</u> 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.

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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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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).

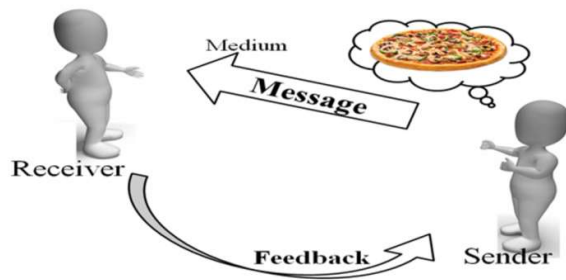
Channel: the signal carrier or medium

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 Venn 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 or 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?

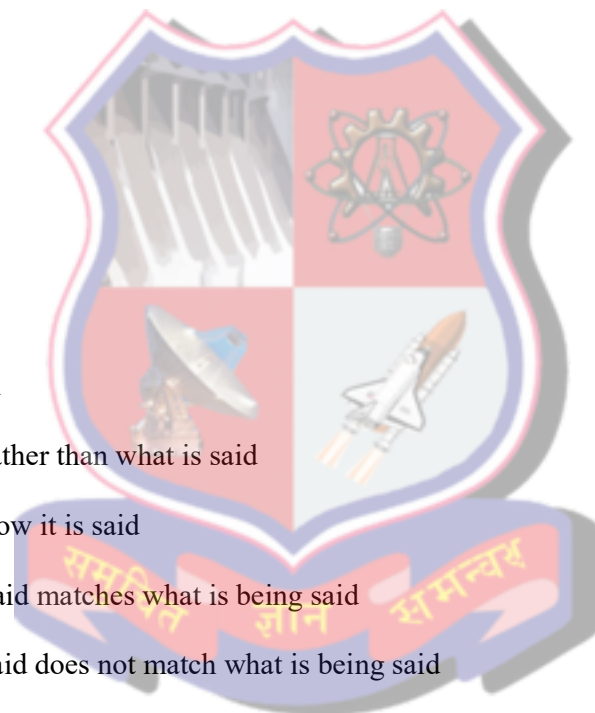
- a. Language for the disabled
- b. How something is said, rather than what is said
- c. What is said, rather than how it is said
- d. When how something is said matches what is being said
- e. When how something is said does not match what is being said

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



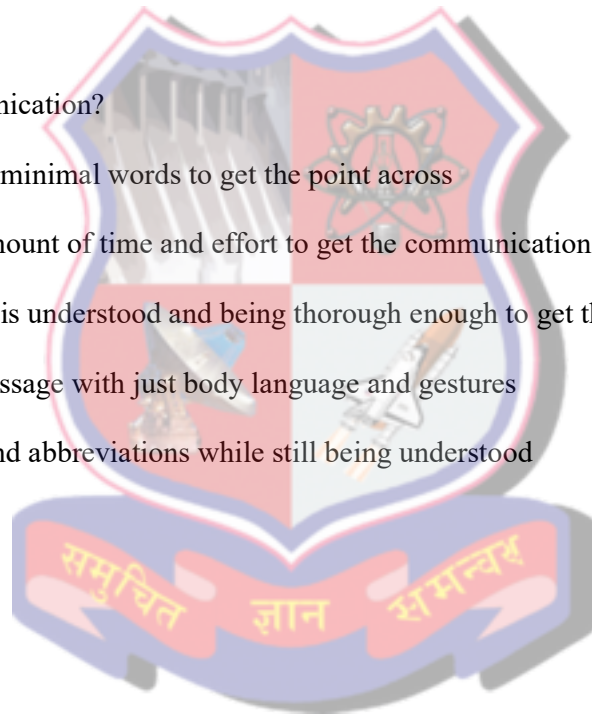
- c. It has the desired outcome
- d. The person is agreeable
- e. The person tells you

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. Theiris example for many of us.
5. Theaddressed 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 seenbook?
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 atruck on the road.
2. There arebuildings in mega cities.
3. The garden hasflowers.
4. My friend is wearing ashirt.
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.

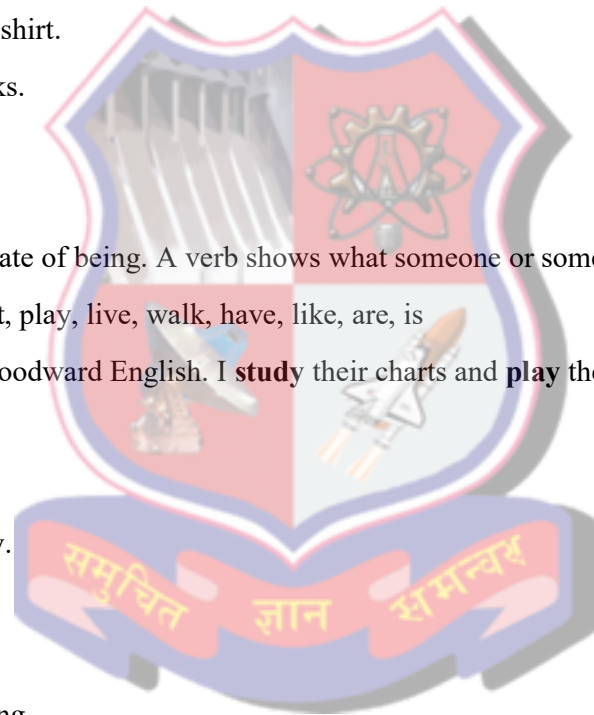
Examples: go, speak, run, eat, play, live, walk, have, like, are, is

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. Wenewspapers.
4. The managerthe meeting.
5. Ithis 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 unspecified 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 foodthemselves.
9. I saw him runningthe 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.

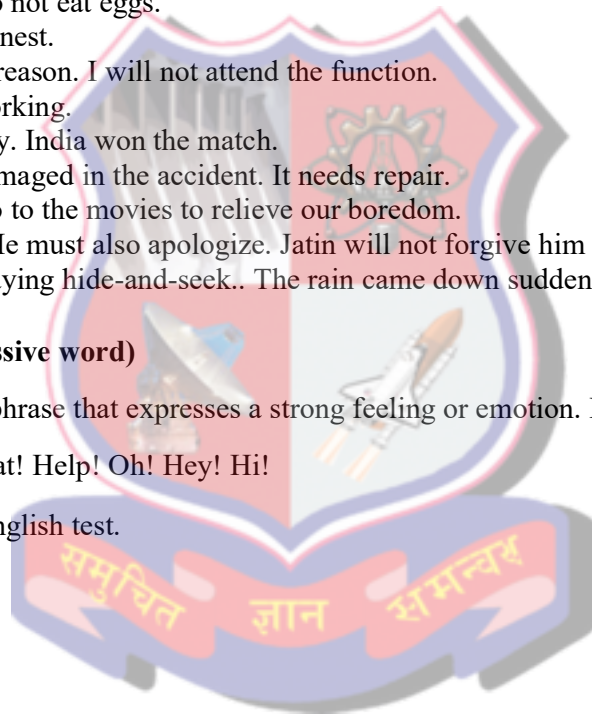
1. He passed the exam. He had a good teacher.
2. I do not eat meat. I do not eat eggs.
3. She is poor. She is honest.
4. I can not tell you the reason. I will not attend the function.
5. I felt ill. I went on working.
6. Rohit scored a century. India won the match.
7. The car was badly damaged in the 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.

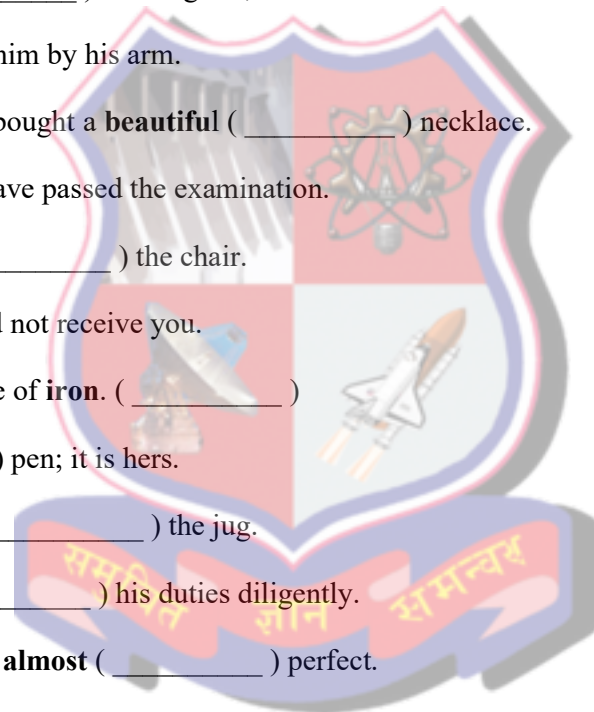
The drawing made by you is **almost** (_____) perfect.

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 360° 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:

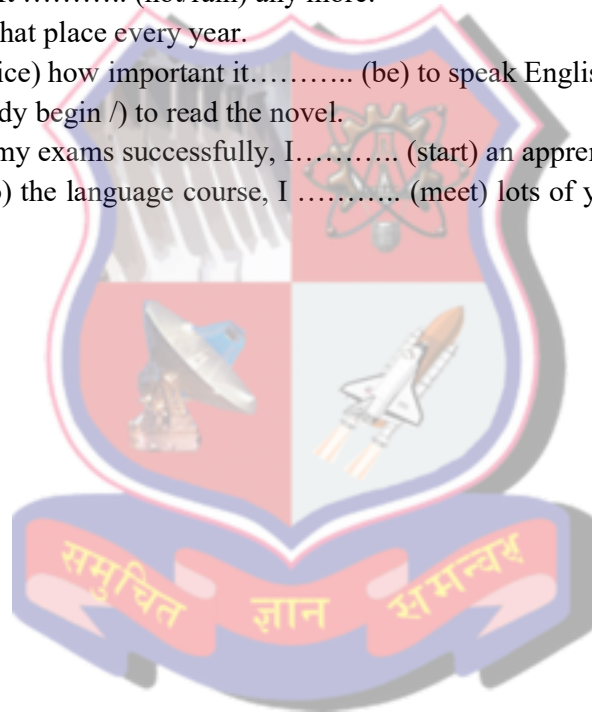
- i. To talk about facts in the future time which we cannot control.
Examples:
- My uncle will turn forty this Sunday
 - It will rain this week.
- ii. To indicate an action that we think, expect, hope or believe will happen in the future. Examples:
- I think Brazil will win the World Cup.
 - I'm sure 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

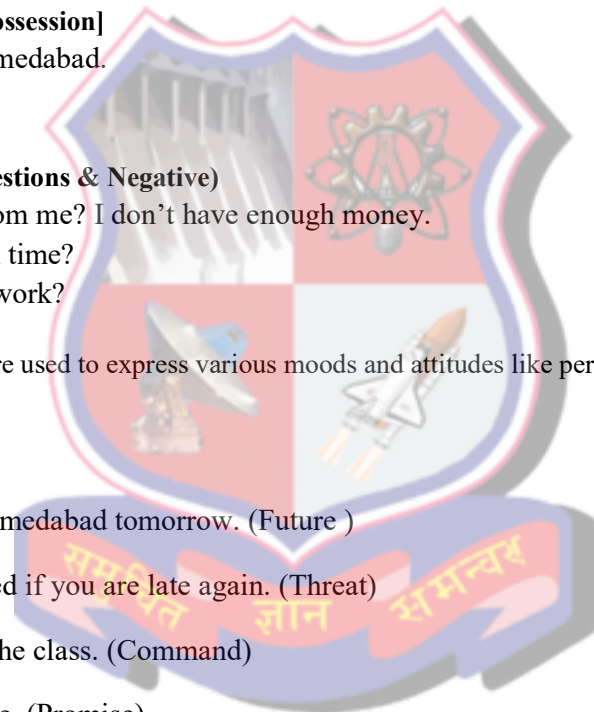
- He shall leave for Ahmedabad tomorrow. (Future)
- You shall be punished if you are late again. (Threat)
- You shall go out of the class. (Command)
- She shall have a prize. (Promise)
- Shall we have a cup of coffee?(Suggestion/ Proposal)
- Shall I carry your luggage? (to offer service)

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)

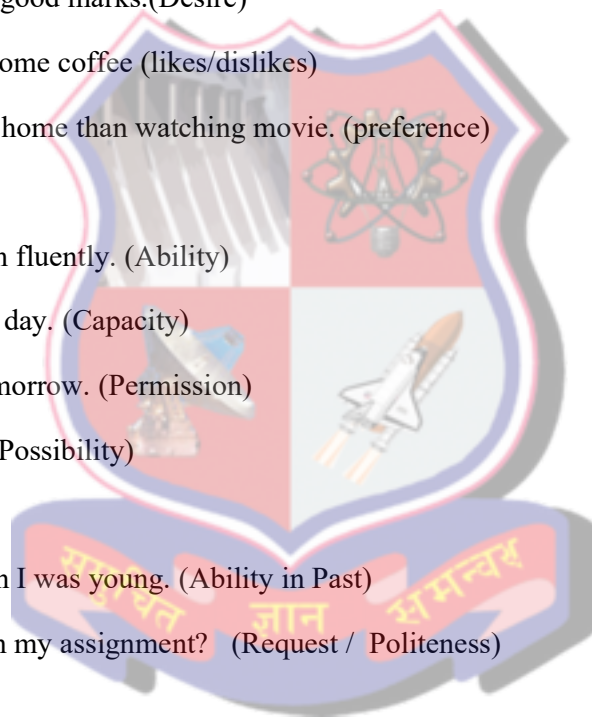
MAY

- 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:

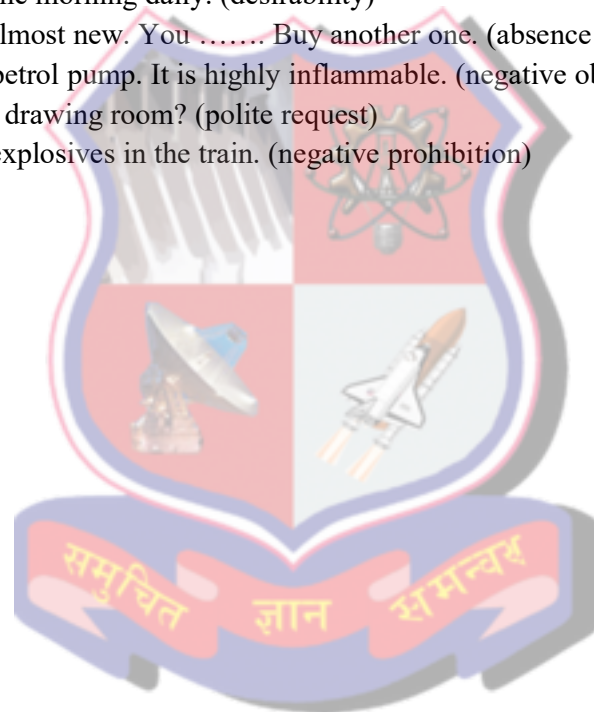
[1] Fill in the blanks with appropriate modal auxiliary:

1. On Saturdays, wego to school in informal dress.
2. Varun go for a vacation this summer.
3. When I was young, I swim across Ganga.
4. Younot 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) Shecome 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) Henot tell a lie before me. (Desirability)
- 10) Youcome whenever you like. (Permission)
- 11)god help you. (Blessing)
- 12) Wehonour 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) Iborrow from this library very soon. (Ability)
- 18) Wehelp the needy. (Desirability)
- 19)I carry your luggage? (Permission)
- 20) Younot 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) Theynot 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/weights) 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.

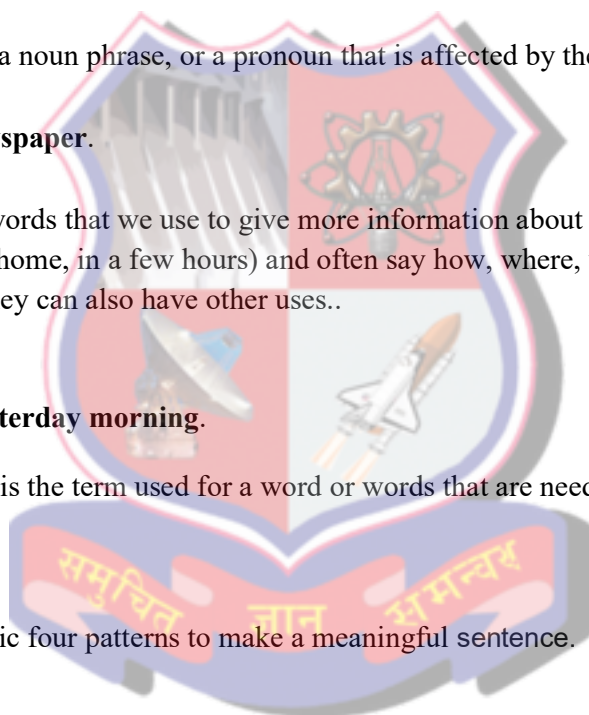
2. S+V+O: Subject + Verb+ Object

- 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 rocksworn 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 felt almost 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 I realized 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 sunlight that 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 that the place belonged to me, that dominion was mine.

The stream had at least one other regular visitor, a spotted fork-tail, and though it did 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 fork-tail 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 fork-tail often disappeared. I had no intention of robbing the bird: I was simply curious to see its 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 fork-tail, 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 fork-tail 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 her nest.

I decided to take her by surprise, and stood up suddenly, in time to see not the fork-tail 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 fork-tail 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-eater in 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. I wondered 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 another.

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 air and 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 houses on 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 lovers who 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-face with 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 was something 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 the human 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 a fine specimen?'

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

I walked home through the silent forest. It was very silent, almost as though the birds 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 steep and 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:

- 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
- When the author discovered the stream, it was month of ...
(a) May (b) June (c) February (d) April
- The ... was a regular visitor of the stream.
(a) Forktail (b) Tiger (c) lion (d) sparrow
- Leopard skins are sold in
(a) Delhi (b) Kolkatta (c) Lucknow (d) Mumbai
- 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."

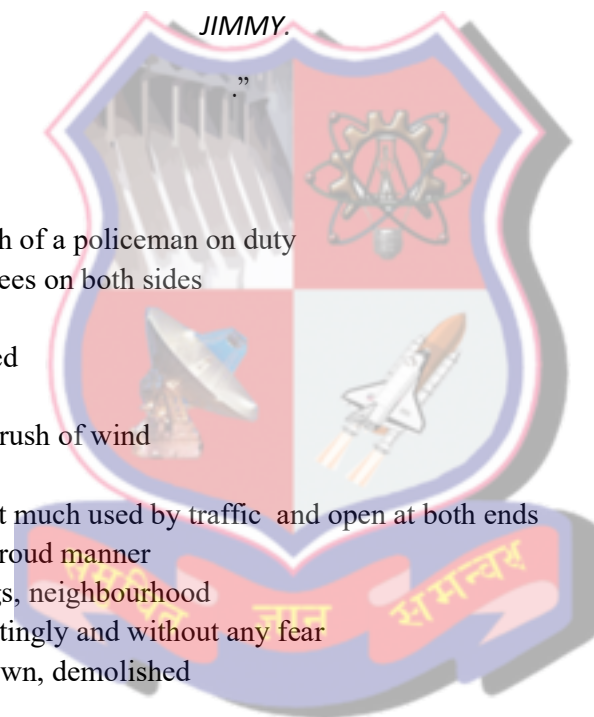
"It sometimes changes a good man into a bad one," said the tall man. "You've been under arrest for ten minutes, 'Silky' Bob. Chicago thinks you may have dropped over our way and wires us she wants to have a chat with you. Going quietly, are you? That's sensible. Now, before we go on to the station here's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

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?

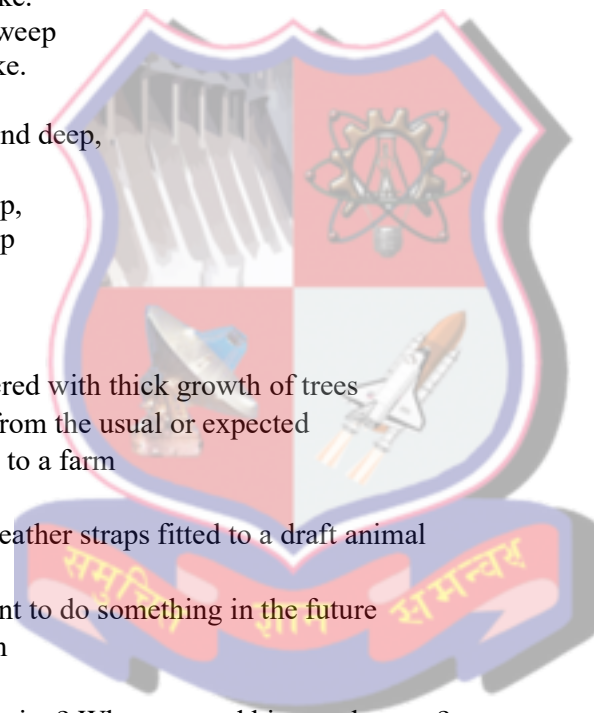
Q.7 What message do the last paragraph convey?

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



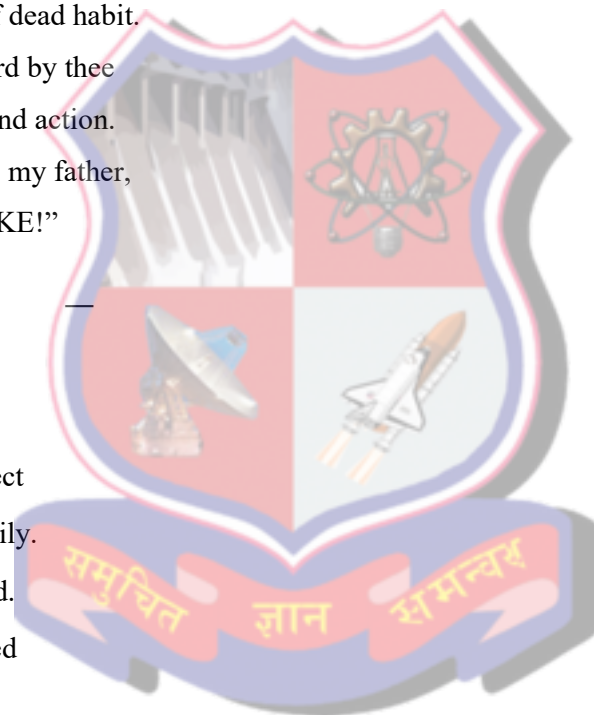
UNIT 4 Where the Mind is Without Fear

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 its 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

From: Sender's email id
To: Recipient's email id
Cc: Other individuals receiving the same mail with visible ids
Bcc: Other individuals receiving the same mail with invisible ids
Subject: Title or the reason of writing mail
Salutation: Words like Dear, Respected, Hi etc.
Main body: the main content of the email
<ol style="list-style-type: none"> 1. Introduction 2. Matter in detail 3. Conclusion
Closing: Ending Statement
Attachments: Attached Files with emails
Signature Line: Sender's name, signature, and other details of contact

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

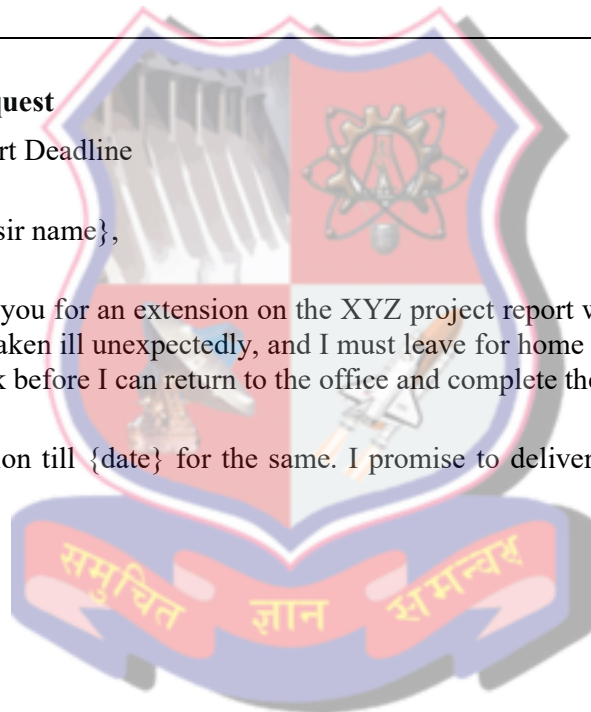
Subject: Extension on Report Deadline

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 2021 but 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 for 500 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: suhasininoveltyies@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.

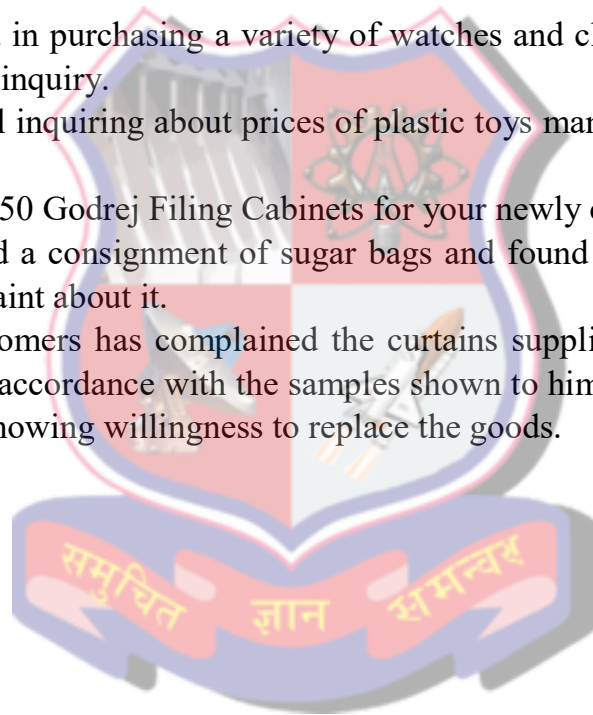
Thank You

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:

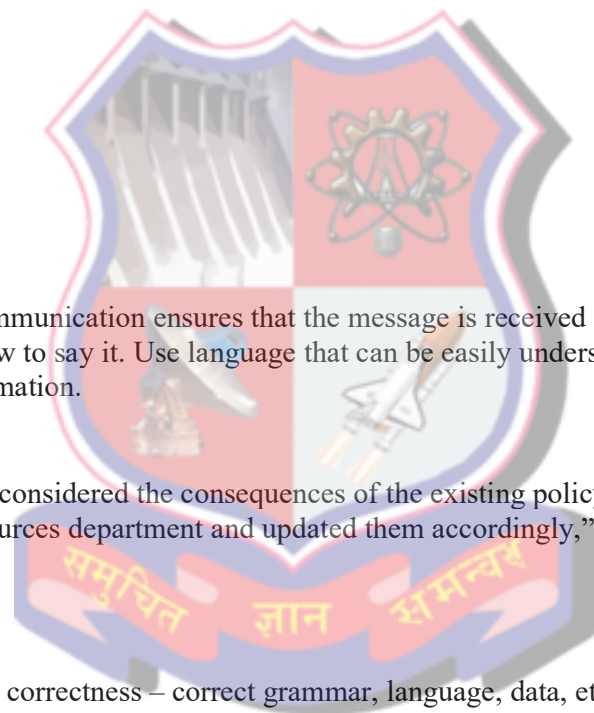
- “What are the opening hours, and what ID is considered relevant?”

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.

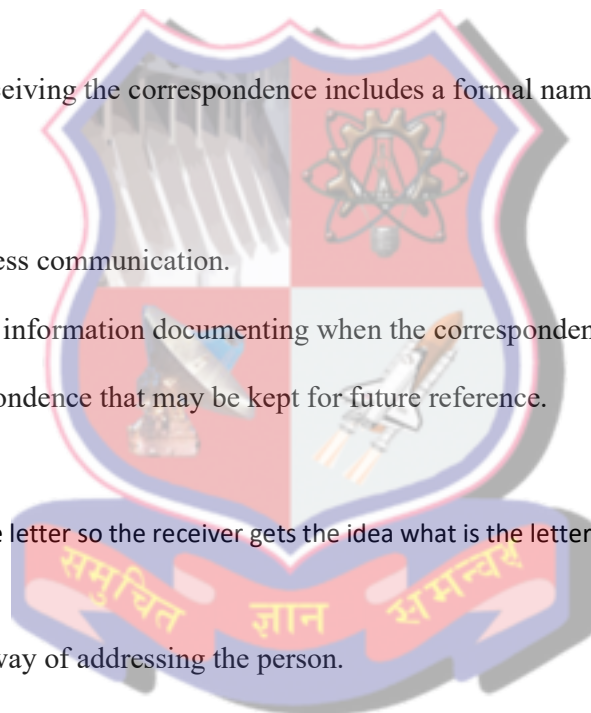
It is a summary in a sentence or two that explains the goal of the letter.

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

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

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. ← Body

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
Jack Jones
ABC Corporation ← Signature



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)

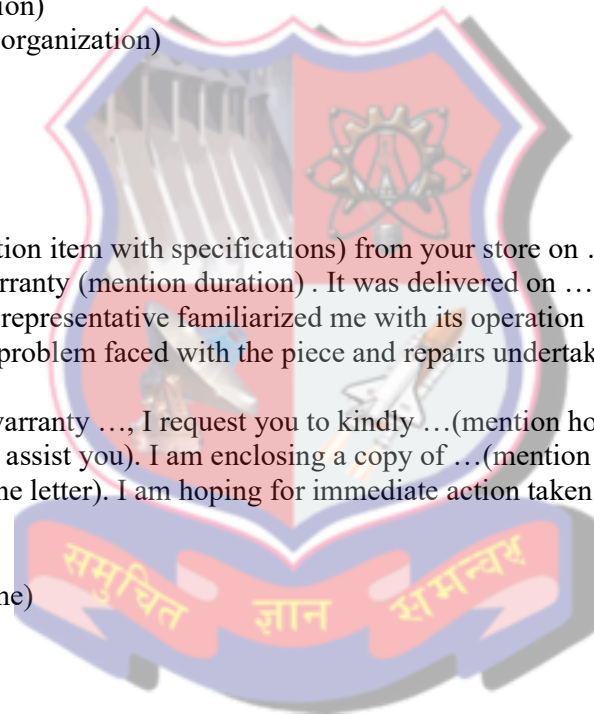
Dear Sir/Madam,

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.

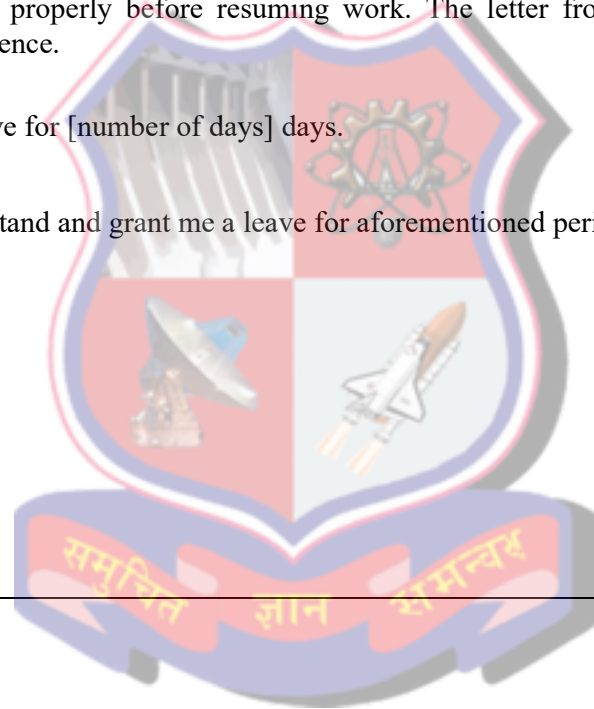
Kindly grant me a leave for [number of days] days.

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				
L	T	P		Theory Marks		Practical Marks		Total Marks
			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
	<p>the given liquid.</p> <p>3.d Explain viscosity, coefficient of viscosity, terminal velocity and Stokes' law.</p> <p>3.e Apply the concept of viscosity in explaining hydraulic system.</p> <p>3.f Explain types of fluid motion and Reynold number</p>	<p>3.1.5 Stress-Strain curve</p> <p>3.2 Surface Tension</p> <p>3.2.1 Surface tension; concept and units</p> <p>3.2.2 Cohesive and adhesive forces</p> <p>3.2.3 Molecular range and sphere of Influence</p> <p>3.2.4 Laplace's molecular theory</p> <p>3.2.5 Angle of contact, Ascent Formula (No derivation)</p> <p>3.2.6 Surface energy</p> <p>3.2.7 Applications of surface tension</p> <p>3.2.8 Effect of temperature and impurity on surface tension</p> <p>3.3 Viscosity</p> <p>3.3.1 Viscosity and its SI units</p> <p>3.3.2 Newton's law of Viscosity</p> <p>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</p> <p>3.3.4 Types of fluid motion, stream line and turbulent flow, critical velocity, Reynold's number</p> <p>3.3.5 Stokes' law</p> <p>3.3.6 Effect of temperature on viscosity</p> <p>3.3.7 Applications of viscosity in hydraulic systems</p>
<p>Unit- IV</p> <p>Heat and Thermometry</p>	<p>4.a Distinguish between heat and temperature.</p> <p>4.b Explain modes of heat transmission.</p> <p>4.c Explain various temperature scales and conversion between them.</p> <p>4.d Explain heat capacity and specific heat.</p> <p>4.e Explain types of thermometers and their uses.</p> <p>4.f Apply the concept of coefficient of thermal conductivity to solve</p>	<p>4.1 Heat and temperature</p> <p>4.2 Modes of Heat transfer: Conduction, Convection and Radiation</p> <p>4.3 Temperature measurement scales: Kelvin, Celsius and Fahrenheit and interconversion between them</p> <p>4.4 Heat capacity and specific heat</p> <p>4.5 Types of thermometers: Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer and their uses.</p>

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 ($y = A\sin(\omega t + \varphi)$) [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 ‘Application 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:

- Prepare model to demonstrate concepts of physics.
- Undertake micro-projects in teams
- Give seminar on any relevant topic.
- Measure physical quantities using smart phone.
- 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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- 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.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- 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:

- Measurement: Measure physical quantities using smart phone applications.
- Prepare proto type Vernier Calipers of given least count.
- Collect wires and sheets of different gauges from market and estimate errors in measurements using analog and digital Vernier Calipers.
- Elasticity: Prepare working model to demonstrate the stress – strain behavior of different wires of different thickness and material.
- Viscosity: Collect 3 to 5 liquids and prepare a working model to differentiate liquids based on viscosity and demonstrate their applications.
- Motion: Prepare model of ball rolling down on inclined plane to demonstrate the conservation of energy and motion of an object in inclined plane.
- Waves in string: standing waves in string using woofer loudspeaker.
- 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, 11 th 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, 10 th 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, 7 th edition, Delhi, 2015, ISBN-13: 978-1292057125
12	Principles of Physics	Jearl Ealker, David Halliday, Robert Resnick	Wiley India, Navi Mumbai 10 th 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

- <https://ocw.mit.edu/courses/physics/>
- <https://www.einstein-online.info/en/category/elementary/>
- <https://academicearth.org/physics/>
- www.nptel.iitm.ac.in
- http://phys23p.sl.psu.edu/phys_anim/Phys_anim.htm
- <http://www.atoptics.co.uk/>
- <https://www.khanacademy.org/science/physics>
- <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 <i>Use principles of physics to solve broadly defined engineering problems</i>	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	gragquantum@gmail.com

S. No.	Name and Designation	Institute	Contact No.	Email
5	Late Dr. Gaurang S. Patel Lecturer in Physics	Dr. S. & S. S. Gandhy 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: **Physics**

(Course Code: 4300005)

Diploma programme in which this course is offered	Semester in which offered
Biomedical Engineering, Electronics and Communication Engineering, Instrumentation & Control, Printing Technology	First
Computer Engineering, Electrical Engineering, Information Technology, Power Electronics	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 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:

- Use relevant instruments with precision to measure the dimension of given physical quantities in various engineering situations.
- Apply the concepts of electrostatics and capacitance for engineering applications.
- Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.
- Use the concept of waves and sound waves for various engineering applications involving wave dynamics.
- Use the concepts of LASER and Fiber optics for various engineering applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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) 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'.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Use Vernier calipers 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 a parallel plate capacitor to investigate the dependence of capacitance of a parallel plate capacitor on various factors.	II	02*
4	Use principles of series and parallel combinations of capacitance in solving various electrical circuits.	II	02
5	Use different types of thermometers to measure temperature of a hot bath and convert it into different scales.	III	02*
6	Use Searle's method to measure the coefficient of thermal conductivity of a given metallic rod.	III	02
7	Use Searle's method to determine the coefficient of linear expansion of the given metallic rod.	III	02
8	Use sonometer to find the frequency of given tuning fork.	IV	02*
9	Use resonance tube to determine velocity of sound in air at room temperature.	IV	02
10	Determine the refractive index of given semi-circular glass block using TIR.	V	02*
11	Determine refractive index of liquid by concave mirror.	V	02
12	Determine the value of the numerical aperture (NA) of given optical fibre.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
13	Use ultrasonic interferometer to determine the velocity of ultrasonic waves in different liquids.	V	02
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.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Vernier caliper analog - least count- 0.02 mm	1
2	Micrometer screw gauge analog (0-25 mm) – least count 0.01mm	2
3	Parallel plate capacitor (variable plate distance and area)	3
4	Digital capacitance meter	3, 4
5	Hot water bath	5
6	Mercury filled glass thermometer 0-110 °C, Mercury filled glass thermometer 0-250 °C., digital food thermometer, bimetallic thermometer.	5

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
7	Clamp with stand.	5
8	Searle's thermal conductivity apparatus - made up of pure copper and outer boxes are of wooden polished material, 04 thermometers, steam boiler, measuring cylinder, constant water level tank, pinch cork, stop watch (1/100 s), rubber tube.	6
9	Linear expansion apparatus, steam generator, rubber tubing, metal rods of aluminum, iron, copper, brass, and steel.	7
10	A Sonometer with a tuning fork set and two sharp edge wedges and a weight box.	8
11	Resonance tube apparatus, tuning forks of different frequencies, rubber pad, thermometer	9
12	Semi-circular glass block	10
13	Laser light pen	10
14	A concave mirror, stand, pointer	11
15	Complete set up to determine numerical aperture (NA) of optical fiber with LASER source.	12
16	Hot plate (1800 W)	6, 7
17	Ultrasonic interferometer - gold plated quartz crystal, operating voltage - 220 Volt, display - analog, frequency - 2MHz with position control	13
18	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 methods 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: Electrostatics	2.a Explain Coulomb's inverse square law and apply it on system of charges. 2.b Explain an electric field, electric flux, electric potential and potential difference. 2.c Explain the concepts of a capacitor, capacitance and working of parallel plate capacitor. 2.d Apply the concept of series and parallel combination of capacitors to solve problems in electrical circuits.	2.1 Charge, unit of charge, Coulomb's law 2.2 Electric field, electric field lines and its properties 2.3 Electric flux, electric potential and potential difference (point charge only) 2.4 Capacitor and its capacitance. ($C = Q/V$), Working of the parallel capacitor, formula ($C = \epsilon_0 \frac{A}{d}$), types of capacitors: Plane, spherical & cylindrical (Information only) 2.5 Equivalent capacitance of capacitors in series and in parallel combinations. 2.6 Effect of dielectric material on the capacitance of parallel plate capacitor. (No Derivation)
Unit – III: Heat and	3.a Distinguish between Heat and Temperature. 3.b Explain modes of heat	3.1 Heat and Temperature 3.2 Modes of Heat transfer: Conduction, Convection and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Thermometry	transmission. 3.c Explain various temperature scales and conversion between them. 3.d Explain Heat Capacity and Specific Heat. 3.e Explain types of thermometers and their uses. 3.f Apply the concept of coefficient of thermal conductivity to solve engineering problems. 3.g Explain expansion in solids and coefficient of linear expansions in solids.	Radiation 3.3 Temperature measurement scales: Kelvin, Celsius and Fahrenheit and interconversion between them 3.4 Heat Capacity and Specific Heat 3.5 Types of thermometers (Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer) and their uses 3.6 Coefficient of thermal conductivity and its engineering applications 3.7 Expansion of solids, coefficient of linear expansion
Unit – IV: Wave motion and its applications	4.a Explain wave and wave motion with example. 4.b Distinguish between longitudinal and transverse waves. 4.c Explain frequency, periodic time, amplitude, wave length and wave velocity. 4.d Explain sound waves, light waves and their properties 4.e Explain amplitude, phase, phase difference and wave equation. 4.f Explain principle of superposition of waves, interference and beat formation. 4.g Explain ultrasonic waves, production and their properties. 4.h Explain engineering and medical applications of ultrasonic waves.	4.1 Waves, wave motion, and types of waves: longitudinal and transverse waves 4.2 Frequency, periodic time, amplitude, wave length and wave velocity and their relationship 4.3 Properties of sound and light waves 4.4 phase, phase difference and various terms of wave equation ($y = A \sin(\omega t + \phi)$) [NO equations of velocity and acceleration] 4.5 Superposition of waves, Interference: constructive and destructive interference, condition for stationary interference pattern, beat formation 4.6 Ultrasonic waves, production of ultrasonic waves – magnetostriction and piezoelectric method, their properties, applications of ultrasonic waves in the field of engineering and medical
Unit – V: Optics and Modern Physics	5.a Apply Snell's law to calculate refractive index of given medium 5.b Explain the phenomenon of total internal reflection 5.c Explain LASER and its in	5.1 Refraction, refractive index and Snell's law 5.2 Total internal reflection, critical angle and necessary conditions for total internal reflection 5.3 Application of total internal

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	engineering and medical applications. 5.d Explain construction and working principle of step index and graded index optical fibers. 5.e Comprehend engineering and medical applications of optical fiber.	reflection in optical fibre 5.4 LASER, characteristics of LASER, differences between LASER and ordinary light 5.5 Applications of LASER in engineering and medical field. 5.6 Optical fiber and light propagation through optical fiber, acceptance angle and numerical aperture 5.7 Step index and graded index 5.8 Applications of optical fiber in engineering and medical. 5.9 Advantages of optical fiber over coaxial cable.

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.

- '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 instruction and assessment in each unit.
- Only scalar treatment is to be given to Coulomb's law (No Vector Treatment)
- Concept of electric potential and potential difference is constrained to Point charge only.
- Types of capacitors: parallel plate, spherical & cylindrical are for information point of view only.
- Types of Optical Fiber: Step index and Graded index (Only Single mode)

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	8	4	4	5	13
II	Electrostatics	8	4	4	5	13
III	Heat and Thermometry	8	2	5	6	13
IV	Wave motion and its applications	9	4	6	5	15
V	Optics and Modern Physics	9	4	7	5	16
Total		42	18	26	26	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 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-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) Measurement: Measure physical quantities using smart phone applications.
- b) Prepare proto type Vernier calipers of given least count.
- c) Arduino: Physical quantities such as Voltage, Magnetic field, Temperature, Light, Sound and distance can be measured with the help of low-cost sensors and Arduino.
- d) Paper Capacitor: Aluminum foil and tissue paper can be used to make cylindrical capacitor.
- e) Variable capacitor: Two copper cylinders and plastic pipe can be used to make variable capacitor.
- f) Sugar and bending of light: prepare a solution of sugar and water to demonstrate bending of light (using semiconductor LASER).
- g) Fiber optics: prepare an optical fiber cable using transparent flexible plastic tube, laser and water to demonstrate the property of optical fiber cable.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	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)
2	Physics for Scientists and Engineers with Modern Physics	John W. Jewett & Raymond A. Serway	CENGAGE Learning, 2010, Boston, 10 th edition, ISBN-10: 1337553298
3	University Physics (Volume I, II & III) (Open-source Material)	William Moebs, Samuel J. Ling & Jeff Sanny	OPENSTAX, 2016, Houston, Texas ISBN-13: 1-947172-20-4
4	PHYSICS for SCIENTISTS & ENGINEERS with Modern Physics	Douglas C. Giancoli	Pearson, 2015, 7 th edition, Delhi, ISBN-13: 978-1292057125
5	Principles of Physics	Jearl Ealker, David Halliday, Robert Resnick	Wiley India, 2015, Navi Mumbai 10 th edition, ISBN-13: 978-8126552566
6	Physics in Daily Life With illustrations	L.J.F. Hermans & Wiebke Drenckhan	EDP Sciences, 2012, France ISBN: 978-2-7598-0705-5
7	Introductory Physics: Building Models to Describe Our World (Open-Source Material)	Ryan Martin, Emma Neary, Joshua Rinaldo & Olivia Woodman	Creative Commons license, 2019, GitHub
8	Concept of Physics (volume I & II)	H.C. Verma	Bharati Bhavan Publishers, 2017, 1 st edition, New Delhi, ISSN-13: 978-8177091878

S. No.	Title of Book	Author	Publication with place, year and ISBN
9	Introduction to Fiber optics	Ajoy Ghatak & K. Thyagarajan	Cambridge University Press India Pvt. Ltd., New Delhi, ISBN: 9780521577854

14. SUGGESTED LEARNING WEBSITES

- www.williamson-labs.com
- www.cadsoft.io
- www.nptel.iitm.ac.in
- www.khanacademy
- www.olabs.edu.in
- www.vlab.co.in
- www.vlabs.iitb.ac.in
- www.vlab.amrita.edu
- www.praxilabs.com
- www.compadre.org/osp/
- www.datasheetcafe.com

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Physics (Course Code: 4300005)						
	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 <i>Use Principles of Physics to solve broadly defined engineering problems.</i>	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) Apply the concepts of electrostatics and capacitance for engineering applications	3	1	1	2	-	-	1
CO c) Apply the basic concepts of heat transfer and thermometric properties to provide solutions for various engineering problems.	3	1	1	2	1	-	1
CO d) Use the concept of waves and sound waves for various engineering applications involving wave -dynamics.	3	1	1	2	1	-	1
CO e) Use the concepts of LASER and Fiber optics for various engineering applications.	3	-	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**

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1	Shri Dineshkumar V. Mehta Lecturer in Physics	Government Polytechnic, Gandhinagar	9879690825	dv_mehta@yahoo.com
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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
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

I/II – Semester

Course Title: **Engineering Chemistry**

(Course Code: 4300006)

Diploma programme in which this course is offered	Semester in which offered
Electrical Engineering, Power Electronics Engineering	First
Biomedical Engineering	Second

1. RATIONALE

The background of chemistry allows engineers to get the most out of raw elements in creating fuels, drugs, new and modern materials, construction materials etc. needed in wide variety of engineering and technological applications. The in-depth comprehension of concepts and chemical reactions involved in chemistry would be applicable in solving the problems of engineering in spectrum of engineering branches like, electrical, Power Electronics Engineering, Biomedical Engineering etc.

The deep understanding of various topics/ subtopics of engineering chemistry course would enable the diploma engineers to understand and solve the various engineering problems, developments and breakthrough in engineering and technology in a very systematic and scientific way.

2. COMPETENCY

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

- **Use principles of engineering chemistry 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:

- Apply the principles of chemical bonding and solutions to solve various engineering problems.
- Solve engineering problems using the concepts of electrochemistry and corrosion.
- Use relevant fuels and lubricants for domestic and industrial applications.
- Select appropriate engineering materials for industrial applications.
- **Choose various types of electrochemical devices for domestic and industrial applications.**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 the integration of COs, and the remaining 20 marks are 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 subcomponents of the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.		Approx. Hrs. required
1	Prepare a standard solution of oxalic acid or potassium permanganate.	I		02
2	Determine the strength of the given sodium hydroxide solution by titrating against standard oxalic acid solution using phenolphthalein indicator.	I		02
3	Standardize potassium permanganate solution by standard oxalic acid solution and estimate ferrous ions.	II	Any three	02
4	Determine pH-Values of given samples of Solution by using Universal Indicator and pH-meter.	II		02
5	Determine emf of an electrochemical cell (Daniel cell).	II		02
6	Determine electrochemical equivalent of copper metal using Faraday's first law.	II		02
7	Determine the rate of corrosion for different metals in the given solution.	III		02
8	Determine the rate of corrosion of metal in the solution of different pH.	III		02
9	Determine the calorific value of solid or liquid fuel using a bomb calorimeter.	IV		02
10	Determine the percentage of moisture content in the given sample of coal by proximate analysis.	IV		02
11	Determine the ash content of the given sample of coal by proximate analysis.	IV		02
12	Determine the viscosity of the lubricating oil using a Redwood viscometer.	V	Any three	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
13	Determine the Acid value of the given lubricating oil.	V	02
14	Determine the Saponification value of the given lubricating oil	V	02
15	Determine flash point and fire point of the given lubricating oil using Pensky Martens/Cleveland open cup/Able's flashpoint apparatus.	V	02
16	Prepare Polystyrene and Bakelite. (Any one)	VI	02
Total Hrs.			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 experimental setup accurately.	10
2	Use apparatus for precise measurements.	20
3	Practice and adapt good and safe measuring techniques.	10
4	Good Record keeping of the observations accurately.	20
5	Interpret the results and their conclusion.	20
6	Prepare Report in prescribed format	10
7	Viva-Voce	10
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 the conduction of practice in all institutions across the state in a proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Digital pH Meter: Type: Microcontroller Based, Display: LED / LCD / Touch Screen, 3 digits, Calibration: up to 3 points with auto buffer, pH Range (pH): 0.00 to 14.00, +/- 0.05, Power Requirements: 230 V +/- 10, 50 Hz AC, Modes: pH mV- C, Temperature Compensation Type: Automatic,	4

S. No.	Equipment Name with Broad Specifications	PrO. No.
	Temperature Compensation Range (Degree C): 0 to 100, Temperature Accuracy (Degree C): +/- 0.3, Resolution (pH): 0.01	
2.	Bomb Calorimeter: Calorimeter outer container: Aluminum with rolled rim, Shape of the container: Cylindrical, Type of top cover: Removable, Calorimeter vessel: Copper, Calorimeter vessel size (Height x dia.), in mm: 100x75, Material of Stirrer: Copper, Stirrer size (Height x dia.), in mm, (min): 100 x 3.5, Stirrer with a loop at the bottom to fit inside the Calorimeter, Thermometer holder, removable: Nickel-plated brass.	9
3.	Hot Air Oven: Temperature is controlled by digital temperature indicator cum controller from ambient to 250°C with $\pm 0.1^\circ\text{C}$ Accuracy. Power supply: 220/230V, 50Hz single phase, Capacity (Approx.): 50 – 100 liter, Type of Shelves: 03, Material of Inner Chambers: SS 304, Material of Outer Chamber: MS with powder coated paint, Material of Shelves: SS wire mesh.	10
4.	Muffle Furnace: The Furnace should be provided with a fast response temperature probe and with high-density energy-saving Ceramic Wool, Temperature Range 0-1200 °C. Muffle Size (approx.): 6" X 6" X 12", Display: LED.	11
5.	Redwood viscometer: Flow Range (Viscosity) in second: 20-2000, Redwood Viscometer Model No.: 01, Material: Stainless Steel, Bath Capacity (Approx.): 7 liters, Temperature Required: 95 °C, Power supply: 220 Volt, 800 Watt, 50 Hz.	12
6.	Pensky Martens flash point apparatus: Voltage: 220-240V, Phase: Single phase, Power Source: Electric, Timing Range: 999.9s <u>OR</u> Cleveland Open Cup apparatus: Temperature range: Ambient to 370°C, Temp. measurement PT100 temp. sensor, Temp. scale resolution 0.1°C, Ignition source gas or electric, cooling forced air cooling, heating coil, heating 888W, 220V, AC. <u>OR</u> Abel's flash point apparatus: Material: Stainless Steel, Power Source: Electric, Voltage: 115V/220-240V, 50-60 Hz, Dimensions: 230 mm x 470 mm x 470 mm (W x D x H) Temperature Range: 70 °C, Resolution: 0.1 °C	15
7.	Laboratory weighing balance: Type of Laboratory Balance: Analytical, Sensitivity (mg): 1 mg, Maximum Capacity of weighing (grams): 200 g, Shape of PAN: Circular, Power Supply: Single Phase, Display: LED.	All
8	Hot plate with Magnetic stirrer: Number of stirring Positions:1, Calibration: Automatic Calibration, Magnetic stirrer with a hot plate, Speed Control Accuracy of set speed	1,2,3,4,13,14

S. No.	Equipment Name with Broad Specifications	PrO. No.
	(+/-) (RPM): 5, Maximum Stirring capacity per position: 3000 ml, Top plate Material: Stainless steel.	

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.

- Work as a leader/a team member.
- Follow ethical practices
- Observe safety measures
- Good house keeping
- Time management
- Practice environmentally 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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year.
- '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 the attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Atomic Structure, Chemical Bonding and Solutions	1a. Apply the different atomic theories, models and principles for structural illustration. 1b. Explain Pauli's exclusion principle, Hund's rule and Aufbau rule with examples. 1c. Write the electronic configurations of different elements. 1d. Describe the different types of chemical bonds. 1e. Differentiate among the ionic, covalent and coordinate compounds based on the type of chemical bonding.	1.1. Atomic Structure: Concepts of orbit and orbital, Pauli's exclusion principle. 1.2. Hund's rule of maximum multiplicity, 1.3. Aufbau rule, electronic configuration of atom (up to atomic number 30) 1.4. Chemical Bonding: Concept of chemical bonding, types of chemical bonds, Ionic bond, and its characteristics (example NaCl), Covalent bond and its characteristics (example H ₂ , O ₂ , N ₂ , HF, NH ₃ , H ₂ O, CH ₄), Coordinate covalent bond (example NH ₄ ⁺ , H ₃ O ⁺), Metallic bond and its

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	1f. Explain various properties of Materials depending upon bond formation. 1g. Prepare the solution of given concentrations (Normality, Molarity).	characteristics, Hydrogen bonding, its types, and Significance, Intermolecular force of attraction. 1.5. Molecular arrangement in solid, liquid and gases, Structure of solids - Molecular solid, Ionic solid, Network solid, and Metallic solid. 1.6. Solutions: The Idea of solute and solution, Methods to express the concentration of solution - Normality, Molarity ($M = \text{mole per liter}$), ppm, mass percentage, volume percentage, and mole fraction.
Unit – II Concepts of Electrochemistry	2a. Explain the theory of ionization and the factors affecting it. 2b. Describe pH value and its industrial application. 2c. Describe different types of buffer solutions and their application. 2d. Differentiate electrolyte and nonelectrolyte. 2e. Describe the construction and working of an electrochemical cell and standard hydrogen electrode (SHE) 2f. State the Nernst equation and Faraday's laws of electrolysis and its application. 2g. Use the different electrolysis process such as electro metallurgy, electroplating and electrorefining to solve wide variety of industrial problems.	2.1. Arrhenius theory of ionization. 2.2. Electronic concept of oxidation, reduction, and redox reactions. 2.3. Degree of ionization and factors affecting the degree of ionization. 2.4. Definition of pH, pH of acid, base and neutral solution, pH calculations for acid, base, and salt solutions at different concentrations, Importance of pH in various fields. 2.5. Definition of buffer solution, buffer action and types of buffer solution, Application of buffer solution. 2.6. Definition of terms: electrolytes, non-electrolytes with suitable examples, Types of electrolytes. 2.7. Construction and working of Electrochemical Cell. 2.8. Construction and working of Standard Hydrogen Electrodes (SHE). 2.9. Nernst theory of single electrode potential and Nernst equation. 2.10. Electrochemical series. 2.11. Electrolysis, Faraday's laws of electrolysis. 2.12. Industrial application of electrolysis: Electro metallurgy, electroplating, and electro refining.
Unit– III	3a. Describe the various types of corrosion.	3.1. Corrosion: Dry or Chemical corrosion: Oxidation corrosion-

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Corrosion of metals and its prevention	3b. Identify the different factors affecting the rate of corrosion. 3c. Explain the various type of protective measures to prevent corrosion. 3d. Select relevant method to prevent metal from corrosion	mechanism, Corrosion by other gases. 3.2. Wet or Electrochemical corrosion- H ₂ liberation and O ₂ absorption mechanism of electrochemical corrosion. 3.3. Galvanic corrosion mechanism. 3.4. Concentration cell corrosion. 3.5. Pitting corrosion, Waterline and Crevice corrosion. 3.6. Factors affecting the rate of corrosion: Nature of the metal, Nature of surface film, Relative areas of the anodic and cathodic parts, Purity of metal, Temperature, Humidity of air, Influence of pH. 3.7. Internal and External corrosion preventive measures: Modification of environment, Modification of the properties of metal, Use of protective coatings, Anodic and cathodic protection, Modification in design and choice of material
Unit– IV Fuels and Combustion	4a. Classify various types of fuels. 4b. Calculate the calorific value of various fuels using Dulong's formula. 4c. Determine proximate analysis of coal for assessing its quality for domestic and industrial use. 4d. Assess the efficiency of coal by determining the calorific value of fuel. 4e. State the significance of octane and cetane number. 4f. Justify the need for alternative fuels.	4.1. Definition and Classification of fuels, Calorific values and their units. Determination of calorific value using a bomb calorimeter. 4.2. Characteristics of good fuel. 4.3. Comparison between solid, liquid, and gaseous fuels. 4.4. Theoretical calculation of HCV and LCV of fuel using Dulong's formula. 4.5. Solid fuels: Coal, Classification of coal, Proximate and ultimate analysis of coal. 4.6. Liquid fuels: Petroleum, Origin of petroleum and classification of petroleum, Refining of petroleum. 4.7. Petrol and Diesel-fuel rating (Octane and Cetane numbers), Power alcohol and Bio-diesel. 4.8. Chemical composition, Calorific values, and Applications of LPG, CNG, water gas, coal gas, producer gas, and biogas.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– V Lubricants	5a. Explain terms lubricant and lubrication 5b. Describe the types of lubricants. 5c. Describe the physical and chemical properties of a lubricant. 5d. Selection of proper lubricants for engineering use. 5e. Select relevant lubricant based on their function and characteristic properties for use in different kind of machinery. 5f. Determine viscosity, flash and fire point of given lubricant for their specific use. 5g. State the biodegradable lubricants.	5.1. lubricants and Lubrication, Functions of lubricants. 5.2. Mechanism of Lubrication: Fluid lubrication, Boundary lubrication. Classification of lubricant with examples: Solid, Semi-solid, liquid and synthetic lubricants. 5.3. Physical Properties of lubricants: Viscosity and viscosity index, Flash and fire point, Cloud and pour point, Oiliness. 5.4. Chemical properties of lubricants: Saponification number, Neutralization number, Emulsification number. 5.5. Selection of lubricants for different types of Machinery like: Gears, Cutting tools, Steam turbine, Transformers. 5.6. Biodegradable lubricants
Unit– VI Polymers, Elastomers, and Insulating Materials	6a. Classify Polymers based on molecular structures and monomers. 6b. Differentiate thermoplastic and thermosetting polymers with examples. 6c. Explain polymerization reactions with examples. 6d. Describe the applications of thermoplastic and thermosetting polymers. 6e. Describe the application of biodegradable polymers. 6f. Explain the properties and application of synthetic rubbers. 6g. Explain the process of vulcanization of rubber. 6h. Use relevant insulating materials for engineering applications.	6.1. Definition of Monomer, Polymer and Polymerization. 6.2. Classification of Polymers based on molecular structure: Linear Polymers, branched polymers, Cross-linked polymers. 6.3. Classification of polymers based on Monomer: Homopolymer, Copolymer. 6.4. Classification of polymers based on thermal behavior: Thermoplastics and Thermosetting polymers. 6.5. Types of polymerizations: Addition and condensation polymerization 6.6. Simple reactions involved in the preparation and their properties and application of thermoplastics and thermosetting polymers: Polyethylene, Polypropylene, Polyvinyl chloride, Polytetrafluoroethylene (Teflon), Polystyrene, Polyacrylonitrile, Bakelite, Epoxy resins. 6.7. Biodegradable Polymers:

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		Introduction, chemical composition, and application: Poly β -hydroxybutyrate-co- β -hydroxy valerate (PHBV), Nylon-2-nylon-6. 6.8. Rubber: Natural rubber and its properties, Vulcanization of rubber, Synthetic rubber – simple reaction involved in the preparation and their properties and application: Buna-S rubber, Buna-N rubber, Neoprene rubber 6.9. Insulating Materials: Types and Properties of Insulating materials, Application of Thermal and Electrical Insulating Materials.
Unit– VII Electrochemical Energy Sources	7a. Describe the construction and working of various batteries. 7b. Explain the working of fuel cell. 7c. Describe the solar cells. 7d. Use the different types of fuel cells based on their mechanism and characteristics.	7.1 Batteries: An electrochemical source of energy, Types of Batteries: Primary, Secondary and Fuel batteries 7.2 Dry cell - construction and working. 7.3 Lead-acid storage cell - construction and working. 7.4 Nickel/Cadmium battery - construction and working. 7.5 Fuel cells - definition, example Hydrogen fuel cell, and biochemical fuel cell, Characteristics of fuel cells, Solar Cells.

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	Atomic Structure, Chemical Bonding, and Solutions	06	03	03	02	08
II	Concepts of Electrochemistry	07	02	06	04	12
III	Corrosion of metals and its prevention	05	02	04	02	08
IV	Fuels and Combustion	07	03	05	04	12
V	Lubricants	05	02	04	02	08

VI	Polymers, Elastomers, and Insulating Materials	07	03	06	05	14
VII	Electrochemical Energy Sources	05	02	04	02	08
Total		42	17	32	21	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, 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 group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidence such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

- a) Prepare a PowerPoint presentation or animation showing different types of chemical bonds and atomic structures.
- b) Prepare a model of an atom with the help of a ball and stick or of any other items.
- c) pH Calculations for acid, base, and salt solutions at different concentrations.
- d) Preparation of a table showing the different methods used for prevention of corrosion.
- e) Solve simple problems on hardness calculation.
- f) Market survey of different lubricating oil and compare their physical and chemical properties.
- g) Library survey regarding polymers, synthetic rubber, and adhesives used in different industries.
- h) Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.
- i) Market survey of different batteries and differentiate primary and secondary batteries.

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/activities.
- c) Different types of teaching methods i.e. video demonstration, activity-based learning, case study, m-learning need to be employed by teachers to develop the outcomes.

- d) **Some of the topics/sub-topics** which are relatively simpler or descriptive are to be given to the students for **self-learning** but to be assessed using different assessment methods.
- e) Teachers need to ensure to create opportunities and provisions for **co-curricular** activities.
- f) Guide students to address issues on environment and sustainability with reference to using the knowledge of this course.
- g) OERs, Vlab, and Olabs may be used to teach for the teaching of different concepts.

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-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 the 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 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 (so that they develop industry-oriented COs).

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

- a) Prepare a PowerPoint animation that can explain the structure of an atom.
- b) Prepare a chart of the modern periodic table which gives information about the atomic number and mass number of different elements.
- c) Prepare common salt crystals from NaCl solution
- d) Prepare a chart representing compounds and solutions which affect human life positively and negatively.
- e) Prepare a model of an atom with the help of a ball and stick or of any other items.
- f) Form three groups of students in the class. Consider a hypothetical situation of exchanging/ sharing/giving of different items/belongings and demonstrate the type of ionic, covalent, and co-ordinate bonding amongst the students in a simulated situation. Present your findings.
- g) Model of electronic configurations for different atoms ($Z=30$)
- h) Prepare a model to demonstrate the application of electrolysis cells.
- i) Collect three metallic strips of Al, Cu, Fe, strips, Place them in different acidic and alkaline solutions of the same concentration. Observe and record the loss in weight of metals due to an acidic and alkaline environment. Discuss the findings with your teacher and colleagues.
- j) Classify the surrounding corrosion into dry corrosion and wet corrosion.
- k) Collect different samples of utensils reinforced materials, iron, copper, brass, bronze, and other alloys. Place them in an open environment under tin shade. Observe the corrosive properties over a period of four weeks. Record your observations. Discuss the findings with your teacher and colleagues.
- l) Collect samples of petrol, kerosene oil, diesel, any edible oil, coconut oil. Find out the

flash point and fire point, cloud and pour point, and viscosity of the same. Compare the properties and justify their use in relevant applications.

- m) Depending on the type of machinery, the load applied, speed of the machine, heat generated, etc, select the appropriate lubricant which can be applied to the machinery. Discuss with your teachers and colleagues and present the same.
- n) Make a table showing the availability of natural rubber in India and show places on the India map.
- o) Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.
- p) Collect fuel samples from different sources and prepare a chart showing their calorific values and uses.
- q) Mapping of energy resources in India.
- r) Collection of data of various electrochemical cells-batteries used in equipment and devices and available in the market.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with the place, year and ISBN
1	Engineering Chemistry	Jain & Jain	Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2015, ISBN: 93-521-6000-2
2	A Textbook of Engineering Chemistry	Dr. S. S. Dara & Dr. S. S. Umare	S. Chand & Co.(P) Ltd., New Delhi, 2014, ISBN:81-219-0359-9
3	Textbook of Chemistry for Class XI & XII (Part-I & II)	NCERT	NCERT, New Delhi, 2017-18, Class-XI, ISBN: 81-7450-494-X (part-I), 81-7450-535-O (part-II), Class-XII, ISBN: 81-7450-648-9 (part-I), 81-7450-716-7 (part-II)
4	Engineering Chemistry	Shikha Agarwal	Cambridge Uni. Press, New Delhi, 2019, ISBN: 978-1-108-72444-9
5	Understanding Chemistry	C.N.R. Rao	World scientific publishing Co., 2009, ISBN: 9789812836045
6	Engineering Chemistry	Dr. Vikram, S.	Wiley India Pvt. Ltd., New Delhi, 2013, ISBN: 9788126543342
7	Applied Chemistry Laboratory Practices, Vol. I & II	Dr. G.H. Hunger & Prof. A.N. Pathak.	NITTTTR, Chandigarh, Publication, 2013-14
8	Chemistry for Engineers	Rajesh Agnihotri	Wiley India Pvt. Ltd., 2014, ISBN: 9788126550784
9	Fundamental of Electrochemistry	V. S. Bagotsky	Wiley International N. J.,2005, ISBN: 9780471700586

14. SUGGESTED LEARNING WEBSITES

- a) <http://www.chemguide.co.uk/atommenu.html>
- b) <https://www.visionlearning.com>
- c) <http://www.chem1.com>

- d) <http://www.em-ea.org>
 e) <https://ncert.nic.in>
 f) www.onlinelibrary.wiley.com
 g) www.rsc.org
 h) www.chemcollective.org
 i) www.wqa.org
 j) <https://docslib.org/insulation-materials-science-and-application>
 k) <http://www.olabs.edu.in/>
 l) http://chemcollective.org/activities/type_page/1
 m) <http://www.presentingscience.com/vac/corrosion/index.htm>
 n) <https://vlab.amrita.edu/index.php?sub=2&brch=190>

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Engineering Chemistry (Course Code: 430006)						
	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 engineering chemistry to solve broadly-defined engineering problems.	3	2	2	1	1	1	1
Course Outcomes CO1: Apply the principles of chemical bonding and solutions to solve various engineering problems.	3	1	-	1	-	-	1
CO2: Solve engineering problems using the concepts of electrochemistry and corrosion.	3	1	-	1	1	-	1
CO3: Use relevant fuels and lubricants for domestic and industrial applications.	3	1	1	1	1	-	1
CO4: Select appropriate engineering materials for industrial application.	3	1	-	1	1	1	1
CO5: Choose various types of electrochemical devices for domestic and industrial applications.	3	1	-	1	1	1	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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NITTR Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

I/II – Semester

Course Title: **Basic Chemistry**

(Course Code: 4300011)

Diploma programme in which this course is offered	Semester in which offered
Chemical Engineering, Textile Processing Technology	First
Printing Technology, Textile Manufacturing Technology, Textile Designing	Second

1. RATIONALE

The branch of applied science that deals with chemistry is known as Basic chemistry. The study of concepts and principles of Basic chemistry will aid the technicians in comprehending and solving engineering problems. Thus, a strong foundation in applied science will help the students in their self-development to cope up with the constant influx of innovations. There are numerous materials used in fabricating and manufacturing devices for the comfort of life. The selection, characterization, and suitability assessment of natural raw materials essentially requires principles and concepts of Basic Chemistry for technicians. Successful completion of this course content will enable technicians to understand, ascertain and analyze properties of natural raw materials required for producing economical and eco-friendly finished products.

2. COMPETENCY

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

- **Use principles of basic chemistry 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:

- Apply the principles of chemical bonding and solutions to solve various engineering problems.
- Solve the engineering problems using the concepts of electrochemistry and corrosion.
- Use relevant water treatment methods to solve domestic and industrial problems.
- Classify organic compounds on the basis of their functional groups.
- **Choose various types of engineering materials like lubricants, polymers, Elastomers and Adhesives for domestic and industrial applications.**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 the integration of COs, and the remaining 20 marks are 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 subcomponents of the COs. *These PrOs need to be attained to achieve the Cos.*

S. No.	Practical Outcomes (PrOs)	Unit No.		Approx. Hrs. required
1	Prepare a standard solution of oxalic acid or potassium permanganate.	I		02
2	Determine the strength of the given sodium hydroxide solution by titrating against standard oxalic acid solution using phenolphthalein indicator.	I		02
3	Standardize potassium permanganate solution by standard oxalic acid solution and estimate ferrous ions.	II	Any Three	02
4	Determine pH-Values of given samples of Solution by using Universal Indicator and pH-meter.	II		02
5	Determine emf of an electrochemical cell (Daniel cell).	II		02
6	Determine electrochemical equivalent of copper metal using Faraday's first law.	II		02
7	Determine the rate of corrosion for different metals in the given solution.	III		02
8	Determine the rate of corrosion for metal in the solution of different pH.	III		02
9	Estimate total hardness of given water sample using standard EDTA solution.	IV	Any Three	02
10	Estimate alkalinity of given water sample using 0.01M sulphuric acid solution.	IV		02
11	Determine Total Dissolved Solid (TDS) and Total	IV		02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Suspended Solid (TSS) in a given sample of water.		
12	Determine viscosity of lubricating oil using Redwood viscometer.	VI	02
13	Determine the Acid value of the given lubricating oil	VI	02
14	Determine the Saponification value of the given lubricating oil	VI	02
15	Determine flash point and fire point of the given lubricating oil using Pensky Martens/Cleveland open cup apparatus/Able's flashpoint apparatus.	VI	02
16	Prepare Polystyrene and Bakelite (Any one).	VII	02
	Total Hrs.		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.

i. The **following are some sample 'Process' and 'Product' related skills** (more may be added/deleted depending on the course) with approximate percentage weightage 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 % (Approximate)
1	Prepare experimental setup accurately.	10
2	Use apparatus for precise measurements.	20
3	Practice and adapt good and safe measuring techniques.	10
4	Good Record keeping of the observations accurately.	20
5	Interpret the results and their conclusion.	20
6	Prepare Report in prescribed format	10
7	Viva-Voce	10
	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 the conduction of practice in

all institutions across the state in a proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	<p>Digital pH Meter: Type: Microcontroller Based, Display: LED / LCD / Touch Screen, 3 digits, Calibration: up to 3 points with auto buffer, pH Range (pH): 0.00 to 14.00, +/- 0.05, Power Requirements: 230 V +/- 10, 50 Hz AC, Modes: pH mV- C, Temperature Compensation Type: Automatic, Temperature Compensation Range (Degree C): 0 to 100, Temperature Accuracy (Degree C): +/- 0.3, Resolution (pH): 0.01</p>	4
2.	<p>Redwood Viscometer: Flow Range (Viscosity) in second: 20-2000, Redwood Viscometer Model No.: 01, Material: Stainless Steel, Bath Capacity (Approx.): 7 liters, Temperature Required: 95 °C, Power supply: 220 Volt, 800 Watt, 50 Hz.</p>	12
3.	<p>Pensky Martens Flash Point Apparatus: Voltage: 220-240V, Phase: Single phase, Power Source: Electric, Timing Range: 999.9s</p> <p style="text-align: center;"><u>OR</u></p> <p>Cleveland Open Cup Apparatus: Temperature range: Ambient to 370°C, Temp. measurement PT100 temp. sensor, Temp. scale resolution 0.1°C, Ignition source gas or electric, cooling forced air cooling, heating coil, heating 888W, 220V, AC.</p> <p style="text-align: center;"><u>OR</u></p> <p>Abel's Flash Point Apparatus: Material: Stainless Steel, Power Source: Electric, Voltage: 115V/220-240V, 50-60 Hz, Dimensions: 230 mm x 470 mm x 470 mm (W x D x H) Temperature Range: 70 °C, Resolution: 0.1 °C</p>	15
4.	<p>Hot Air Oven: Temperature is controlled by digital temperature indicator cum controller from ambient to 250°C with ± 0.1°C Accuracy. Power supply: 220/230V, 50Hz single phase, Capacity (Approx.): 50 – 100 liter, Type of Shelves: 03, Material of Inner Chambers: SS 304, Material of Outer Chamber: MS with powder coated paint, Material of Shelves: SS wire mesh.</p>	11
5.	<p>Laboratory Weighing Balance: Type of Laboratory Balance: Analytical, Sensitivity (mg): 1 mg, Maximum Capacity of weighing (grams): 200 g, Shape of PAN: Circular, Power Supply: Single Phase, Display: LED.</p>	All

6	Hot Plate With Magnetic Stirrer: Number of stirring Positions:1, Calibration: Automatic Calibration, Magnetic stirrer with a hot plate, Speed Control Accuracy of set speed (+/-) (RPM): 5, Maximum Stirring capacity per position: 3000 ml, Top plate Material: Stainless steel	1,2,3,4,9,10, 11,13,14,
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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) Observe safety measures
- d) Good house keeping
- e) Time management
- f) Practice environmentally 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

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 the attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Atomic Structure, Chemical Bonding and Solutions	1a. Apply the different atomic theories, models and principles for structural illustration. 1b. Explain Pauli's exclusion principle, Hund's rule and Aufbau rule with examples. 1c. Write the electronic configurations of different elements. 1d. Describe the different types of chemical bonds.	1.1. Atomic Structure: Concepts of orbit and orbital, Pauli's exclusion principle. 1.2. Hund's rule of maximum multiplicity, 1.3. Aufbau rule, electronic configuration of atom (up to atomic number 30) 1.4. Chemical Bonding: Concept of chemical bonding, types of chemical bonds, Ionic bond, and its characteristics (example NaCl), Covalent bond and its

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	1e. Differentiate among the ionic, covalent and coordinate compounds based on the type of chemical bonding. 1f. Explain various properties of materials depending upon bond formation. 1g. Prepare the solution of given concentrations (Normality, Molarity).	characteristics (example H_2 , O_2 , N_2 , HF , NH_3 , H_2O , CH_4), Coordinate covalent bond (example NH_4^+ , H_3O^+), Metallic bond and its characteristics, Hydrogen bonding, its types, and Significance, Intermolecular force of attraction. 1.5. Molecular arrangement in solid, liquid and gases, Structure of solids - Molecular solid, Ionic solid, Network solid, and Metallic solid. 1.6. Solutions: The idea of solute, solvent, and solution, Methods to express the concentration of solution - Normality, Molarity ($M = \text{mole per liter}$), ppm, mass percentage, volume percentage, and mole fraction.
Unit – II Concepts of Electrochemistry	2a. Explain the theory of ionization and the factors affecting it. 2b. Describe pH value and its industrial application. 2c. Describe different types of buffer solutions and their application. 2d. Differentiate electrolyte and nonelectrolyte. 2e. Describe the construction and working of an electrochemical cell and standard hydrogen electrode (SHE) 2f. State the Nernst equation and Faraday's laws of electrolysis and its application. 2g. Use the different electrolysis processes such as electro metallurgy, electroplating, and electrorefining to solve wide variety of industrial	2.1. Arrhenius theory of ionization. 2.2. Electronic concept of oxidation, reduction, and redox reactions. 2.3. Degree of ionization and factors affecting the degree of ionization. 2.4. Definition of pH, pH of acid, base and neutral solution, pH calculations for acid, base, and salt solutions at different concentrations, Importance of pH in various fields. 2.5. Definition of buffer solution, buffer action and types of buffer solution, Application of buffer solution. 2.6. Definition of terms: electrolytes, non-electrolytes with suitable examples, Types of electrolytes. 2.7. Construction and working of Electrochemical Cell. 2.8. Construction and working of Standard Hydrogen Electrodes (SHE). 2.9. Nernst theory of single electrode potential and Nernst equation. 2.10. Electrochemical series.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	problems.	2.11. Electrolysis, Faraday's laws of electrolysis. 2.12. Industrial application of electrolysis: Electro metallurgy, electroplating, electro refining.
Unit– III Corrosion of metals and its prevention	3a. Describe the various types of corrosion. 3b. Identify the different factors affecting the rate of corrosion. 3c. Explain the various type of protective measures to prevent corrosion. 3d. Select relevant method to prevent metal from corrosion	3.1. Corrosion: Dry or Chemical corrosion: Oxidation corrosion-mechanism, Corrosion by other gases. 3.2. Wet or Electrochemical corrosion- H ₂ liberation and O ₂ absorption mechanism of electrochemical corrosion. 3.3. Galvanic corrosion mechanism. 3.4. Concentration cell corrosion. 3.5. Pitting corrosion, Waterline and Crevice corrosion. 3.6. Factors affecting the rate of corrosion: Nature of the metal, Nature of surface film, Relative areas of the anodic and cathodic parts, Purity of metal, Temperature, Humidity of air, Influence of pH. 3.7. Internal and External corrosion preventive measures: Modification of environment, Modification of the properties of metal, Use of protective coatings, Anodic and cathodic protection, Modification in design and choice of material.
Unit– IV Water	4a. Classify hard and soft water based on their properties . 4b. Determine the hardness of water by EDTA method. 4c. Softening the hard water by applying the different water softening methods. 4d. Apply the different treatment methods for purification of water. 4e. Use the Indian standard specification of drinking water.	4.1 Introduction, Source of water, Hard water and soft water. 4.2 Salts cause water hardness, Unit of hardness, and simple numerical on water hardness. 4.3 Problems caused by the use of hard water in boilers and its prevention. 4.3.1 Scale and sludge, Foaming and Priming, Caustic embrittlement, Corrosion 4.4 Water softening techniques: Soda-lime process, Zeolite process, Ion exchange process, Reverse Osmosis process (R.O.) 4.5 Treatment of Municipal drinking

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		<p>water: Screening, Sedimentation, Coagulation, Filtration, Sterilization of water by chlorination, Break-point of Chlorination.</p> <p>4.6 Enlist Indian standard specification of drinking water.</p>
<p>Unit- V</p> <p>Basic concepts of Organic Chemistry</p>	<p>5a. Differentiate Organic and Inorganic compounds.</p> <p>5b. Explain the concept of hybridization.</p> <p>5c. Describe the term of isomerism and homologous series, saturated and unsaturated hydrocarbon.</p> <p>5d. Classify organic compounds based on functional groups</p> <p>5e. Write the IUPAC name of simple hydrocarbons.</p> <p>5f. Describe the preparation method, properties and application of ethane, ethylene and acetylene.</p>	<p>5.1 Organic and Inorganic Compounds.</p> <p>5.2 Tetravalency of carbon.</p> <p>5.3 concept of hybridization- sp, sp² and sp³ types of hybridization with examples of each.</p> <p>5.4 Sigma and pi bonding.</p> <p>5.5 Classification of Organic compounds and IUPAC nomenclature of simple hydrocarbons.</p> <p>5.6 Functional group classification.</p> <p>5.7 Isomerism and Homologous series, Saturated and unsaturated hydrocarbon,</p> <p>5.8 Source of hydrocarbon: 5.8.1 Distillation of coal tar, Refining of petroleum.</p> <p>5.9 Preparation, properties and applications of, Alkane – Ethane, Alkene – Ethylene, Alkyne - Acetylene.</p>
<p>Unit- VI</p> <p>Lubricants</p>	<p>6a. Explain terms lubricant and lubrication</p> <p>6b. Describe the types of lubricants.</p> <p>6c. Describe the physical and chemical properties of a lubricant.</p> <p>6d. Selection of proper lubricants for engineering use.</p> <p>6e. Select relevant lubricant based on their function and characteristic properties for use in different kind of machinery.</p> <p>6f. State the biodegradable lubricants.</p>	<p>6.1 lubricants and Lubrication, Functions of lubricants.</p> <p>6.2 Mechanism of Lubrication: Fluid lubrication, Boundary lubrication. Classification of lubricant with examples: Solid, Semi-solid, liquid and synthetic lubricants.</p> <p>6.3 Physical Properties of lubricants: Viscosity and viscosity index, Flash and fire point, Cloud and pour point, Oiliness.</p> <p>6.4 Chemical properties of lubricants: Saponification number, Neutralization number, Emulsification number.</p> <p>6.5 Selection of lubricants for different types of Machinery like: Gears, Cutting tools, Steam turbine, Transformers.</p> <p>6.6 Biodegradable lubricants.</p>

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– VII Polymers, Elastomers, and Adhesives	7a. Classify Polymers based on molecular structures and monomers. 7b. Differentiate thermoplastic and thermosetting polymers with examples. 7c. Explain polymerization reactions with examples. 7d. Describe the applications of thermoplastic and thermosetting polymers. 7e. Describe the application of biodegradable polymers. 7f. Explain the properties and application of synthetic rubbers. 7g. Explain the process of vulcanization rubber. 7h. Explain the different types of adhesives and their application	7.1 Definition of Monomer, Polymer and Polymerization. 7.2 Classification of Polymers based on molecular structure: Linear Polymers, Branched Polymers and Cross-linked Polymers. 7.3 Classification of polymers based on Monomer: Homopolymer, Copolymer. 7.4 Classification of polymers based on thermal behavior: Thermoplastics and Thermosetting polymers. 7.5 Types of polymerizations: Addition and condensation polymerization 7.6 Simple reactions involved in the preparation and their properties and application of thermoplastics and thermosetting polymers: Polyethylene, Polypropylene, Polyvinyl chloride, Polytetrafluoroethylene (Teflon), Polystyrene, Polyacrylonitrile, Bakelite, Epoxy resins 7.7 Biodegradable Polymers: Introduction, chemical composition, and application: Poly β -hydroxybutyrate-co- β -hydroxy valerate (PHBV), Nylon-2-nylon-6. 7.8 Rubber: Natural rubber and its properties, Vulcanization of rubber, Synthetic rubber – simple reaction involved in the preparation and their properties and application: Buna-S rubber, Buna-N rubber, Neoprene rubber 7.9 Adhesives: Characteristics, Classification, and application of adhesives.

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	Atomic Structure, Chemical Bonding, and Solutions	06	03	03	02	08

II	Concepts of Electrochemistry	07	02	06	04	12
III	Corrosion of Metals and its Prevention	05	02	04	02	08
IV	Water	07	02	05	05	12
V	Basic concepts of Organic Chemistry	05	03	04	03	10
VI	Lubricants	05	02	04	02	08
VII	Polymers, Elastomers, and Adhesives	07	02	06	04	12
Total		42	16	32	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.

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 perform the following activities in group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidence such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

- Prepare a PowerPoint presentation or animation showing different types of chemical bonds and atomic structures.
- Prepare a model of an atom with the help of a ball and stick or of any other items.
- pH Calculations for acid, base, and salt solutions at different concentrations.
- Preparation of a table showing the different methods used for prevention of corrosion.
- Solve simple problems on hardness calculation.
- Preparation of a table showing the difference between Organic and Inorganic Compounds.
- Market survey of different lubricating oil and compare their physical and chemical properties.
- Library survey regarding polymers, synthetic rubber, and adhesives used in different industries.
- Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.

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:

- Massive open online courses (MOOCs) may be used to teach various topics/subtopics.

- b) Guide student(s) in undertaking micro-projects/activities.
- c) Different types of teaching methods i.e. video demonstration, activity based learning, case study, m-learning need to be employed by teachers to develop the outcomes.
- d) Some of the topics/sub-topics which are relatively simpler or descriptive are to be given to the students for *self-learning* but to be assessed using different assessment methods.
- e) Teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- f) Guide students to address issues on environment and sustainability with reference to using the knowledge of this course
- g) OERs, Vlab, and Olabs may be used to teach for the teaching of different concepts.

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-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 the 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 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 industry-oriented COs).

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

- a) Prepare common salt crystals from NaCl solution
- b) Form three groups of students in the class. Consider a hypothetical situation of exchanging/ sharing/giving of different items/belongings and demonstrate the type of ionic, covalent, and co-ordinate bonding amongst the students in a simulated situation. Present your findings.
- c) Prepare a model to demonstrate the application of electrolysis cells.
- d) Collect three metallic strips of Al, Cu, Fe, strips, Place them in a different acidic and alkaline solution of the same concentration. Observe and record the loss in weight of metals due to an acidic and alkaline environment. Discuss the findings with your teacher and colleagues.
- e) Collect different samples of utensils reinforced materials, iron, copper, brass, bronze, and other alloys. Place them in an open environment under tin shade. Observe the corrosive properties over a period of four weeks. Record your observations. Discuss the findings with your teacher and colleagues.
- f) Collect water samples from different water sources and measure the hardness of the water.
- g) Collect the water sample from different sources of ground and surface water (at least five). Explore the new and simplest softening and water treatment methods and

perform the same at your home by creating the different assemblies and manipulative techniques at home. Determine the turbidity and pH of water (using pH paper).

- h) Suppose you have been selected at the top diploma engineering college in the metro city. You have been living there for more than three months. Based on your critical observation and experience on the different kinds of activities/performances, identify the type of water being used by you. Draw your inferences on the same.
- i) Collect samples of petrol, kerosene oil, diesel, any edible oil, coconut oil. Find out the flash point and fire point, cloud and pour point, and viscosity of the same. Compare the properties and justify their use in relevant applications.
- j) Depending on the type of machinery, the load applied, speed of the machine, heat generated, etc, select the appropriate lubricant which can be applied to the machinery. Discuss with your teachers and colleagues and present the same.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with the place, year, and ISBN
1	Engineering Chemistry	Jain & Jain	Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2015, ISBN: 93-521-6000-2
2	A Textbook of Engineering Chemistry	Dr S. S. Dara & Dr S. S. Umare	S. Chand & Co.(P) Ltd., New Delhi, 2014, ISBN:81-219-0359-9
3	Textbook of Chemistry for Class XI & XII (Part-I & II)	NCERT	NCERT, New Delhi, 2017-18, Class-XI, ISBN: 81-7450-494-X (part-I), 81-7450-535-O (part-II), Class-XII, ISBN: 81-7450-648-9 (part-I), 81-7450-716-7 (part-II)
4	Engineering Chemistry	Shikha Agarwal	Cambridge Uni. Press, New Delhi, 2019, ISBN: 978-1-108-72444-9
5	Understanding Chemistry	C.N.R. Rao	World scientific publishing Co., 2009, ISBN: 9789812836045
6	Engineering Chemistry	Dr. Vikram S.	Wiley India Pvt. Ltd., New Delhi, 2013, ISBN: 9788126543342
7	Applied Chemistry Laboratory Practices, Vol. I & II	Dr. G.H. Hunger & Prof. A.N. Pathak.	NITTTR, Chandigarh, Publication, 2013-14
8	Chemistry for Engineers	Rajesh Agnihotri	Wiley India Pvt. Ltd., 2014, ISBN: 9788126550784
9	Fundamental of Electrochemistry	V. S. Bagotsky	Wiley International N. J., 2005, ISBN: 9780471700586

14. SUGGESTED LEARNING WEBSITES

- <http://www.chemguide.co.uk/atommenu.html>
- <https://www.visionlearning.com>
- <http://www.chem1.com>
- <https://www.wastewaterelearning.com/elearning/>
- <https://www.wqa.org/>
- <https://ncert.nic.in>
- <http://www.olabs.edu.in/>
- http://chemcollective.org/activities/type_page/1
- <http://www.presentingscience.com/vac/corrosion/index.htm>
- <https://vlab.amrita.edu/index.php?sub=2&brch=190>

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Basic Chemistry (Course Code: 4300011)						
	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 engineering chemistry to solve broadly defined engineering problems.	3	2	2	1	1	1	1
Course Outcomes CO1: Apply the principles of chemical bonding and solutions to solve various engineering problems.	3	1	-	1	-	-	1
CO2: Solve engineering problems using the concept of electrochemistry and corrosion.	3	1	-	1	1	-	1
CO3: Use relevant water treatment methods to solve domestic and industrial problems.	3	1	1	1	1	1	1
CO4: Classify organic compounds based on their functional groups.	3	1	-	1	1	-	1
CO5: Choose various types of engineering materials like lubricants, polymers, Elastomers and Adhesives for domestic and industrial applications.	3	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.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE**GTU Resource Persons**

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Narendra Makwana, Lecturer in Chemistry	Government Polytechnic, Chhotaudepur	9909911391	ngmakwana@yahoo.com
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NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr. Bashirulla Shaik, Assistant Professor	Dept. of Applied Science Education	9981382711	bshaik@nitttrbpl.ac.in
2.	Dr. Anju Rawlley, Professor	Curriculum Development & Assessment Education	9406947814	arawlley@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				
L	T	P		Theory Marks		Practical Marks		Total Marks
			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.

- Work as a leader/a team member.
- Follow ethical practices.
- 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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year.
- '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

<p>Unit – II</p> <p>Differentiation and its Applications</p>	<p>2a. Apply the working rules and standard forms of differentiation to find the derivative of simple functions.</p> <p>2b. Invoke the concept of Chain Rule to find the derivative of simple functions.</p> <p>2c. Find the derivative of given Implicit and Parametric functions.</p> <p>2d. Apply the standard forms and rules of derivative to find the second order derivative of simple functions.</p> <p>2e. Apply the concept and rules of derivative to solve the problems related to velocity, acceleration and Maxima-Minima of given simple functions.</p>	<p>2.1. Concept and Definition of Differentiation</p> <p>2.2. Working rules : Sum, Product, Division</p> <p>2.3. Chain Rule</p> <p>2.4. Derivative of Implicit functions</p> <p>2.5. Derivative of Parametric functions</p> <p>2.6. Logarithmic Differentiation</p> <p>2.7. Successive Differentiation up to second order</p> <p>2.8. Applications: Velocity, Acceleration, Maxima & Minima of given simple functions.</p>
<p>Unit– III</p> <p>Integration and its Applications</p>	<p>3a. Apply the working rules and standard forms of integration to find the integral of simple functions.</p> <p>3b. Find the integral of simple functions using the method of substitution and integration by parts.</p> <p>3c. Solve given problems related to definite integral using properties.</p> <p>3d. Apply the rules and standard forms of integration to solve the problems related to area and volume.</p>	<p>3.1 Concept and Definition of Integration.</p> <p>3.2 Working rules and Integral of standard functions.</p> <p>3.3 Method of substitution.</p> <p>3.4 Integration by parts.</p> <p>3.5 Definite Integral and its properties.</p> <p>3.6 Applications: Area and volume. (Simple problems)</p>
<p>Unit– IV</p> <p>Differential Equations</p>	<p>4a. Find the order and degree of given differential equations.</p> <p>4b. Solve Differential Equations related to Variable Separable method.</p> <p>4c. Solve given linear differential equations.</p>	<p>4.1 Concept and Definition, Order and Degree of differential equation.</p> <p>4.2 Solution of DE of first degree and first order by Variable Separable method.</p> <p>4.3 Solution of linear Differential equation.</p>
<p>Unit– V</p> <p>Statistics</p>	<p>5a. Find Mean for the given data.</p> <p>5b. Calculate Mean deviation for the given data.</p> <p>5c. Calculate Standard deviation for the given data.</p>	<p>5.1 Mean for ungrouped and grouped data.</p> <p>5.2 Mean deviation and Standard deviation about Mean for ungrouped and grouped data.</p>

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:

- 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.
- Explore the opportunity to visit Science city, ISRO or nearby Science centers.
- Explore the opportunity to visit Mathematics Lab Virtually.
- Prepare charts showing formulas of differentiation.
- Prepare charts showing formulas of integrations.
- Use Graphing calculator to plot the graph of solutions explaining Engineering applications.
- 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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- 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.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- 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, 15 th 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 10 th 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

- <https://www.youtube.com/channel/UCLJVrQyPYsseCf78QWCDsvA/featured>
(YouTube Channel of DTEGUJ)
- <https://www.geogebra.org/?lang=en>
- [https://nios.ac.in/online-course-material/sr-secondary-courses/mathematics-\(311\).aspx](https://nios.ac.in/online-course-material/sr-secondary-courses/mathematics-(311).aspx)
- www.dplot.com/ - DPlot
- www.wolfram.com/mathematica/
- www.easycalculation.com
- www.scilab.org/ - SCI Lab
- <https://ncert.nic.in/textbook.php> (NCERT Textbooks of Mathematics 11th and 12th Science)
- <https://www.desmos.com/>

15. PO-COMPETENCY-CO MAPPING

Semester II	Applied Mathematics (Course Code:4320001)
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Competency & Course Outcomes	POs						
	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
<u>Competency</u>	Solve broad-based technology problems using the principles of Applied mathematics.						
<u>Course Outcomes</u>							
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
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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
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NITTTR Resource Persons

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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester -II

Course Title: **Engineering Mathematics**

(Course Code: 4320002)

Diploma programmes in which this course is offered	Semester in which offered
Biomedical Engineering, Computer Engineering, Electrical Engineering, Electronics & Communication Engineering, Environment Engineering, Information Technology, Instrumentation & Control Engineering, Power Electronics Engineering	Second

1. RATIONALE

This course is an extension of the course based on Mathematics of first semester namely Engineering 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 Complex numbers. 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. Complex numbers, is one of the most elegant and interesting topics in mathematics. Complex numbers, their algebra and geometry has always been an important tool to crack thousands of the problems based on Pure and Applied Mathematics. In fact, some properties are easier in complex than real variables. DeMoivre's Theorem is one of the most important and useful theorems which connects complex numbers and trigonometry and also helpful for obtaining relationships between trigonometric functions of multiple angles. 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 engineering 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:

- Demonstrate the ability to Crack engineering related problems based on Matrices.
- Demonstrate the ability to solve engineering related problems based on applications of differentiation.
- Demonstrate the ability to solve engineering related problems based on applications of integration.
- Develop the ability to apply differential equations to significant applied problems.
- Represent complex numbers algebraically and geometrically for solving engineering related problems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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

S. No.	Practical Outcomes (PrOs)/Tutorials	Unit No.	Approx. Hrs. required
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
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 problems related to algebraic operations of complex numbers, conjugate, modulus and inverse of given complex number.	V	1
14	Solve problems related to polar form of a complex number, argument of complex number, De Moivre's Theorem and square root of a given complex number.	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 prove theorems 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.	20
3	Perform basic operations of complex numbers geometrically.	30
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.	60
2	Write expressions in equivalent forms to solve problems.	20
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
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 2×2 and 3×3 . 1.6 Solution of Simultaneous linear equations of two variables.
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 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 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	4a. Find the order and degree of differential equations.	4.1 Concept and Definition, Order and Degree of differential equation.

Differential Equations	4b. Solve Differential Equations related to Variable Separable method. 4c. Solve given linear differential equations	4.2 Solution of DE of first degree and first order by Variable Separable method. 4.3 Solution of linear Differential equation.
Unit– V Complex Numbers	5a. Convert the complex form into $a+ib$ form using algebraic operations of complex numbers. 5b. Find conjugate, modulus and inverse of a given complex number. 5c. Convert the given complex number into polar form using the concept of modulus and argument. 5d. Use De Moivre's Theorem to simplify mathematical expressions. 5e. Find the square root of a given complex number and cube root of unity.	5.1 Concept of Complex number. 5.2 Algebra of Complex numbers. 5.3 Conjugate, Modulus and inverse of Complex numbers. 5.4 Argument and Polar form of a Complex number. 5.5 De Moivre's Theorem and related simple examples. 5.6 Square root of a Complex number and cube root of unity.

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
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	Complex Numbers	07	2	6	4	12
Total		42	16	26	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 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 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) **Charts:** Prepare the Charts of formulae for Matrix, Differentiation, Integration, Complex Numbers.
- 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 and 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 verify 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 verify 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) **Geometrical representation of complex numbers:** Formulate the geometrical representation of addition, subtraction, multiplication, etc. and explain using suitable software.

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, 15 th Edition. ISBN: 978-81-7409-257-1
2	Engineering Mathematics (Third edition).	Croft, Anthony	Pearson Education, New Delhi, 2014. ISBN 978-81-317-2605-1
3	Calculus and Its Applications	Marvin L. Bittinger David J. Ellenbogen Scott A. Surgent	Addison-Wesley 10 th 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

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](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	Engineering Mathematics (Course Code:4320002)						
	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
<u>Competency</u>	Solve broad-based technology problems using the principles of Engineering mathematics.						
<u>Course Outcomes</u>							
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	3	1	1	-	-	-	1

significant applied problems							
CO e) Represent complex numbers algebraically and geometrically for solving engineering related problems	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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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
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

I/II – Semester

Course Title: **Applied Chemistry**

(Course Code: 4300009)

Diploma programme in which this course is offered	Semester in which offered
Metallurgy Engineering	First
Civil Engineering, Ceramic Engineering, Environment Engineering, Mining Engineering	Second

1. RATIONALE

The applied chemistry deals with solving the various issues and problems of industries, the environment, and day-to-day life for the benefit of people at large, through applications of various concepts and principles of chemistry. Applied chemistry helps to develop and enhance the thinking capabilities of the diploma passouts in line with the modern trends in engineering and technology through the inclusion of various creative activities/micro projects etc. Many global problems/issues and their in-depth understanding is addressed through the inclusion of topics of relevance like corrosion, electrochemistry, Water, Chemical Bonding and solutions, Cement, Glasses, Refractories, paints, and varnishes Insulating materials, Polymers, Elastomers, and Adhesives in this course.

2. COMPETENCY

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

- **Use principles of applied chemistry 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:

- Apply the principles of chemical bonding and solutions to solve various engineering problems.
- Solve engineering problems using the concepts of electrochemistry and corrosion
- Use relevant water treatment methods to solve domestic and industrial problems.
- Select appropriate engineering materials like cement, glass, and refractory for industrial applications.
- **Choose various types of engineering materials like polymers, Elastomers, and Adhesives for domestic and industrial applications.**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 the integration of COs, and the remaining 20 marks are 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 subcomponents of the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare a standard solution of oxalic acid or potassium permanganate.	I	02
2	Determine the strength of the given sodium hydroxide solution by titrating against standard oxalic acid solution using phenolphthalein indicator.	I	02
3	Standardize potassium permanganate solution by standard oxalic acid solution and estimate ferrous ions.	II	02
4	Determine pH-Values of given samples of Solution by using Universal Indicator and pH-meter.	II	02
5	Determine emf of an electrochemical cell (Daniel cell).	II	02
6	Determine electrochemical equivalent of copper metal using Faraday's first law.	II	02
7	Determine the rate of corrosion for different metals in the given solution.	III	02
8	Determine the rate of corrosion for metal in the solution of different pH.	III	02
9	Estimate total hardness of given water sample using standard EDTA solution.	IV	02
10	Estimate alkalinity of given water sample using 0.01M sulphuric acid solution.	IV	02
11	Determine Total Dissolved Solid (TDS) and Total Suspended Solid (TSS) in a given sample of water.	IV	02
12	Determine the Iron content in a given cement sample using a colorimeter.	V	04

13	Prepare Polystyrene and Bakelite. (Any one)	VII	02
	Total Hrs.		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 experimental setup accurately.	10
2	Use apparatus for precise measurements.	20
3	Practice and adapt good and safe measuring techniques.	10
4	Good Record keeping of the observations accurately.	20
5	Interpret the results and their conclusion.	20
6	Prepare Report in prescribed format	10
7	Viva-Voce	10
	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 the conduction of practice in all institutions across the state in a proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Digital pH Meter: Type: Microcontroller Based, Display: LED / LCD / Touch Screen, 3 digits, Calibration: up to 3 points with auto buffer, pH Range (pH): 0.00 to 14.00, +/- 0.05, Power Requirements: 230 V +/- 10, 50 Hz AC, Modes: pH mV- C, Temperature Compensation Type: Automatic, Temperature Compensation Range (Degree C): 0 to 100, Temperature Accuracy (Degree C): +/- 0.3, Resolution (pH): 0.01	4,8
2.	Hot Air Oven: Temperature is controlled by digital temperature indicator cum controller from ambient to 250°C with ± 0.1°C Accuracy. Power supply: 220/230V, 50Hz single phase, Capacity (Approx.): 50 – 100 liter, Type of Shelves: 03, Material of Inner Chambers: SS	11

S. No.	Equipment Name with Broad Specifications	PrO. No.
	304, Material of Outer Chamber: MS with powder coated paint, Material of Shelves: SS wire mesh.	
3.	Colorimeter: Wavelength range: 400-700 nm, Wavelength selection: 8 in built gelatin filters, Measurement ranges: 0 -100 %T, 0 -1.99 Abs (O.D.), 0.1 to 1000 Concentration, Resolution: 1% T, 0.01 Abs (O.D.), 0.1 to 1 Concentration, Display: 3-digit digital display, Accessories: 4 nos. flat bottom test tubes. Power: 230V, 50Hz.	12
4.	Laboratory weighing balance: Type of Laboratory Balance: Analytical, Sensitivity (mg): 1 mg, Maximum Capacity of weighing (grams): 200 g, Shape of PAN: Circular, Power Supply: Single Phase, Display: LED.	All
5	Hot plate with Magnetic stirrer: Number of stirring Positions:1, Calibration: Automatic Calibration, Magnetic stirrer with a hot plate, Speed Control Accuracy of set speed (+/-) (RPM): 5, Maximum Stirring capacity per position: 3000 ml, Top plate Material: Stainless steel	1,2,3,4,9,10,11, 12

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) Observe safety measures
- d) Good housekeeping
- e) Time management
- f) Practice environmentally 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

The major Underpinning Theory is formulated as given below. Many of the higher-level UOs of *Revised Bloom's taxonomy* are mentioned for the development of the COs and competency in the students by the teachers (Higher level UOs automatically include lower level UOs in them). If required, more such higher-level UOs could be included by the course teacher to focus on the attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Atomic Structure, Chemical Bonding and Solutions	1a. Apply the different atomic theories, models, and principles for structural illustration. 1b. Explain Pauli's exclusion principle, Hund's rule, and Aufbau's rule with examples. 1c. Write the electronic configurations of different elements. 1d. Describe the different types of chemical bonds. 1e. Differentiate among the ionic, covalent, and coordinate compounds based on the type of chemical bonding. 1f. Explain various properties of Materials depending upon bond formation. 1g. Prepare the solution of given concentrations (Normality, Molarity).	1.1. Atomic Structure: Concepts of orbit and orbital, Pauli's exclusion principle. 1.2. Hund's rule of maximum multiplicity, 1.3. Aufbau rule, electronic configuration of atom (up to atomic number 30) 1.4. Chemical Bonding: Concept of chemical bonding, types of chemical bonds, Ionic bond, and its characteristics (example NaCl), Covalent bond and its characteristics (example H ₂ , O ₂ , N ₂ , HF, NH ₃ , H ₂ O, CH ₄), Coordinate covalent bond (example NH ₄ ⁺ , H ₃ O ⁺), Metallic bond and its characteristics, Hydrogen bonding, its types, and Significance, Intermolecular force of attraction. 1.5. Molecular arrangement in solid, liquid, and gases, Structure of solids - Molecular solid, Ionic solid, Network solid, and Metallic solid. 1.6. Solutions: The idea of solute, solvent, and solution, Methods to express the concentration of solution - Normality, Molarity ($M = \text{mole per liter}$), ppm, mass percentage, volume percentage, and mole fraction.
Unit – II Concepts of Electrochemistry	2a. Explain the theory of ionization and the factors affecting it. 2b. Describe pH value and its industrial application. 2c. Describe different types of	2.1. Arrhenius theory of ionization. 2.2. Electronic concept of oxidation, reduction, and redox reactions. 2.3. Degree of ionization and factors affecting the degree of ionization. 2.4. Definition of pH, pH of acid, base

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	<p>buffer solutions and their application.</p> <p>2d. Differentiate electrolyte and nonelectrolyte.</p> <p>2e. Describe the construction and working of an electrochemical cell and standard hydrogen electrode (SHE)</p> <p>2f. State the Nernst equation and Faraday's laws of electrolysis and its application.</p> <p>2g. Use the different electrolysis processes such as electrometallurgy, electroplating, and electrorefining to solve a wide variety of industrial problems</p>	<p>and neutral solution, pH calculations for acid, base, and salt solutions at different concentrations, Importance of pH in various fields.</p> <p>2.5. Definition of buffer solution, buffer action and types of buffer solution, Application of buffer solution.</p> <p>2.6. Definition of terms: electrolytes, non-electrolytes with suitable examples, Types of electrolytes.</p> <p>2.7. Construction and working of Electrochemical Cell.</p> <p>2.8. Construction and working of Standard Hydrogen Electrodes (SHE).</p> <p>2.9. Nernst theory of single electrode potential and Nernst equation.</p> <p>2.10. Electrochemical series.</p> <p>2.11. Electrolysis, Faraday's laws of electrolysis,</p> <p>2.12. Industrial application of electrolysis: Electrometallurgy, electroplating, electrorefining.</p>
<p>Unit– III</p> <p>Corrosion of metals and its prevention</p>	<p>3a. Describe the various types of corrosion.</p> <p>3b. Identify the different factors affecting the rate of corrosion.</p> <p>3c. Explain the various types of protective measures to prevent corrosion.</p> <p>3d. Select relevant methods to prevent metal from corrosion.</p>	<p>3.1. Corrosion: Dry or Chemical corrosion: Oxidation corrosion-mechanism, Corrosion by other gases.</p> <p>3.2. Wet or Electrochemical corrosion- H₂ liberation and O₂ absorption mechanism of electrochemical corrosion.</p> <p>3.3. Galvanic corrosion mechanism.</p> <p>3.4. Concentration cell corrosion.</p> <p>3.5. Pitting corrosion, Waterline, and Crevice corrosion.</p> <p>3.6. Factors affecting the rate of corrosion: Nature of the metal, Nature of surface film, Relative areas of the anodic and cathodic parts, Purity of metal, Temperature, Humidity of air, Influence of pH.</p> <p>3.7. Internal and external corrosion preventive measures: Modification</p>

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		of environment, Modification of the properties of metal, Use of protective coatings, Anodic and cathodic protection, Modification in design, and choice of material.
Unit– IV Water	4a. Classify hard and soft water based on their properties. 4b. Determine the hardness of water by the EDTA method. 4c. Softening the hard water by applying the different water softening methods. 4d. Apply the different treatment methods for the purification of water. 4e. Use the Indian standard specification of drinking water.	4.1 Introduction, Source of water, Hard water and soft water. 4.2 Salts cause water hardness, Unit of hardness, and simple numerical on water hardness. 4.3 Problems caused by the use of hard water in boilers and its prevention. 4.3.1 Scale and sludge, Foaming and Priming, Caustic embrittlement, Corrosion 4.4 Water softening techniques: Soda-lime process, Zeolite process, Ion exchange process, Reverse Osmosis process (R.O.) 4.5 Treatment of Municipal drinking water: Screening, Sedimentation, Coagulation, Filtration, Sterilization of water by chlorination, Break-point of Chlorination. 4.6 Enlist Indian standard specifications of drinking water.
Unit– V Cements, Glasses and Refractories	5a. Describe the constituents of cement 5b. Use Portland cement appropriately for engineering applications 5c. Select appropriate glass for use in different engineering applications. 5d. Classify the refractories based on their characteristics for use in a variety of applications.	5.1 Cement, constituting compounds in cement. 5.2 Composition and manufacture of Portland cement. 5.3 Setting and hardening of cement. 5.4 Glass and its general properties. 5.5 Manufacture of glass, variety of glasses and their application. 5.6 Definition of refractories. 5.7 Characteristics and Application of refractories. 5.8 Classification of refractories: Acid, Basic and neutral refractories.
Unit– VI Paints, Varnishes and Insulating Materials	6a. Explain the functions of different ingredients of paints. 6b. Differentiate between paints and varnishes 6c. Use different types of	6.1 Definition of paints, the purpose of oil paints, characteristics of oil paints. 6.2 Ingredients of paints: Function and example of each ingredient. 6.3 Varnishes: Types of varnishes,

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	insulating materials based on their properties.	Differentiate between paints and varnishes. 6.4 Insulating materials: Types and properties of Insulating materials. 6.5 Application of Thermal, Acoustic, Waterproofing, and Fireproofing insulating materials.
Unit– VII Polymers, Elastomers, and Adhesives	7a. Classify Polymers based on molecular structures and monomers. 7b. Differentiate thermoplastic and thermosetting polymers with examples. 7c. Explain polymerization reactions with examples. 7d. Describe the applications of thermotropic and thermosetting polymers. 7e. Describe the application of biodegradable polymers. 7f. Explain the properties and application of synthetic rubbers. 7g. Explain the process of vulcanization rubber. 7h. Explain the different types of adhesives and their application	7.1. Definition of Monomer, Polymer, and Polymerization. 7.2. Classification of Polymers based on molecular structure: Linear Polymers, branched polymers, Cross-linked polymers. 7.3. Classification of polymers based on Monomer: Homopolymer, Copolymer. 7.4. Classification of polymers based on thermal behavior: Thermoplastics and Thermosetting polymers. 7.5. Types of polymerizations: Addition and condensation polymerization 7.6. Simple reactions involved in the preparation and their properties and application of thermoplastics and thermosetting polymers: Polyethylene, Polypropylene, Polyvinylchloride, Polytetrafluoroethylene (Teflon), Polystyrene, Polyacrylonitrile, Bakelite, Epoxy resins 7.7. Biodegradable Polymers: Introduction, chemical composition, and application: Poly β -hydroxybutyrate-co- β -hydroxy valerate (PHBV), Nylon-2-nylon-6. 7.8. Rubber: Natural rubber and its properties, Vulcanization of rubber, Synthetic rubber – simple reaction involved in the preparation and their properties and application: Buna-S rubber, Buna-N rubber, Neoprene rubber 7.9. Adhesives: Characteristics, Classification and application of adhesives.

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	Atomic Structure, Chemical Bonding, and Solutions	06	03	03	02	08
II	Concepts of Electrochemistry	07	02	06	04	12
III	Corrosion of metals and its prevention	05	02	04	02	08
IV	Water	07	02	05	05	12
V	Cements, Glasses and Refractories	05	03	05	02	10
VI	Paints, Varnishes and Insulating Materials	05	03	03	02	08
VII	Polymers, Elastomers, and Adhesives	07	03	04	05	12
Total		42	18	30	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.

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 group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidence such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

- Prepare a PowerPoint presentation or animation showing different types of chemical bonds and atomic structures.
- Prepare a model of an atom with the help of a ball and stick or of any other items.
- pH Calculations for acid, base, and salt solutions at different concentrations.
- Preparation of a table showing the different methods used for prevention of corrosion.
- Solve simple problems on hardness calculation
- Preparation of a table showing the general chemical composition of cement and glass along with their application.
- Market survey of different paints, varnishes, insulating materials and compare its properties and applications.
- Library survey regarding polymers, synthetic rubber, and adhesives used in different industries.
- Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.

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/activities.
- c) Different types of teaching methods i.e. video demonstration, activity-based learning, case study, m-learning need to be employed by teachers to develop the outcomes.
- d) **Some of the topics/sub-topics** which are relatively simpler or descriptive are to be given to the students for **self-learning** but to be assessed using different assessment methods.
- e) Teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- f) Guide students to address issues on environment and sustainability with reference to using the knowledge of this course
- g) OERs, Vlab and Olabs may be used to teach for the teaching of different concepts.

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-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 the 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 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 industry-oriented COs).

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

- a) Prepare a PowerPoint animation that can explain the structure of an atom.
- b) Prepare a chart of the modern periodic table which gives information about the atomic number and mass number of different elements.
- c) Prepare common salt crystals from NaCl solution
- d) Prepare a chart representing compounds and solutions which affect human life positively and negatively.
- e) Prepare a model of an atom with the help of a ball and stick or of any other items.
- f) Form three groups of students in the class. Consider a hypothetical situation of exchanging/ sharing/giving of different items/belongings and demonstrate the type of ionic, covalent, and co-ordinate bonding amongst the students in a simulated situation. Present your findings.
- g) Model of electronic configurations for different atoms ($Z=30$)
- h) Prepare a model to demonstrate the application of electrolysis cells.

- i) Collect three metallic strips of Al, Cu, Fe, strips, Place them in different acidic and alkaline solutions of the same concentration. Observe and record the loss in weight of metals due to acidic and alkaline environments. Discuss the findings with your teacher and colleagues.
- j) Classify the surrounding corrosion into dry corrosion and wet corrosion.
- k) Collect different samples of utensils reinforced materials, iron, copper, brass, bronze, and other alloys. Place them in an open environment under tin shade. Observe the corrosive properties over a period of four weeks. Record your observations. Discuss the findings with your teacher and colleagues.
- l) Collect water samples from different water sources and measure the hardness of the water.
- m) Make a table showing the availability of natural rubber in India and show places on the India map.
- n) Collect the water sample from different sources of ground and surface water (at least five). Explore the new and simplest softening and water treatment methods and perform the same at your home by creating the different assemblies and manipulative techniques at home. Determine the turbidity and pH of water (using pH paper).
- o) Suppose you have been selected at a top diploma engineering college in the metro city. You have been living there for more than three months. Based on your critical observation and experience on the different kinds of activities/ performances, identify the type of water being used by you. Draw your inferences on the same.
- p) Collection of data of various cement, glass, paints, and varnishes available in the market.
- q) Make a table showing the availability of natural rubber in India and show places on the India map.
- r) Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with the place, year and ISBN
1	Engineering Chemistry	Jain & Jain	Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2015, ISBN: 93-521-6000-2
2	A Textbook of Engineering Chemistry	Dr S. S. Dara & Dr S. S. Umare	S. Chand & Co.(P) Ltd., New Delhi, 2014, ISBN:81-219-0359-9
3	Textbook of Chemistry for Class XI & XII (Part-I & II)	NCERT	NCERT, New Delhi, 2017-18, Class-XI, ISBN: 81-7450-494-X (part-I), 81-7450-535-O (part-II), Class-XII, ISBN: 81-7450-648-9 (part-I), 81-7450-716-7 (part-II)
4	Engineering Chemistry	Shikha Agarwal	Cambridge Uni. Press, New Delhi, 2019, ISBN: 978-1-108-72444-9
5	Understanding Chemistry	C.N.R. Rao	World scientific publishing Co., 2009, ISBN: 9789812836045

S. No.	Title of Book	Author	Publication with the place, year and ISBN
6	Engineering Chemistry	Dr. Vikram, S.	Wiley India Pvt. Ltd., New Delhi, 2013, ISBN: 9788126543342
7	Applied Chemistry Laboratory Practices, Vol. I & II	Dr. G.H. Hunger & Prof. A.N. Pathak.	NITTTTR, Chandigarh, Publication, 2013-14
8	Chemistry for Engineers	Rajesh Agnihotri	Wiley India Pvt. Ltd., 2014, ISBN: 9788126550784
9	Fundamental of Electrochemistry	V. S. Bagotsky	Wiley International N. J., 2005, ISBN: 9780471700586

14. SUGGESTED LEARNING WEBSITES

- <http://www.chemguide.co.uk/atommenu.html>
- <https://www.visionlearning.com>
- <http://www.chem1.com>
- <https://www.wastewaterelearning.com/elearning/>
- <https://www.capital-refractories.com/>
- <https://www.wqa.org/>
- <https://ncert.nic.in>
- <https://docslib.org/insulation-materials-science-and-application>
- <http://www.olabs.edu.in/>
- http://chemcollective.org/activities/type_page/1
- <http://www.presentingscience.com/vac/corrosion/index.htm>
- <https://vlab.amrita.edu/index.php?sub=2&brch=190>

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Applied Chemistry (Course Code: 4300009)						
	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 engineering chemistry to solve broadly-defined engineering problems.	3	2	2	1	1	1	1
Course Outcomes CO1: Apply the principles of chemical bonding and solutions to solve various engineering problems.	3	1	-	1	-	-	1
CO2: Solve engineering problems using the concepts of electrochemistry and	3	1	-	1	1	1	1

Semester I/II	Applied Chemistry (Course Code: 4300009)						
	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
corrosion							
CO3: Use relevant water treatment methods to solve domestic and industrial problems.	3	1	1	1	1	-	1
CO4: Select appropriate engineering materials like cement, glass, and refractory for industrial applications.	3	1	-	1	1	-	1
CO5: Choose various types of engineering materials like polymers, Elastomers, and Adhesives for domestic and industrial applications.	3	1	-	1	1	1	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. Narendra Makwana, Lecturer in Chemistry	Government Polytechnic, Chhotaudepur	9909911391	ngmakwana@yahoo.com
2.	Rehana Baiju Mampilly, Lecturer in Chemistry	Government Polytechnic, Kheda	8758267072	rehanabaijum@gmail.com
3.	Dr. Lopa KiranKumar Sanghavi	Govt. Polytechnic for Girls, Ahmedabad	9429810823	lopa4ever@gmail.com

NITTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1	Dr. Bashirulla Shaik, Assistant Professor	Dept. of Applied Science Education	9981382711	bshaik@nittrbpl.ac.in
2	Dr. Anju Rawlley, Professor	Curriculum Development & Assessment Education	9406947814	arawlley@nittrbpl.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, Metallurgy, Mining, Textile Processing Technology, Textile Manufacturing Technology, Architectural Assistantship, CAD/CAM, 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

The purpose 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:

- List salient features and characteristics of the constitution of India.
- Follow fundamental responsibilities, privileges, rights and duties as responsible citizen and engineer of the country.
- Differentiate between state and central administrative setup of the country.
- Explain major constitutional amendment procedures and emergency provisions in the country
- 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				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 and PrOs. More could be added to fulfil the development of this course competency.

- Work as a leader/a team member.
- Follow constitutional duties and responsibilities
- Follow ethical practices.
- 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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year.
- '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 meaning of 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. 4.3 Emergency 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 course 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	Teaching	Distribution of Theory Marks
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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 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. 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) :weblink<https://indiankanoon.org/doc/1120103/>
 - Golaknath case (1967) :weblink<https://indiankanoon.org/doc/120358/>
 - Kesavananda Bharati case(1973):weblink<https://indiankanoon.org/doc/257876/>
 - Indira Nehru Gandhi v. Raj Narain case (1975):weblink<https://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):weblink<https://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/](https://indiankanoon.org/doc/235821/)
- Justice K.S.Puttaswamy(Retd) ... vs Union Of India And Ors.: Right To Privacy (2017)[weblinkhttps://indiankanoon.org/doc/1857950/](https://indiankanoon.org/doc/1857950/)
- L Chandra Kumar Case (1997):[weblink https://indiankanoon.org/doc/1152518/](https://indiankanoon.org/doc/1152518/)
- Habeas Corpus Case (1976): [weblink https://indiankanoon.org/doc/1735815/](https://indiankanoon.org/doc/1735815/)
- Romesh Thapar Case (1950): [weblink https://indiankanoon.org/doc/456839/](https://indiankanoon.org/doc/456839/)
- M.C. Mehta And Anr vs Union of India &Ors on 20 December, 1986 Bhopal Gas Tragedy:[weblinkhttps://indiankanoon.org/doc/1486949/](https://indiankanoon.org/doc/1486949/)
- M.C. Mehta vs Union Of India &Ors on 30 December, 1996 Taj Mahal:[weblink https://indiankanoon.org/doc/1964392/](https://indiankanoon.org/doc/1964392/)
- M.C. Mehta vs Union Of India on 15 November, 2019 Delhi Pollution: [weblink ttps://indiankanoon.org/doc/174204561/](https://indiankanoon.org/doc/174204561/)
- Samit Mehta v. Union of India &Ors.;National Green [weblink:https://www.casemine.com/judgement/in/5b17d5604a932678010063da](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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- 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.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- 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 15 th 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, 6 th 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

- <http://www.legislative.gov.in/constitution-of-india>
- https://en.wikipedia.org/wiki/Constitution_of_India
- <https://www.india.gov.in/my-government/constitution-india>
- <https://eci.gov.in/about/about-eci/the-setup-r1/>
- <https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india>
- <https://main.sci.gov.in/constitution>
- <https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf>
- <https://legallaffairs.gov.in/sites/default/files/chapter%203.pdf>
- https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india--e.htm
- <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 and Testing	PO 5 Engineering practices for society, sustainability and environment	PO 6 Project Management	PO 7 Life-long learning
Competency <i>Follow policies, processes, duties, rights and federal structure of Indian constitution as responsible citizens</i>							

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 Peena Thanky 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	0989320501 1	rpradhan@nitttrbpl.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester - II

Course Title: Industrial Chemistry

(Course Code: 4320501)

Diploma programmes in which this course is offered	Semester in which offered
Chemical Engineering	Second

1. RATIONALE

Industrial Chemistry deals with the transformation of raw materials into required products that are beneficial to humanity using physical and chemical processes and fundamental principles of chemistry.

In chemical industries, during processes various organic compounds are used. The knowledge of physical and chemical properties of these compounds helps the diploma engineers how to use and control processes effectively. Therefore, for a diploma engineer, the skills and fundamental information related to industrial chemistry are essential for understanding the parameters which control chemical processes such as Halogenation, Oxidation, Nitration, Pyrolysis, Isomerisation, Dehydrogenation, Phase rule, Adsorption, etc. Production of synthetic materials like fertilizers, pesticides, dyes, drugs, plastics, cosmetics, etc used by human beings is harmful to living beings. This pollutes environment. For this, presently, scientists are trying to develop methods to produce environmentally favourable chemical synthesis by Green Chemistry and judicious use of them.

This course is developed in the way by which fundamental information will help the diploma engineers to apply the basic concepts of industrial chemistry to solve broad problems in chemical industries.

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 industrial chemistry to solve broadly-defined chemical engineering 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) Solve various engineering problems applying the concepts of organic compounds on the basis of their properties.
- b) Use relevant aliphatic and aromatic compounds to solve domestic and industrial applications.
- c) Illustrate the principles of one component system using phase rule for industrial applications.

- d) Apply different adsorption phenomena and its isotherms for domestic and industrial applications.
- e) Solve the engineering problems using eco-friendly chemicals and synthesis methods using the principles of green chemistry.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 '*' (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)	Unit No.	Option	Approx. Hrs. Required
1	Identify the functional group (Carboxylic acid, Alcohol, Ketone, Aldehyde) present in given organic compound.	I		02
2	Perform tests for saturation and unsaturation using Br ₂ water and Baeyer's (KMnO ₄) solution of given aliphatic compound.	I		02*
3	Determine aliphatic/aromatic nature of given organic compounds.	II		02*
4	Determine the nature (acidic, phenolic, basic, neutral) of the given organic compound by preliminary tests of organic qualitative analysis.	I, II		02
5	Identify the given organic compound (Acetic acid, Oxalic acid, Benzoic acid) by organic qualitative analysis.	I, II		02*
6	Identify the given organic compound (Aniline, N-methyl aniline) by organic qualitative analysis.	I, II		02
7	Identify 1°, 2°, 3° alcohols by Lucas Test.	II		02
8	Identify the given alcohol (Methanol, Ethanol) by organic qualitative analysis.	II		02
9	Identify the given organic compound (Phenol, Catechol, Resorcinol, Quinol) by organic qualitative analysis.	II		02
10	Purify raw (brown) sugar using activated charcoal.	IV		02*
11	Prepare a solution of given concentration in terms of	IV	Any	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Option	Approx. Hrs. Required
	percentage weight by weight (% w/w) for a given compound.		Two	
12	Prepare a solution of given concentration in terms of percentage volume by volume (% v/v) for a given compound.	IV		02
13	Prepare a solution of given concentration in terms of percentage weight by volume (% w/v) for a given compound.	IV		02
14	Determine boiling point of azeotropic mixture.	IV		02
15	Synthesize p-methoxy chalcone by grinding method.	V		02
	Total			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 accurately	10
2	Handling of apparatus/glasswares for precise measurements	20
4	Record observations correctly	10
3	Practice and adapt good and safe measuring techniques	10
5	Housekeeping	10
6	Observance/Follow safety rules	10
#7	Does Calculations, Interpret the Results and their Conclusion/s	10
#8	Prepare report of practical in prescribed format	10
#9	Viva-voce	10
	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	Laboratory Weighing Balance: Type of Laboratory Balance: Analytical, Sensitivity (mg): 1 mg, Maximum Capacity of weighing (grams): 200 g, Shape of PAN:	10, 11,13,15

S. No.	Equipment Name with Broad Specifications	PrO.No.
	Circular, Power Supply: Single Phase, Display: LED.	
2	Hot Plate With Magnetic Stirrer: Number of stirring Positions:1, Calibration: Automatic Calibration, Magnetic stirrer with a hot plate, Speed Control Accuracy of set speed (+/-) (RPM): 5, Maximum Stirring capacity per position: 3000 mL, Top plate Material: Stainless steel	10, 11, 12,13

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.

- Inculcate professional skills and ethical values in the context of industrial chemistry.
- Work as a leader/a team member.
- Follow ethical practices
- Observance/Follow safety rules
- Housekeeping
- Time management
- Does Calculations, Interpret the Results and their Conclusion/s
- Practice environmentally friendly methods and processes for industrial purposes. (Environment-related Green Chemistry aspects)

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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year.
- '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 Concepts of Organic Chemistry	1a. Write the IUPAC name of organic compounds. 1b. Write structural formula from IUPAC names of organic compounds. 1c. Draw structures of alkanes and compare their reactivity. 1d. Describe the preparation	1.1 IUPAC nomenclature of organic compounds 1.2 Alkanes, Alkenes, Alkynes and Cycloalkanes: Preparation, Properties (Halogenation, Oxidation, Nitration, Pyrolysis, Isomerisation, Dehydrogenation) and Uses 1.3 Structures and Reactivity of Alkanes

	methods, properties and uses of alkanes, alkenes, alkynes and cycloalkanes.	(1°, 2°, 3°) 1.4 Alkenes: Action of Ozone, Halogen acids, Sulphuric acid; Hydrogenation, Polymerization
Unit – II Aromatic and Aliphatic compounds	2a. Explain aromaticity. 2b. Deduce the structure of benzene. 2c. Explain preparation, properties and uses of benzene. 2d. Classify alkyl halides and alcohols. 2e. Describe the preparation, properties and uses of Alkyl halides, Alcohols and Phenol.	2.1. Concepts of Aromaticity; Structure of Benzene; Preparation, Properties (Halogenation, Hydrogenation, Pyrolysis) and Uses of Benzene 2.2. Alkyl halides: Classification, Isomerism, Preparation, Properties (Substitution and Elimination reactions) and Uses 2.3. Alcohols: Classification, Preparation (Methanol, Ethanol), Properties and Uses 2.4. Phenol: Preparation, Properties and Uses
Unit– III Phase Rule	3a. Explain the terms of Phase rule. 3b. Use phase diagrams to identify stable phases at given temperatures and pressures, and to describe phase transitions resulting from changes in these properties. 3c. Describe one component (water) system. 3d. State the applications and limitations of Phase rule.	3.1. Phase Rule - Phase, Components, Degrees of Freedom 3.2. Phase Diagrams 3.3. One Component System - Water Systems 3.4. Applications of Phase Rule 3.5. Limitations of Phase Rule
Unit– IV Adsorption and Solutions	4a. Explain the differences between absorption and adsorption. 4b. Describe the types of adsorption. 4c. Comprehend the different factors affecting adsorption. 4d. Explain adsorption isotherms. 4e. State the applications of adsorption. 4f. Describe solutions and indicators. 4g. Explain ideal and non-ideal solution. 4h. Describe azeotropic mixture.	4.1. Adsorption and Absorption, Desorption, Sorption with suitable examples 4.2. Differences between Adsorption and Absorption 4.3. Types of Adsorption - Physical adsorption, Chemical adsorption 4.4. Factors influencing Adsorption 4.5. Adsorption Isotherms - Freundlich adsorption isotherm, Langmuir adsorption isotherm 4.6. Applications of Adsorption 4.7. Solutions and Indicators 4.8. Ideal solution and Non-ideal solution

		4.9. Azeotropic mixture
Unit– V Green Chemistry	5a. Familiarize with green chemistry. 5b. Explain briefly basic principles of green chemistry. 5c. Learn about green synthesis. 5d. Justify the need of green chemistry. 5e. State the applications of green chemistry in different fields.	5.1. Concept of Green Chemistry 5.2. Basic Principles of Green Chemistry 5.3. Examples of Green Synthesis - Synthesis of Adipic acid from Cyclohexene, Synthesis of soluble Polyphenol 5.4. Advantages of Green Chemistry 5.5. Green Chemistry in day-to-day life - In dry-cleaning of clothes, In bleaching of paper 5.6. Applications of Green Chemistry in Industries

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	Concepts of Organic Chemistry	12	5	7	8	20
II	Aromatic and Aliphatic compounds	11	6	7	5	18
III	Phase Rule	5	3	5	2	10
IV	Adsorption and Solutions	6	4	3	3	10
V	Green Chemistry	8	4	6	2	12
Total		42	22	28	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 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:

- Prepare tabular classification of functional groups with examples.
- Prepare chart on IUPAC nomenclature of organic compounds.
- Prepare table of organic compounds of relevant topics with structure and industrial applications.
- Library survey of different aliphatic hydrocarbons used in industries.
- Library survey of different aromatic hydrocarbons used in industries.
- Prepare a table showing the difference between aliphatic and aromatic compounds.

- g) Market survey of different aliphatic and aromatic compounds, and differentiate by their physical and chemical properties.
- h) Prepare a category-wise list of all compounds with their IUPAC names/common names and structural formulae covered in the syllabus.
- i) Make a list of all probable organic conversions with their reaction-equations covered in the syllabus.
- j) Make a chart showing examples of different terms of phase rule.
- k) Collect different adsorbates and adsorbents and make a chart based on their type, properties, and uses. Also write examples illustrating absorption, adsorption, desorption and sorption.
- l) Make a chart showing differences between Freundlich adsorption isotherm and Langmuir adsorption isotherm.
- m) Give seminar on any relevant topic.
- n) Prepare a PowerPoint presentation or animation for the given topic.
- o) Identify green synthesis of various intermediates and renewable raw materials of organic compounds used in industries.

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 with reference by using the knowledge of this course.
- g) Open Educational Resources (OER), NPTEL, Vlabs and Olabs can be used to teach different concepts.
- h) Guide students for using websites, web links, blog/s and applications for micro-project work and learning.

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) **Organic compounds:** Prepare a chart for classification of organic compounds.
- b) **IUPAC Nomenclature:** Prepare a PowerPoint presentation or animation that can explain the IUPAC nomenclature system.
- c) **Aliphatic hydrocarbons:** Prepare molecular models of alkanes, alkenes and alkynes to demonstrate the structures.
- d) **Aromatic characteristics of Benzene:** Prepare a chart/poster showing aromatic characteristics of Benzene.
- e) **Standard methods used in Industries:** Make a list of standard methods used to prepare different aliphatic and aromatic compounds in industries.
- f) **Terms of Phase rule :** Prepare a chart or PowerPoint presentation showing calculation of the number of phases, components and degrees of freedom in different systems.
- g) **Adsorption :** Collect different types of adsorbates and adsorbents. Observe adsorption process in relevant materials and prepare report based on observations.
- h) **Eco-friendly Indicators:** Prepare eco-friendly acid-base indicators by extraction from flowers and vegetables. Also demonstrate it by chart/poster/PowerPoint presentation.
- i) **Use of Chemicals in Day-to-day Life:** Prepare a chart/poster on chemicals which are used in day-to-day life - their names, structures, physical and chemical properties and uses.
- j) **Green Synthesis:** Prepare a list of green synthesis of organic renewable raw materials used in industries. Discuss the findings with your teacher and classmates.
- k) **Green Chemistry:** Compile report of green synthesis methods used in industries. Discuss the findings with your teacher and classmates.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Textbook of Organic Chemistry	Rakesh K. Parashar, V. K. Ahluwalia	Viva Books Private Limited, New Delhi, 2012, ISBN: 9788130917740
2	A Textbook of Organic Chemistry	Bahl Arun, Bahl B. S.	S. Chand & Company Ltd., New Delhi, 2016, ISBN: 9352531965
3	Organic Chemistry Volume 1: The Fundamental Principles	I. L. Finar	ELBS, Singapore, ISBN: 058240746 X

S. No.	Title of Book	Author	Publication with place, year and ISBN
	(6 th Edition)		
4	Text Book of Chemistry for Class XI & XII (Part - I, Part - II)	NCERT	NCERT, New Delhi, 2017-18, Class XI, ISBN: 81-7450-494-X (part-I), 81-7450-535-O (part-II), Class-XII, ISBN: 81-7450-648-9 (part-I), 81-7450-716-7 (part-II)
5	Advanced Physical Chemistry Book	D. N. Bajpal	S. Chand Publishing, 2001, New Delhi, 2001, ISBN: 8121904080
6	Engineering Chemistry	P. C. Jain & Monica Jain	Dhanpat Rai and Sons Publishing Company (P) Ltd., New Delhi, 2015, ISBN: 8187433175
7	Principles of Physical Chemistry	B. R. Puri, L. R. Sharma and Madan S. Pathania	Shoban Lal Nagin Chand & Co., Jalandhar, 1989.
8	Vogel's Textbook of Practical Organic Chemistry (4 th Edition)	Furniss, Hannaford, Rogers, Smith, Tatchell	ELBS, Singapore, ISBN: 0582002478
9	Handbook of Green Chemistry and Technology	Clark James	Wiley India Pvt. Ltd, New Delhi, ISBN: 9788126548002
10	Green Chemistry	V. K. Ahluwalia	Narosa Publishing House Pvt. Ltd., New Delhi, 2012, ISBN: 8184872011

14. SOFTWARE/LEARNING WEBSITES

- <https://ndl.iitkgp.ac.in>
- <https://vlab.amrita.edu/index.php?sub=2&brch=190>
- www.vlab.co.in
- <http://www.olabs.edu.in/>
- www.chemistry.msu.edu
- www.chemistryteaching.com
- <https://www.asdlib.org/onlineArticles/ecourseware/Manahan/GreenChem-2.pdf>
- https://www.mygreenlab.org/uploads/2/1/9/4/21945752/green_chemistry_principles_and_lab_practices_2.0.pdf
- https://www.ikbooks.com/home/samplechapter?filename=195_Sample-Chapter.pdf

15. PO-COMPETENCY-CO MAPPING

Semester II	Industrial Chemistry (Course Code: 4320501)						
	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
<u>Competency</u>	Use principles of industrial chemistry to solve broadly-defined chemical engineering problems.						
<u>Course Outcomes</u>							
CO a) Solve various engineering problems applying the concepts of organic compounds on the basis of their properties.	3	1	-	1	-	-	2
CO b) Use relevant aliphatic and aromatic compounds to solve domestic and industrial applications.	3	1	-	1	-	-	2
CO c) Illustrate the principles of one component system using phase rule for industrial applications.	3	2	-	-	-	-	1
CO d) Apply different adsorption phenomena and its isotherms for domestic and industrial applications.	3	1	-	1	-	-	1
CO e) Solve the engineering problems using eco-friendly chemicals and synthesis methods using the principles of green chemistry.	3	2	-	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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