



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Branch: Sem 1: Electrical/Information Technology/Power Electronics Engineering

Sem 2: Bio-Medical/Computer/Electronics & Communication/Computer Science & Engineering/ICT/CACDDM/Renewable Energy

Subject Code: DI01C00071(Only for C to D Students)

Course / Subject Name: Engineering Chemistry

w. e. f. Academic Year:	2024-25
Semester:	1 or 2
Category of the Course:	Basic Science Courses

<b>Prerequisite:</b>	Fundamental knowledge of Chemistry and basic Arithmetic for simple calculations.
<b>Rationale:</b>	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 Engineering, 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. Engineering chemistry helps to develop and enhance the thinking capabilities of the diploma pass outs 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 atomic structure, chemical bonding and solutions; electrochemistry; corrosion; fuels; lubricants, polymers, elastomers, insulating materials and semiconductors; electrochemical energy sources in this course.

## Course Outcome:

After Completion of the Course, Student will able to:

No.	Course Outcomes	RBT Level
01	Apply the principles of atomic structure, chemical bonding and solutions to solve various engineering problems.	R/U/A
02	Solve engineering problems using the concepts of electrochemistry and corrosion.	R/U/A
03	Use relevant fuels and lubricants for domestic and industrial applications.	R/U/A



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04	Choose various types of engineering materials like polymers, elastomers, insulating materials and semiconductors for domestic and industrial applications.	R/U/A
05	Select various types of electrochemical devices for domestic and industrial applications.	R/U/A

\*Revised Bloom's Taxonomy (RBT)

## Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA/CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Atomic Structure, Chemical Bonding and Solutions</b> <b>Atomic Structure:</b> 1.1. Concepts of orbits and orbitals. 1.2. Pauli's exclusion principle, Hund's rule of maximum spin multiplicity, Aufbau rule. 1.3. Electronic configuration of elements having atomic number 1 to 30. <b>Chemical Bonding:</b> 1.4. Concept of chemical bond, Octet rule, Types of chemical bonds : 1.4.1 Ionic (Electrovalent) bond and its characteristics (Example NaCl.), 1.4.2 Covalent bond and its characteristics (examples–Non-polar covalent bond: H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> , CH <sub>4</sub> ; Polar covalent bond: HCl, H <sub>2</sub> O, And NH <sub>3</sub> .),	08	17% (12 Marks)



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	<p>1.4.3 Coordinate covalent (Dative) bond (examples – <math>\text{NH}_4^+</math>, <math>\text{H}_3\text{O}^+</math>),</p> <p>1.4.4 Metallic bond and its characteristics,</p> <p>1.4.5 Hydrogen bond, its types and significance,</p> <p>1.4.6 Intermolecular force of attraction (van der Waals bond).</p> <p>1.5. Structures of solids: Ionic solids, Molecular solids, Network solids, and Metallic solids.</p> <p><b>Solutions:</b></p> <p>1.6. Definitions of solute, solvent, solution and concentration, Modes of expressing concentration of solutions – Molarity (<math>M = \text{mole/litre}</math>), Normality (<math>N</math>), Molality (<math>m</math>), mass percentage (%w/w), volume percentage (%v/v), mass by volume percentage (%w/v), mole fraction (<math>\chi</math>), ppm (<math>\mu\text{g/mL}</math>).</p>		
2.	<p><b>Electrochemistry</b></p> <p>2.1. Arrhenius theory of ionization.</p> <p>2.2. Electronic concept of oxidation, reduction, and redox reactions.</p> <p>2.3. Degree of ionization (<math>\alpha</math>) and the factors affecting on it.</p> <p>2.4. Concept of pH and pOH; pH scale for acids, bases and neutral solutions, Calculations of pH and pOH for dilute solutions of acids and bases, Importance of pH in various fields.</p> <p>2.5. Buffer solutions, Types of buffer solutions: Acidic buffers and Basic buffers, Applications of buffer solutions.</p> <p>2.6. Definition of Electrolytes, Non-electrolytes with suitable examples, Types of Electrolytes with examples.</p> <p>2.7. Construction, working, cell-reactions and symbolic representation of an Electrochemical cell.</p> <p>2.8. Conditions for a half-cell to be standard.</p> <p>2.9. Construction and working of Standard Hydrogen Electrode (SHE).</p> <p>2.10. Measurement of Standard half-cell potential / Standard electrode potential (<math>E^\circ_R</math> or <math>E^\circ_L</math>), Electrochemical/electromotive force (emf) series, Standard cell potential (<math>E^\circ_{\text{cell}}</math>).</p> <p>2.11. Construction of Electrolytic cell and Electrolysis.</p> <p>2.12. Faraday's Laws of Electrolysis.</p>	07	15% (11 Marks)



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	2.13. Industrial applications of electrolysis: 2.13.1 Electrometallurgy, 2.13.2 Electroplating, 2.13.3 Electro-refining.		
3.	<b>Corrosion of metals and its prevention</b> 3.1. Definition of Corrosion with example. 3.2. Dry or Chemical corrosion: Oxidation corrosion, Corrosion by other gases. 3.3. Wet or electrochemical corrosion: Liberation of H <sub>2</sub> , Absorption of O <sub>2</sub> . 3.4. Galvanic (Bimetallic) corrosion. 3.5. Concentration cell corrosion. 3.6. Pitting corrosion, Waterline corrosion and Crevice corrosion. 3.7. 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. 3.8. Preventive measures for internal corrosion and External corrosion: Modification of environment, Modification of the properties of metal, Use of protective coatings, Anodic and cathodic protection, Modification in design and choice of material.	05	12% (8 Marks)
4.	<b>Fuels and Combustion</b> 4.1 Definition and Classification of Fuels. 4.2 Calorific values and their Units. 4.3 Determination of Calorific value using a Bomb Calorimeter. 4.4 Characteristics of a good fuel. 4.5 Comparison between solid, liquid, and gaseous fuels. 4.6 Theoretical calculation of HCV and LCV of fuel using Dulong's formula. 4.7 Solid fuels: Coal, Classification of coal, Proximate and ultimate analysis of coal. 4.8 Liquid fuels: Petroleum, Origin of petroleum and classification of petroleum, Refining of petroleum, Petrol and Diesel-fuel rating (Octane and Cetane numbers), Power alcohol and Bio-diesel, Chemical composition.	07	14% (10 Marks)



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	4.9 Calorific values and Applications of LPG, CNG, and Biogas.		
5.	<b>Lubricants</b> 5.1 Lubricants and Lubrication, Functions of lubricants. 5.2 Mechanism of Lubrication: Fluid lubrication, Boundary lubrication. 5.3 Classification of lubricants with examples: Solid, Semi-solid, Liquid and Synthetic lubricants. 5.4 Physical Properties of lubricants: Viscosity and Viscosity index, Flash point and Fire point, Cloud point and Pour point, Oiliness. 5.5 Chemical properties of lubricants: Saponification number, Neutralization number, Emulsification number. 5.6 Selection of lubricants for different types of Machinery like: Gears, Cutting tools, Steam turbine, Transformers. 5.7 Biodegradable lubricants.	04	10% (7 Marks)
6.	<b>Polymers, Elastomers, Insulating Materials and Semiconductors</b> <b>Polymers:</b> 6.1 Definition of Monomer, Polymer, Polymerization, Degree of polymerization (n) and Repeating unit. 6.2 Classification of polymers based on Molecular structure: Linear polymers, Branched polymers, Cross-linked polymers. 6.3 Classification of polymers based on Monomer: Homo polymer, Co-polymer. 6.4 Classification of polymers based on Thermal behavior: Thermoplastic polymers and Thermosetting polymers. 6.5 Types of polymerizations: Addition polymerization and Condensation polymerization 6.6 Preparation (by simple reactions), Properties and Uses of some thermoplastic polymers and thermosetting polymers: Polyethylene (PE), Polypropylene (PP), PolyVinylChloride (PVC), PolyTetraFluoroEthylene (PTFE, Teflon, and Fluon), Polystyrene (PS), PolyAcryloNitrile (PAN), Bakelite, and Epoxy resins. 6.7 Biodegradable Polymers: Definition, Chemical composition and Uses of Poly- $\beta$ -HydroxyButyrate-co- $\beta$ -hydroxyl Valerate (PHBV), Nylon-2-nylon-6.	08	20% (14 Marks)



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	<p><b>Elastomers (Rubbers):</b></p> <p>6.8 Natural rubber and its Properties.</p> <p>6.9 Vulcanization of rubber and its Advantages.</p> <p>6.10 Synthetic rubbers: Preparation (by simple reactions), Properties and Uses of Buna-S (GR-S or Styrene) rubber, Buna-N (GR-A or Nitrile) rubber, Neoprene (GR-M) rubber.</p> <p><b>Insulating Materials:</b></p> <p>6.11 Definition, Types and Properties of Insulating Materials.</p> <p>6.12 Applications of Thermal and Electrical insulating materials.</p> <p><b>Semiconductors:</b></p> <p>6.13 Definition and Classification of Semiconductors.</p> <p>6.14 Enlist Semiconductor devices.</p> <p>6.15 Elemental Semiconductors : Intrinsic Semiconductors, Extrinsic Semiconductors (n-type Semiconductors, p-type Semiconductors).</p>		
7.	<p><b>Electrochemical Energy Sources</b></p> <p>7.1 Batteries: An electrochemical source of energy, Types of Batteries: Primary, Secondary and Fuel batteries.</p> <p>7.2 Construction and Working of Dry cell.</p> <p>7.3 Construction and Working of Lead-acid storage cell.</p> <p>7.4 Construction and Working of Nickel-Cadmium battery/cell.</p> <p>7.5 Fuel cells: Definition and Characteristics, Construction and Working of Hydrogen-Oxygen fuel cell.</p> <p>7.6 Biochemical Fuel cells.</p> <p>7.7 Solar Cells.</p>	06	12% (8 Marks)
	<b>Total</b>	<b>45</b>	<b>100% (70 Marks)</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
24 Marks (35%)	32 Marks (45%)	14 Marks (20%)	-	-	-



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Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per 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.

## References/Suggested Learning Resources:

### (a) Books:

Sr. 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	Chemistry for Engineers	Rajesh Agnihotri	Wiley India Pvt. Ltd., 2014, ISBN: 9788126550784
8	Fundamental of Electrochemistry	V. S. Bagotsky	Wiley International N.J., 2005, ISBN: 9780471700586

### (b) Open source software and website:

1. <http://www.chemguide.co.uk/atommenu.html>
2. <https://www.visionlearning.com/>
3. <http://www.chem1.com/>



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4. <http://www.em-ea.org/>
5. <https://ncert.nic.in/>
6. <http://www.onlinelibrary.wiley.com/>
7. <http://www.rsc.org/>
8. <https://docslib.org/insulation-materials-science-and-application>
9. <http://www.olabs.edu.in/>
10. <http://chemcollective.org>
11. [http://chemcollective.org/activities/type\\_page/1](http://chemcollective.org/activities/type_page/1)
12. <http://www.presentingscience.com/vac/corrosion/index.htm>
13. <https://vlab.amrita.edu/index.php?sub=2&brch=190>

## Suggested Course Practical List:

Sr. No.	Practical Outcomes (PrOs)	Unit No.
1	Prepare a standard solution of oxalic acid or potassium permanganate.	1
2	Prepare a solution of given concentration in terms of percentage weight by weight (% w/w) of a given compound.	1
3	Prepare a solution of given concentration in terms of percentage volume by volume (% v/v) of a given compound.	1
4	Prepare a solution of given concentration in terms of percentage weight by volume (% w/v) of a given compound.	1
5	Determine the strength of the given sodium hydroxide solution by titrating against standard oxalic acid solution using phenolphthalein indicator.	1
6	Standardize potassium permanganate solution by standard oxalic acid solution and estimate ferrous ions.	2
7	Determine pH-Values of given samples of Solution by using Universal Indicator and pH-meter.	2
8	Determine emf of an electrochemical cell (Daniel cell).	2, 7
9	Determine electrochemical equivalent of copper metal using Faraday's first law.	2
10	Determine the rate of corrosion for different metals in the given solution.	3



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11	Determine the rate of corrosion for metal in the solution of different ph.	3
12	Determine the calorific value of solid or liquid fuel using a bomb calorimeter.	4
13	Determine the percentage of moisture content in the given sample of coal by proximate analysis.	4
14	Determine the ash content of the given sample of coal by proximate analysis.	4
15	Determine the viscosity of the lubricating oil using a Redwood viscometer.	5
16	Determine the Acid value of the given lubricating oil.	5
17	Determine the Saponification value of the given lubricating oil.	5
18	Determine flash point and fire point of the given lubricating oil using Pensky Martens/Cleveland open cup/Able's flashpoint apparatus.	5
19	Prepare Polystyrene and Bakelite. (Any one)	6

**Note:**

- Practical Exercises of at least 28 Hrs. should be completed by the end of the term.*
- More Practical Exercises can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
- The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed Practical Exercises of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %	Maximum Marks for PA/CA (I)
➤	<b>"Process" related skills</b>		
1.	– Prepare experimental setup accurately. – Handling of apparatus/glassware for precise measurements.	20	4
2.	– Practice and adapt good and safe measuring techniques. – Record observations correctly.	20	4
3.	– Housekeeping. – Observance /Follow safety rules.	20	4



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➤	<i>"Product" related skills</i>		
4.	– Does Calculations. – Interpret the Results and their Conclusion/s.	20	4
5.	– Prepare report of practical in prescribed format. – Viva-voce.	20	4
<b>Total</b>		100	<b>20</b>

## List of Laboratory Equipment's required:

No.	Equipment's / Instruments	Practical No.
1	Electronic Weighing Balance / Digital Weighing Balance (OR Analytical Balance)	1, 6, 7, 8, 9, 10, 13, 14, 16
2	Digital pH meter	4, 8
3	Voltmeter	5
4	6 V Battery	6
5	Ammeter	6
6	Rheostat	6
7	Dryer	7, 8
8	Hot air oven	9, 10
9	Hot plate with Magnetic stirrer	3
10	Bomb Calorimeter	9
11	Muffle furnace	11
12	Redwood viscometer No.1	12
13	Stop watch	12
14	Pensky-Marten's apparatus OR Cleveland open cup OR Abel's flashpoint apparatus	15



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## Suggested Project List:

1. Prepare a model of an atom with the help of a ball and stick or of any other items.
2. Prepare a PowerPoint animation that can explain the structure of an atom.
3. Prepare a chart showing (1) Atomic number ( $Z = e^- = p^+$ ) 1 to 30, (2) Name of the element, (3) Symbol, (4) Electronic configuration and (5) Condensed Electronic configuration of elements in tabular form.
4. Prepare a chart of the modern periodic table which gives information about the atomic number and mass number of different elements.
5. Prepare crystals of common salt from NaCl solution.
6. 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.
7. Prepare a chart representing compounds and solutions which affect human life positively and negatively.
8. Classify the surrounding corrosion into dry corrosion and wet corrosion.
9. 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 classmates.
10. Collect three metallic strips of Cu, Al and Fe. 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 classmates.
11. Prepare a model to demonstrate the application of electrolysis.
12. Collect fuel samples from different sources and prepare a chart showing their calorific values and uses.



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13. Collect samples of petrol, kerosene, diesel, any edible oil, coconut oil. Find out the flash point and fire point, cloud point and pour point, and viscosity of the same. Compare the properties and justify their use in relevant applications.
14. 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 classmates and present the same.
15. Make a table showing the availability of natural rubber in India and show places on the map of India.
16. Prepare a chart showing (1) name & formula of the Polymer, (2) name and formula of the Monomer/s used to prepare that polymer, (3) simple reaction equation for Preparation of polymer, (4) Properties in short and (5) Uses in tabular form.
17. Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.
18. Do mapping of energy resources in India.
19. Collect data of various electrochemical cells (batteries) used in equipment's and devices and available in the market and prepare a report on it.
20. Classify Semiconductors with examples. Enlist Semiconductor Devices. Also collect Semiconductors.

### Suggested Activities for Students:

1. Prepare a Power point presentation or animation showing different atomic structures and different types of chemical bonds.
2. Calculate pH of acid solutions and base solutions having different concentrations.
3. Prepare a chart showing different methods used for the prevention of corrosion.
4. Show theoretical calculations of HCV and LCV of fuel using Dulong's formula.



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5. Do market survey of different types of lubricating oils and compare their physical properties and chemical properties.
6. Do library survey regarding polymers, synthetic rubbers, insulating materials and semiconductors used in different industries.
7. Do market survey of different batteries and differentiate primary and secondary batteries.

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