GANPAT UNIVERSITY

FACULTY OF DIPLOMA ENGINEERING

Programme	Diploma in Petrochemical/Chemical Engineering				
Semester	II		Version	1.0.0.0	
Effective from Academic Year	2025-26		Effective for the batch Admitted in		JULY 2025
Subject code	1BS2102	Subject Name	Chemistry - 2		

I.TEACHING-LEARNING AND ASSESSMENT SCHEME

Course Type	Course Code	Learning Scheme						Assessment Scheme											
		Actual Contact Hrs./Week			SLH	NLH	Credits	Theory				Practical				Based on SL		Total Marks
		CL	TL	LL				FA-TH	SA-TH	TOTAL		FA-PR	SA-PR	TOTAL		SLA		
								MAX	MAX	MAX	MIN	MAX	MAX	MAX	MIN	MAX	MIN	
DSC	1BS2102	3	-	2	3	8	4	40	60	100	40	30	20	50	20	20	8	170

Abbreviation:	**CL-** Classroom Learning	**TL -** Tutorial Learning	**LL -** Laboratory Learning
	SLH - Self Learning Hours	**NLH -** Notional Learning Hours	**SLA -** Self Learning Assessment
	FA - Formative Assessment (Term work +Mid Sem Exam +Attendance)		**SA -** Summative Assessment

II. PRE-REQUISITES

Basic knowledge of Engineering Chemistry.

III. INDUSTRY / EMPLOYER EXPECTED OUTCOMES

Apply chemistry knowledge to solve engineering problems, select and use appropriate materials, prevent corrosion, operate lab equipment safely, support electrochemical processes, use lubricants and insulators, follow safety protocols, document findings, communicate effectively, and adapt to new industrial technologies.

IV. COURSE LEARNING OUTCOMES

At the end of the course, students will be able to achieve the following course learning outcomes:

CO1: Apply the concepts of ionization, electrolysis, and Faraday's laws to analyse chemical and industrial processes.

CO2: Classify and evaluate different electrochemical energy sources such as primary, secondary, and fuel cells with their applications.

CO3: Assess the properties, calorific value, and quality of fuels and combustion processes for energy efficiency.

CO4: Demonstrate knowledge of inert gases, their properties, compounds, and applications in industry and research.

CO5: Apply IUPAC nomenclature rules to systematically name and classify organic compounds with different functional groups.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT:				
Name of Unit	**Theory Learning outcomes (TLO's) aligned to CO's**	**Learning Content mapped with Theory Learning outcomes (TLO's) & CO's**	**Marks**	**Hours**
Unit-1 Ionization& Electrolysis	**TLO 1.1:** Define ionization and explain Arrhenius's theory of ionization. **TLO 1.2:** Define degree of ionization and explain factors affecting it. **TLO 1.3:** Differentiate between electrolytes and non-electrolytes with examples. **TLO 1.4:** Explain the principle of electrolysis and its major industrial applications. **TLO 1.5:** State and apply Faraday's laws of electrolysis.	1.1 Concept of ionization – Arrhenius's definitions of acids and bases – Examples. 1.2 Degree of ionization – Factors: concentration, temperature, nature of solute/solvent. 1.3 Definitions – Properties – Examples of electrolytes (NaCl, HCl) and non-electrolytes (sugar, urea). 1.4 Principle of electrolysis – Electrolytic cell – Applications (electroplating, electrorefining, extraction of metals). 1.5 Faraday's First & Second Laws – Formulae – Numerical problems – Practical uses.	**10**	**5**
Unit-2 **Electro chemical Energy Sources**	**TLO 2.1:** Define electrochemical sources of energy and explain their role in daily life and industries. **TLO 2.2:** Classify batteries into primary, secondary, and fuel cells based on rechargeability and operation. **TLO 2.3:** Illustrate suitable examples of primary, secondary, and fuel cells. **TLO 2.4:** Compare the characteristics, merits, and limitations of primary, secondary, and fuel cells. **TLO 2.5:** Describe the construction and working of dry cells with relevant half-reactions. **TLO 2.6:** Explain the principle and operation of lead-acid storage cells and hydrogen-oxygen fuel cells. **TLO 2.7:** Explain the principle, construction, and	2.1 Definition – Types – Importance in daily life (batteries, fuel cells, solar cells) – Industrial applications. 2.2 Classification of batteries – Primary, secondary, fuel cells – Rechargeability & working principle. 2.3 Examples: Primary (dry cell, mercury cell), Secondary (lead-acid, Ni-Cd), Fuel cells (H_2–O_2 fuel cell). 2.4 Characteristics: energy density, cost, reusability, efficiency – Advantages and disadvantages of each type. 2.5 Structure, reactions at anode & cathode, overall working, uses. 2.6 Construction, working principle, half-cell reactions, charging & discharging (lead-acid), hydrogen-oxygen fuel cell mechanism. 2.7 Principle of solar energy conversion (photovoltaic effect, p–n junction). Construction of solar cells	**10**	**7**

	applications of solar cells as renewable energy sources.	(semiconductor materials, layers, connections). Working mechanism (light absorption, electron–hole pair generation, current flow). Applications: domestic lighting, calculators, satellites, renewable		
Unit-3 **Fuels and combustion**	**TLO 3.1:** Define fuel, explain the characteristics of a good fuel, and classify fuels with examples. **TLO 3.2:** Differentiate between primary and secondary fuels with suitable examples. **TLO 3.3:** Define calorific value (GCV and NCV) and calculate it using bomb calorimeter data. **TLO 3.4:** Describe the construction and working principle of a bomb calorimeter. **TLO 3.5:** Classify types of coal and explain proximate and ultimate analysis for assessing fuel quality. **TLO 3.6:** Explain the origin, composition, and refining of petroleum with fractional distillation and products. **TLO 3.7:** Define octane and cetane numbers, describe power alcohol, and list common gaseous fuels with composition. **TLO 3.8:** Explain the properties and applications of natural gas, CNG, LPG, and LNG.	3.1 Define fuels and their characteristics; classify fuels (solid, liquid, gaseous). 3.2 Classify fuels into primary and secondary types with examples. 3.3 Determine calorific value using a bomb calorimeter. 3.4 Demonstrate understanding of bomb calorimeter construction and working. 3.5 Analyse coal using proximate and ultimate analysis to assess fuel quality. 3.6 Explain petroleum origin, composition, refining, and products. 3.7 Interpret octane and cetane numbers; explain power alcohol and gaseous fuels. 3.8 Describe alternative fuels (natural gas, CNG, LPG, LNG) with their properties and applications.	**12**	**8**
Unit-4 **Inert gases**	**TLO 4.1:** Explain the methods of separation of inert gases from atmospheric air. **TLO 4.2:** Describe the physical and chemical properties of inert gases. **TLO 4.3:** Discuss the important compounds of	4.1 Fractional distillation of liquid air – Dewar's method – Adsorption method of inert gases 4.2 Physical properties (atomic size, density, boiling point, solubility) – Chemical inertness – Reactivity trends of inert gases 4.3 Compounds of xenon (XeF_2, XeF_4, XeF_6, XeO_3) – Preparation	**7**	**4**

	inert gases and their preparation. **TLO 4.4:** Explain the applications of inert gases in industry, research, and daily life.	methods – Stability – Structures. 4.4 Applications of He (cryogenics, balloons, leak detection), Ne (lighting), Ar (welding, lamps), Kr & Xe (lasers, anesthesia).		
Unit-5 **IUPAC system**	**TLO 5.1:** Define organic compounds and classify them based on types and functional groups. **TLO 5.2:** Explain the classification of organic compounds according to their structure. **TLO 5.3:** State the IUPAC rules for naming organic compounds. **TLO 5.4:** Apply IUPAC rules to name organic compounds with different functional groups. **TLO 5.5:** Demonstrate the application of IUPAC nomenclature in systematic naming of organic compounds.	5.1 Definition of organic compounds – Types (aliphatic, aromatic, heterocyclic) – Functional groups and examples. 5.2 Structural classification – Acyclic, cyclic, aromatic, heterocyclic – Open chain vs closed chain compounds. 5.3 Basic rules: selecting longest chain, numbering, substituents, multiple bonds, functional groups, prefixes & suffixes. 5.4 Examples of compounds containing alcohols, aldehydes, ketones, carboxylic acids, halides, amines, esters, etc. 5.5 Stepwise naming of given compounds – Structural isomers, positional isomers, functional isomers – Practice problems.	**7**	**5**
Unit-6 **Industrial Engineering Materials Polymers, Rubber, Insulators,**	**TLO 6.1:** Define polymers and classify them based on origin and structure. **TLO 6.2:** Explain the synthesis, properties, and applications of polyethylene. **TLO 6.3:** Explain the synthesis, properties, and applications of PVC. **TLO 6.4:** Explain the synthesis, properties, and applications of polystyrene. **TLO 6.5:** Describe the structure and properties of natural rubber. **TLO 6.6:** Explain the process of vulcanization and its effect on rubber properties.	6.1 Definition of polymers. Classification of polymers by origin (natural, synthetic, semi-synthetic). Classification by structure (linear, branched, cross-linked). 6.2 Study of the synthesis, properties, and applications of polyethylene as an engineering polymer. 6.3 Examination of the synthesis, properties, and applications of polyvinyl chloride (PVC). 6.4 Analysis of the synthesis, properties, and applications of polystyrene. 6.5 Overview of the structure and properties of natural rubber and its significance. 6.6 Explanation of the vulcanization process and its effects on improving rubber properties. 6.7 Definition, classification, and	**7**	**8**

	TLO 6.7: Define insulating materials, classify them, and explain their properties. **TLO 6.8:** Describe the properties and applications of glass wool and thermocol as insulating materials.	properties of insulating materials used in engineering. 6.8 Properties and applications of glass wool and thermocol as commonly used insulating materials.		
Unit-7 **Industrial Engineering Materials (lubricants, refractories, paints and varnishes, adhesives.)**	**TLO 7.1:** Define lubricants, classify their types, and explain their uses. **TLO 7.2:** Explain the physical and chemical properties of lubricants and the criteria for their selection. **TLO 7.3:** Define refractories, classify them, and describe their key properties. **TLO 7.4:** Explain the industrial applications of refractory materials. **TLO 7.5:** Describe the composition, types, properties, and applications of paints and varnishes. **TLO 7.6:** Define adhesives and explain their properties, manufacturing, and uses. **TLO 7.7:** Define ceramics, cement, and glass, and explain their properties, manufacturing, and applications. **TLO 7.8:** Summarize the importance of engineering materials including lubricants, refractories, paints, adhesives, ceramics, cement, and glass.	7.1 Overview of lubricants: definition, classification, types, and their applications in engineering. 7.2 Study of physical and chemical properties of lubricants and the criteria for selecting appropriate lubricants. 7.3 Introduction to refractories: definition, classification, and key properties for industrial use. 7.4 Exploration of various industrial applications of refractory materials. 7.5 Composition, types, properties, and applications of paints and varnishes used in engineering. 7.6 Definition, properties, manufacturing processes, and applications of adhesives. 7.7 Study of ceramics, cement, and glass, including their properties, manufacturing methods, and engineering applications. 7.8 Summary of essential engineering materials including lubricants, refractories, paints, adhesives, ceramics, cement, and glass, highlighting their importance, properties, and uses.	**7**	**8**

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL			
Sr. No.	**Practical/Laboratory Learning Outcome (LLO)**	**Practical Titles**	**Relevant COs**

1	**LLO1.1** Follow standard laboratory safety rules and demonstrate proper handling and operation of basic chemistry lab equipment	Introduction to Laboratory Safety Rules and Demonstration of Basic Chemistry Equipment	CO1
2	**LLO 2.1** To determine the moisture content of a coal sample to assess its water percentage and quality.	To determine the Moisture content of coal.	CO3
3	**LLO 3.1** To determine the ash content of a coal sample to evaluate its mineral residue after combustion.	To determine the ash content in a given sample of coal.	CO3
4	**LLO 4.1** Measure and compare the pH of various solutions using both universal indicators and pH meter and interpret the results.	Determination of pH Using Universal Indicator and pH Meter	CO1
5	**LLO 5.1** Students will be able to demonstrate separation methods, explain the properties and compounds of inert gases, and discuss their practical applications.	Separation, Properties, and Applications of Inert Gases	CO4
6	**LLO 6.1** Students will be able to apply IUPAC nomenclature rules to classify, identify, and systematically name organic compounds with various functional groups, structures, and isomers.	Application of IUPAC Rules for Classification and Nomenclature of Organic Compounds	CO4
7	**LLO 7.1** Explain and demonstrate the construction and working of an electrochemical cell, electrolyte cell and understand the electrochemical series.	Construction and Working of Electrochemical and Electrolytic Cells	CO2
8	**LLO 8.1** Measure the viscosity of a liquid using Redwood viscometer and relate viscosity with molecular interactions.	Determination of Viscosity of a Liquid Using Redwood Viscometer	CO5
9	**LLO 9.1** To determine the flash and fire points of a lubricating oil sample to assess its flammability and safe handling temperature. Martens or Abel's apparatus and evaluate its safety for usage.	Determination of Flash and Fire Point of a Lubricating Oil	CO5
10	**LLO 10.1** Identify the composition and properties of cement and concrete, and understand their roles in civil engineering applications.	Study of Composition and Properties of Cement and Concrete	CO5
11	**LLO 11.1** Understand the parts and working of a metallurgical microscope and demonstrate proper handling techniques.	Study and Operation of Metallurgical Microscope	CO5

VII. SUGGESTED MICRO PROJECT / ASSIGNMENTS / ACTIVITIES FOR SELF LEARNING / SKILL DEVELOPMENT (SELF LEARNING)

- Teacher guided self-learning activities.
- Course/topic-based internet-based assignments.
- Library survey regarding Engineering Material used in different industries.
- Industrial Visits of one or Two Industries.
- Quiz & Brainstorming session related to Polymeric materials.
- Sampling & Testing of water collected from different places.

VIII. LIST OF INSTRUMENTS / EQUIPMENT / TRAINER BOARD

1	Chemical balance, Glassware and Plasticware identification chart (like Test tubes, beakers, burettes with stand, pipettes, funnels, Measuring cylinders, wash bottle, Buffer solutions, Thermometer, etc.)
2	Standard solutions (HCl, H_2SO_4, NaOH, NH_4OH or similar acid and base), Phenolphthalein, Methyl orange and appropriate pH indicator
3	Digital pH meter with electrodes
4	Desiccator
5	Electrochemical cell trainer kit
6	Redwood Viscometer (No. 1 or 2)
7	Pensky-Martens Apparatus or Abel's Flash Point Apparatus
8	Metallurgical Microscope

IX. LIST OF REFERENCE BOOKS

Sr.No.	Title	Author	Publication
1	Engineering Chemistry	JAIN & JAIN	Dhanpat Rai and Sons
2	A Text Book of Polytechnic Chemistry	V.P. Mehta	Jain Brothers
3	A Text Book of Applied Chemistry	J. Rajaram	Tata McGraw Hill Co. New Delhi
4	Engineering Chemistry	S.S. Dara	S. Chand Publication
5	Industrial Chemistry	B.K. Sharma	Krishna Publication

X. LINK OF LEARNING WEB RESOURCE	
1	https://www.youtube.com/watch?v=2JpZCe_dG6U - General Chemistry (Theory + Practical)
2	https://vlab.amrita.edu/?sub=2 – Amrita VLab (Govt of India)
3	https://www.khanacademy.org/science/chemistry - Corrosion and Electrochemistry
4	https://nptel.ac.in/courses/122102008 – NPTEL IIT Kharagpur
5	https://nptel.ac.in/courses/113106064 – Material Science Course
6	https://phet.colorado.edu/en/simulations/category/chemistry - Science Animation & Simulations
7	https://gtu-paper-solution.com/gtu-applied-chemistry/ - Applied Chemistry Notes (Diploma Gujarat GTU)

XI. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	Chemical Bonding, Catalysis, and Types of Chemical Reactions	CO1	4	2	5	3	10
2	Chemical Properties of Acids and Bases and the Concept of pH	CO2	4	2	6	4	12
3	Physical and Chemical Properties of Metals and Corrosion Prevention	CO3	5	2	6	4	12
4	Concepts of Electro Chemistry	CO4	7	2	5	5	12
5	Properties, Classification, and Applications of Lubricants, Polymers, Insulators, and Industrial Engineering Materials	CO5	10	2	6	6	14
		Grand Total	30	10	28	22	60

XII. COs AND POs AND PSOs MAPPING

Course outcome (Cos)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	0	1			
CO2	3	3	2	2	1	0	1			
CO3	3	3	2	2	2	1	1			
CO4	3	2	2	3	1	1	2			
CO5	3	2	2	2	3	1	2			

Legends: - *3- High 2-Moderate/Medium 1-Slight/Low 0-None*