GANPAT UNIVERSITY

FACULTY OF DIPLOMA ENGINEERING

Programme	Diploma in Petrochemical/Chemical Engineering				
Semester	I		Version	1.0.0.0	
Effective from Academic Year	2025-26		Effective for the batch Admitted in		JULY 2025
Course code	1BS1106	Course Name	Chemistry-1		

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	1BS1106	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 Chemistry.

III. INDUSTRY / EMPLOYER EXPECTED OUTCOMES

Apply chemistry knowledge for Diploma graduates are expected to apply core chemical principles and laboratory techniques to analyze materials, understand atomic and molecular behaviour, evaluate corrosion and water quality issues, and support industrial processes through accurate testing, interpretation, and basic problem-solving in chemical, manufacturing, or maintenance-related roles.

IV. COURSE LEARNING OUTCOMES

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

CO1. Apply basic chemical principles, symbols, and solution techniques to perform laboratory analysis and interpret the behaviour of acids, bases, pH, buffers, and metals in chemical reactions.

CO2. Understand atomic structure, arrange electrons in shells/orbitals using rules like Aufbau, Pauli, Hund's rule and explain trends like ionization energy and electron affinity.

CO3. Understand and explain the fundamental concepts of chemical bonding and catalysis, and classify various types of chemical reactions using balanced chemical equations.

CO4. Describe the physical and chemical properties of metals and explain types, causes, and preventive methods of corrosion.

CO5. Analyze the characteristics of hard and soft water, determine water hardness through calculations, evaluate its effects on boiler operations, and explain the processes involved in industrial and domestic water treatment.

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 Fundamentals of Chemistry and Solution Preparation	**TLO1.1:** Understand and apply chemical symbols, formulae, and balanced equations to represent chemical reactions accurately. **TLO1.2:** Define and differentiate solute, solvent, and solution; explain their roles in solution formation. **TLO1.3:** Explain and compare methods of expressing concentration such as weight/weight (W/W) and weight/volume (W/V), including their applications. **TLO1.4:** Apply the mole concept to calculate molecular and equivalent weights and solve problems in quantitative analysis. **TLO1.5:** Understand and calculate various concentration units: molarity, molality, normality, gram per liter, and PPM. **TLO1.6:** Describe and interpret the physical properties of solutions, including density and viscosity. **TLO1.7:** Prepare standard solutions accurately using appropriate chemical calculations and laboratory techniques.	**1.1** Symbols, formulae, and chemical equations. **1.2**. Definition and roles of solute, solvent, and solution **1.3** Methods of expressing concentration (W/W and W/V methods, types and applications) **1.4** Mole concept, molecular weight, equivalent weight, basic quantitative chemical analysis **1.5** Concentration of solutions: molarity, normality, and related calculations **1.6** Physical properties of solutions (Density, Viscosity) **1.7** Prepare standard solutions accurately using appropriate chemical calculations	**6**	**7**
Unit-2 **Chemical Properties of Acids and**	**TLO2.1**: Explain the basic concepts of acids and bases and describe their characteristic chemical properties.	**2.1** Definition, types, and properties of acids and bases **2.2** Physical properties, comparison between metals and non-metals **2.3** Reactions of metals with	**10**	**8**

Bases and the Concept of pH	**TLO2.2**: Compare the physical properties of metals and non-metals with suitable examples. **TLO2.3:** Explain the chemical behavior of metals based on their reactions with oxygen, water, acids, and salts. **TLO2.4:** Describe and analyze the reactions of metallic oxides with acids and identify acid–base reactions in aqueous solutions. **TLO2.5:** Define pH and understand the pH scale in relation to acidity, neutrality, and alkalinity. **TLO2.6:** Solve numerical problems to calculate pH values using given concentration of hydrogen or hydroxide ions. **TLO2.7:** Explain the real-life significance of pH in areas such as agriculture, biology, industry, and environmental science. **TLO2.8:** Define buffer solutions, classify them into types (acidic and basic), and provide examples with their uses.	oxygen, water, acids, and salts. **2.4** Reaction of metallic oxides with acids; acid–base reactions in aqueous solution **2.5** Definition, pH scale, importance of Ph. **2.6** Numerical problems on calculating pH using [H+] or [OH−]concentrations. **2.7** Applications in agriculture, industry, medicine, biology, environment. **2.8** Definition, types (acidic/basic), examples and applications of Buffer solution.		
Unit-3 **Atomic structure and classification of elements**	**TLO3.1**: Describe the structure of an atom, including the arrangement and roles of protons, neutrons, and electrons; define atomic number. **TLO3.2**: Explain how electrons are distributed in different shells and subshells according to atomic structure rules. **TLO3.3:** Define atomic orbitals and describe their shape, energy levels, and	**3.1** Structure of atom, subatomic particles (proton, neutron, electron), atomic number **3.2** Shells (K, L, M…), subshells (s, p, d, f), maximum electron capacity **3.3** Definition, shapes of orbitals (s, p, d), significance in electron configuration **3.4** Aufbau principle, Pauli exclusion principle, Hund's rule for writing electronic configurations. **3.5** Orbital diagrams for elements ($Z \leq 30$), box notation for electron arrangement.	**10**	**7**

	role in electron arrangement. **TLO3.4:** Apply the Aufbau principle, Pauli exclusion principle, and Hund's rule to write electronic configurations of elements. **TLO3.5:** Use orbital notation to represent electron distribution in atoms up to atomic number 30. **TLO3.6**: Define ionization energy (IE) and electron affinity (EA), and explain their variation across periods and down groups. **TLO3.7:** Interpret periodic trends in properties like atomic size, IE, and EA based on electronic configuration.	**3.6** Concepts, definitions of ionization energy and electron affinity. **3.7** Trends in atomic size, IE, and EA across periods and down groups; relation to electronic configuration		
Unit-4 Chemical Bonding, Catalysis, and Types of Chemical Reactions	TLO4.1. Define and explain ionic bonds, including their formation through electron transfer, and give suitable examples. TLO4.2. Describe covalent and coordinate bonds, highlighting the concept of electron sharing and lone pair donation with relevant examples. TLO4.3. Explain metallic bonding, including the "sea of electrons" model, and discuss its role in the physical properties of metals. TLO4.4. Describe hydrogen bonding, differentiate between intermolecular and intramolecular hydrogen bonds, and provide real-life examples (e.g., water, DNA). TLO4.5 Define catalysis and catalyst; explain types of catalysis, and the roles of	**4.1** Concept of valency and electron transfer **4.2** Covalent bond formation (H_2, O_2, CH_4) **4.3** Metallic bonding theory **4.4** Define, Types and properties of H-bond **4.5** Definition and Types of Catalysis & Catalyst, Catalytic Promoter and Inhibitor **4.6** Writing and Balancing Chemical Equations **4.7** Combination, Decomposition, Displacement, and Double Displacement Reactions	**12**	**7**

	catalytic promoters and inhibitors. TLO4.6 Write and balance chemical equations correctly. TLO4.7 Classify and explain various types of chemical reactions with examples.			
Unit-5 **Physical and Chemical Properties of Metals and Corrosion Prevention**	**TLO5.1** Define corrosion and explain its significance in industrial and everyday contexts. **TLO5.2** Identify and describe the general types of corrosion, including dry, wet and galvanic, corrosion. **TLO5.3** Explain the mechanism and features of pitting corrosion with real-world examples. **TLO5.4** Describe waterline corrosion, its cause in partially immersed metals, and prevention techniques. **TLO5.5** Explain crevice corrosion, including conditions under which it occurs and its effects on metals. **TLO5.6** Analyze various factors affecting the rate of corrosion, such as pH, temperature, moisture, oxygen availability, film nature, and metal purity. **TLO5.7** Classify and explain protective methods such as metallic coatings, anodic/cathodic protection, alloying, and painting. **TLO5.8** Describe the role of material selection and structural design in preventing corrosion in engineering applications.	**5.1** Definition and importance of corrosion in industries and daily life **5.2** Overview of dry, wet, and galvanic corrosion with basic examples. **5.3** Mechanism and characteristics of pitting corrosion with examples. **5.4** Cause and prevention of waterline corrosion in metals exposed to air-water interfaces. **5.5** Explanation of crevice corrosion, its occurrence in confined spaces, and its effects. **5.6** Influence of environmental and material factors on the corrosion rate. **5.7** Methods to prevent corrosion using coatings, electrochemical protection, and alloying. **5.8** Use of corrosion-resistant materials and proper design to minimize corrosion in engineering applications.	**12**	**8**

Unit-6 **Water Treatment**	**TLO6.1:** Differentiate between hard water and soft water and explain their significance in domestic and industrial applications. **TLO6.2:** Describe the types of hardness (temporary and permanent), the salts responsible for hardness, and methods to express hardness (ppm, mg/L, degree Clark, etc.). **TLO6.3:** Solve numerical problems to calculate the hardness of water using given concentrations of calcium and magnesium salts. **TLO6.4:** Explain the effects of hard water in boiler operations, including scale and sludge formation, and describe preventive measures. **TLO6.5:** Describe the Permutit (Zeolite) process for water softening, including the mechanism, regeneration steps. **TLO6.6:** Explain the principle of ion exchange process and differentiate between cation exchange and anion exchange resins used in water softening and demineralization. **TLO6.7:** Define priming and foaming in boilers, identify their causes, and explain methods for their prevention. **TLO6.8:** Describe the various stages of drinking water treatment including screening, sedimentation, coagulation, filtration, and chlorination.	**6.1** Hard and soft water – definitions, characteristics, and significance **6.2** Types of hardness (temporary, permanent), responsible salts, and methods of expression (ppm, mg/L, °Clark) **6.3** Numerical problems on hardness using Ca^{2+} and Mg^{2+} concentrations **6.4** Effects of hard water on boilers: scale and sludge formation, preventive measures. **6.5** Principle and working of zeolite process with regeneration using brine solution. **6.6** Concept of ion exchange and difference between cation and anion exchangers in water softening/demineralization. **6.7** Boiler troubles: priming and foaming – causes and prevention **6.8** Drinking water treatment stages: screening, sedimentation, coagulation, filtration, chlorination	**10**	**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** Determination of Density of a Liquid using Specific Gravity Bottle	To determine the density of a given liquid using a specific gravity bottle.	CO1
3	**LLO 3.1** Perform accurate titration to determine the concentration of a strong acid or strong base and calculate molarity using appropriate indicators.	Volumetric Analysis: Strong Acid–Strong Base Titration	CO2
4	**LLO 4.1** Analyze titration results involving a strong acid and weak base, and select suitable indicators based on pH range.	Volumetric Analysis: Strong Acid–Weak Base Titration	CO2
5	**LLO 5.1** Model Representation of Different Types of Chemical Bonds	To study and demonstrate the formation of ionic, covalent, and coordinate covalent bonds using electron dot structure (Lewis's structure) and molecular models.	CO4
6	**LLO 6.1** Investigate the effect of pH on corrosion rate of metals and conclude the most corrosive conditions.	Study of Corrosion of Metals in Media with Different pH Values	CO5
7	**LLO 7.1** Analyze and compare the corrosion behaviour of metals in different environmental conditions (e.g., air, water, acid, base).	Study of Corrosion of Metals in Different Environmental Mediums	CO5
8	**LLO 8.1**Study of the catalytic action of Manganese dioxide (MnO_2) on the decomposition of Potassium chlorate ($KClO_3$)	To demonstrate the effect of a catalyst (MnO_2) on the decomposition of $KClO_3$ to form oxygen gas.	CO5
9	**LLO 9.1** Purification of turbid water using coagulation, sedimentation, and filtration	To perform basic water treatment steps and observe clarity improvement.	CO6
10	**LLO 10.1** Determination of Water Hardness	To determine the hardness of a given water sample using the complexometric titration method with EDTA.	CO6

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	Desiccator
4	Electrochemical cell trainer kit
5	Crucible
6	Atomic model kits, whiteboard/charts for Lewis's dot diagrams, marker pens
7	Metal samples, air chamber, saltwater bath
8	Turbid water sample, alum, sand and charcoal filter unit, filter paper

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://chem.libretexts.org
2	https://byjus.com/chemistry/ph-of-acids-and-bases/
3	https://www.khanacademy.org/science/chemistry/atomic-structure-and-properties
4	https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Chemical_Bonding
5	https://www.sciencedirect.com/topics/materials-science/corrosion
6	https://www.iwtacademy.com/
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	Fundamentals of Chemistry and Solution Preparation	CO1	7	2	2	2	6
2	Chemical Properties of Acids and Bases and the Concept of pH	CO1	8	2	4	4	10
3	Atomic structure and classification of elements	CO2	7	2	5	3	10
4	Chemical Bonding, Catalysis, and Types of Chemical Reactions	CO3	7	3	5	4	12
5	Physical and Chemical Properties of Metals and Corrosion Prevention	CO4	8	2	5	5	12
6	Water Treatment	CO5	8	1	5	4	10
		Grand Total	45	12	26	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	3	2	3	2	2	2			
CO2	3	3	2	2	1	1	2			
CO3	3	3	2	2	1	1	2			
CO4	3	3	2	2	3	1	2			
CO5	3	3	2	2	3	1	2			
Legends: - *3- High* *2-Moderate/Medium* *1-Slight/Low* *0-None*										