PROGRAMME NAME : COMMON TO ALL ENGINEERING BRANCH
SEMESTER : FIRST
COURSE TITLE : ENGINEERING CHEMISTRY-I
COURSE CODE :

I. RATIONALE:

The role of chemistry and chemical products is expanding greatly in every branch of engineering. Chemistry is considered as one of the core subjects for Diploma Engineering students. The subject Engineering Chemistry creates foundation for understanding basic concepts and principles to solves broad based engineering problems. The comprehension of concepts and principles like Nonmaterial's, water treatment, various aspects with regard to electrochemistry and environment. This course will develop basic understanding and skill in diploma of engineering students.

II. INDUSTRY/ EMPLOYER EXPECTED OUTCOME:

The aim of this course is to attain following industry/ employer expected outcomes through various teaching learning experiences. Apply the principles of chemistry to solves broad- based engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS):

Students will be able to achieve and demonstrate the following COs (course outcomes) on completion of course based learning.
CO1 - Solving various engineering problems applying the basic knowledge of atomic structure and explain the properties of given material based on chemical bonding. Explain the crystal structure of given solids.
CO2 - Learning about solution and able to understand the concept of nano-particles for engineering purpose.
CO3 - Use relevant water treatment method to solve domestic and industrial problems.
CO4 - Solving the engineering problems using concept of Electrochemistry.
CO5 - Able to understand the problem related to pollution and concept of solid waste management.

IV. Theory Learning Outcome and Aligned Course Content:

Sr. No.	Theory Learning Outcomes (TLOs) aligned to COs	Learning content mapped with Theory Learning Outcomes (TLOs) and COs	Suggested Learning Pedagogies	No Of Lecture	CO
1	**TLO1.1:** Explain the chemistry of atom and Indian Philosophy of Atom **TLO1.2:** Explain the properties of given material based on the bond formation. **TLO1.3:** Describe the molecular structure of given solid, liquid and gases.	**UNIT 1: Atomic Structure and Chemical Bonding** Indian Chemistry: Philosophy of atom by Acharya Kanad. Rutherford model of atom, Bohr's theory (expression of energy and radius to be omitted), and hydrogen spectrum explanation based on Bohr's model of atom, Heisenberg uncertainty principle, Quantum	Chalk-board demonstration, Case study and Video demonstration	10	CO1

	TLO1.4: Describe the crystal structure of given solids. **TLO1.5:** Explain property of metallic solid.	numbers - orbital concept. Shapes of s, p and d- orbital. Concept of chemical bonding-Electronic theory of chemical bonding, types of bonds: Ionic bonding (NaCl example), Covalent bond (H_2, F_2, HF hybridization in $BeCl_2$, BF_3, CH_4, NH_3, H_2O), Coordination bond in NH_4^+, and Anomalous properties of NH_3, H_2O due to hydrogen bonding, and metallic bonding. Molecular arrangement in solid, liquid and gases. Structure of solids: Crystalline and amorphous solids, Properties of metallic solids, unit cell: simple cubic, body center cubic (BCC), face center cubic (FCC), hexagonal close pack crystal.			
2	**TLO2.1:** Describe the method to express the concentration. **TLO2.2:** Solve the numerical problem based on molarity, molality, normality. **TLO2.3:** Explain the mechanism of buffer solution. **TLO2.4:** Describe the importance of nano-particles in engineering.	**UNIT 2: Solutions** **Solution –** Idea of solute, solvent and solution, methods to express the concentration of solution-molarity *(M),* Molality (m), Normality (N), ppm, mass percentage, volume percentage and mole fraction with numerical problem related to these terms. Buffer solution and its Mechanism, Indicator and its theory. **Nano-Particles** Definition, Importance of Nano-particles - Area of application in engineering - Mechanical, Electrical, Electronics etc.	Chalk-board demonstration, Case study and Video demonstration	10	CO2
3	**TLO3.1:** Explain types of hardness of water. **TLO3.2:** List salts causing temporary and permanent hardness of water. **TLO3.3:** Describe boiler corrosion and caustic embrittlement. **TLO3.3:** Explain the given type of water softening process. **TLO3.4:** Describe the waste	**UNIT 3: Water Technology** Graphical presentation of water distribution on Earth (pie or bar diagram). Classification of soft and hard water based on soap test, salts causing water hardness, unit of hardness and simple numerical on water hardness. Cause of poor lathering of soap in hard water, problems caused by the use of hard water in boiler	Chalk-board demonstration, Case study and Video demonstration	12	CO3

	water treatment and portable water treatment.	(scale and sludge, foaming and priming, corrosion etc.), and quantitative measurement of water hardness by ETDA method, total dissolved solids (TDS) alkalinity estimation. ***i) Water softening techniques –*** Soda lime process, Zeolite process and ion exchange process. ***ii) Municipal water treatment (in brief only) –*** sedimentation, coagulation, filtration, sterilization. Water for human consumption for drinking and cooking purposes from any water sources and enlist Indian standard specification of drinking water (collect data and understand standards).			
4	**TLO4.1:** Describe mechanism of electrolysis of $CuSO_4$ solution by using cu and pt electrode. **TLO4.2:** Solve numerical based on Faraday's laws of electrolysis. **TLO4.3:** Explain the industrial application of electrolysis. **TLO4.4:** Distinguish between primary and secondary cell.	**UNIT 4: Electro Chemistry** Definition of pH and pOH, pH scale, numerical and its importance. Electronic concept of oxidation, reduction and redox reactions. Definition of terms: Electrolytes, non-electrolytes, ionization dissociation, cathode, anode with suitable examples, Electrochemical series for cation and anion, Mechanism of electrolysis of $CuSO_4$ solution. Faraday's laws of electrolysis: Faraday's first and second law, relation between electrochemical equivalent and chemical equivalent, and simple numerical problems based on Faraday's Law. Industrial application of Electrolysis – • Electrometallurgy • Electroplating • Electrolytic refining. Application of redox reactions in electrochemical cells – • Primary cells – dry cell,	Chalk-board demonstration, Case study and Video demonstration	8	CO4

		• Secondary cell - commercially used lead storage battery, fuel and Solar cells.			
5	**TLO5.1:** Describe the air pollution and its harmful effect. **TLO5.2:** Identify the different factor responsible for air pollution. **TLO5.3:** Describe the water pollution and its effect. **TLO5.4:** Identify the harmful effects of heavy metal ion. **TLO5.5:** Explain the solid waste management. **TLO5.6:** Describe the concept of green chemistry.	**UNIT 5: Environmental Chemistry** General concept of pollution and pollutants: **Air pollution-** Definition, Air pollutants, sources and harmful effects, Formation of acid rain and its effects, Greenhouse effect causes, global warming harmful effects, Importance of ozone layers, causes for depletion of Ozone layer, harmful effects of ozone layer depletion, Smog, Control of Air pollution. **Water pollution-** causes of water pollution, sewage, effluents, harmful effects of sewerage, definition, sewage disposal, Industrial effluents, harmful effects of effluents, harmful effects of heavy metal ions-lead, cadmium, zinc and copper. Treatment of effluents, Eutrophication, definition and harmful effects. **Solid waste management-** Solid waste Definition, Problem Type of solid waste, methods of disposal, Land fill and incineration. **Green Chemistry-** Definition, Goal of green chemistry (Basic ideas), Recycling, Advantage of recycling (Basic ideas)	Chalk-board demonstration, Case study and Video demonstration	8	CO5

V. Laboratory Learning Outcome and Aligned Practical/ Tutorial Experience:

Sr. No.	Practical / Tutorials/ Laboratory Learning Outcome (LLO)	Laboratory Experience/ Practical Titles/ Tutorials Title	Number of hrs.	Relevant COs
1	**LLO1.1** Identify cation in given mixture by performing selective test	Identification of cation in given inorganic mixture	2	All
2	**LLO2.1** Identify anion in given mixture by performing selective test	Identification of anion in given inorganic mixture	2	All
3	**LLO3.1** Identify states of matter of material by	Identification of states of	2	All

	using simulation Applying heating and cooling Techniques **LLO3.2** Relate temperature –pressure diagram.	matter.		
4	**LLO4.1** Determine the electrode potential of copper metal by setting Electrochemical cell. **LLO4.2** Measure electrode potential of Cu using Voltmeter. **LLO4.3** Measure the cell potential for various conditions.	Determine the electrode potential of copper	2	CO4
5	**LLO5.1** Determine the electrode potential of Iron metal by setting Electrochemical cell. **LLO5.2** Measure electrode potential of Iron metal using Voltmeter. **LLO5.3** Measure the cell potential for various conditions.	Determine the electrode potential of Iron metal.	2	CO4
6	**LLO6.1** Determine the voltage generated from chemical reaction using Daniel Cell. **LLO6.2** Set up Daniel cell. Prepare electrolyte solution **LLO6.3** Measure voltage accurately.	Determination of the voltage generated from chemical reaction using Daniel Cell.	2	CO4
7	**LLO7.1** Prepare Electrolyte solution of $CuSO_4$ of known concentration. **LLO7.2** Set up electrolysis apparatus. **LLO7.3** Control various parameters of electrolytes. **LLO7.4** Determine electrochemical equivalent of Cu metal using Faraday's First Law.	Determination of electrochemical equivalent of Cu metal using Faraday's First Law.	2	CO4
8	**LLO8.1** Prepare Electrolyte solution of the given metal of known concentration. **LLO8.2** Set up electrolyte solution. **LLO8.3** Control various parameters of electrolytes. **LLO8.4** Analyze the data obtained from the experiment. **LLO8.5** Verify Faraday's second law of electrolysis.	Determine the equivalent weight of metal using Faraday's second law.	3	CO4
9	**LLO9.1** Prepare acid solution of known concentration. **LLO9.2** Determine alkalinity of water sample.	*Determination of the alkalinity of a given water sample.	2	CO3
10	**LLO10.1** Prepare EDTA solution of Known concentration. **LLO10.2** Determine the total hardness of water by titration. **LLO10.3** Prepare standard solution of standard hard water sample.	*Calculation of total hardness, temporary hardness and permanent hardness of water samples by EDTA method.	3	CO3
11	**LLO11.1** Determine turbidity by using a Nephelometer or simulation.	Determination of turbidity of a given water sample by Nephelometric method by using Nephelometer or simulation.	2	CO5

12	**LLO12.1** Set up titration Apparatus. **LLO12.2** Record the observations. **LLO12.3** Calculate dissolved oxygen.	Determination of dissolved oxygen in the given water sample.	2	CO2
13	**LLO13.1** Prepare AgNO3 solution of known concentration. **LLO13.2** Calculate chloride content in water sample.	Determination of chloride content in the given water sample by Mohr's Method.	2	CO5
14	**LLO14.1** Use universal indicator for pH values. **LLO14.2** Calculate pH value by using pH meter.	*Determination of pH value of given solution using pH meter and universal indicator.	2	CO2
15	**LLO15.1** Set up conductometric titration assembly. **LLO15.2** Record conductance. **LLO15.3** Determine equivalence point.	Determination of equivalence point of acetic acid and ammonium hydroxide using conductivity meter.	2	CO4
Note: Out of above suggestive LLOs '*' Marked Practicals (LLOs) are mandatory. Minimum 80% of the above listed lab experiments are to be performed. Judicious mix of LLOs is to be performed to achieve desired outcomes.				

VI. Suggest Micro project /Assignment / Activities for Specific Learning/ Skills Developments (Self Learning):

MICRO PROJECT:

- Type of bonds: Prepare chart and models displaying different types of bonds with examples.
- Prepare a chart for showing different types of bonds or molecules.
- Crystal structure: Prepare Models of SC, FCC, HCP, BCC.
- Ionization: Prepare chart displaying ionization phenomenon.
- Collect water samples from different water sources and measure of hardness of water.

ASSIGNMENT:

- Explain covalent bond, ionic bond, coordinate bond, hydrogen bond.
- Draw Crystal structures of SC, BCC, FCC, HCP
- Simple problems on hardness calculation.
- Solve numerical based on Faraday's First and second law of electrolysis.
- Prepare chart showing mechanism of electrolysis of $CuSO_4$ solution using Cu and Pt electrode.

VII. Laboratory Equipment / Instruments / Tool / Software Required:

Sr. No.	Equipment Name with Broad Specification	Relevance LLO Number
1.	Electric oven inner size 18 *18*18; temperature range 100 to 250^{0}C with capacity of 40 Lt	LLO3.1 LLO3.2
2	Electronic balance, with scale range of 0.001gm to 500.0gm, pan size 100mm; response time 3-5 sec; power requirement 90-250 V, 10watt	LLO7.1 LLO8.1 LLO9.1

		LLO12.2
3	Voltmeter, Voltmeter range 0-20V or 0-100 V, accuracy +/- 0.1% full scale	LLO4.2 LLO5.2, LLO13.1
4	Digital Thermometer range 50^0C to 300^0C	LLO3.1, LLO4.2

VIII. Suggest weightage to Learning efforts and Assessment purpose (specification Table):

Sr. No.	Unit	Unit Title	Aligned COs	Learning Hours (L+T)	Weightage%
1	I	Atomic structure, Chemical bonding	CO1	10	20
2	II	Solution	CO2	10	14
3	III	Water Treatment	CO3	12	30
4	IV	Electrochemistry	CO4	8	20
5	V	Environmental Chemistry	CO5	8	16
Grand Total				**48**	**100**

IX. Assessment Methodologies/ Tools:

Formative assessment (Assessment for learning)
Two-unit tests of 30 marks and average of two-unit tests and mid-term examination of 50 marks.
For laboratory learning 50 marks
Summative Assessment (Assessment for learning)
End semester assessment of 50 marks for theory
End semester of 50 marks for laboratory learning.

X. SUGGESTED COs- POS MATRIX FORM:

Course Outcomes Cos	Programme Outcomes (POs)						
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of solution	PO-4 Engineering Tools	PO-5 Engineering Practices For society, Sustainability and environment	PO-6 Project Management	PO-7 Life long Learning
CO1	3	1	1	1	1	-	1
CO2	3	1	1	1	1	-	1
CO3	3	2	2	2	2	2	1
CO4	3	2	1	2	2	2	1
CO5	3	2	2	1	2	2	1

XI. Suggested-learning Materials / Books:

Sr. No.	Author	Title	Publisher with ISBN Number
1		Text Book of Chemistry for Class XI & XII (Part-I, Part-II);	N.C.E.R.T., Delhi, 2017-18 ISBN 81-7450-494-X ISBN 81-7450-535-O
2	Shikha Agarwal	Engineering Chemistry	Cambridge University Press; New Delhi, 2015 ISBN978-1-107-47641-7
3	C.N. R. Rao	Understanding Chemistry	Universities Press (India) Pvt. Ltd., 2011.

			ISBN8173712506
4	Dara, S. S. & Dr. S. S. Umare	Engineering Chemistry	S. Chand. Publication, New Delhi, New Delhi, 2015 ISBN 8174505660
5	Dr. Vairam S.	Engineering Chemistry	Wiley India Pvt. Ltd., New Delhi, 2013. ISBN 978-8126543342
6	Dr. G. H. Hugar & Prof A. N. Pathak	Applied Chemistry Laboratory Practices, Vol. I and Vol. II	NITTTR, Chandigarh, Publications, 2013-14
7	Agnihotri, Rajesh	Chemistry for Engineers	Wiley India Pvt. Ltd., 2014 ISBN9788126550784
8	Anuj Rawlly, Devdatta V. Saraf	Applied Chemistry with Lab Manual	Khana Book Publication Co. (P) Ltd. New Delhi, 2021, ISBN 978-93-91505-44-8
9	S.C. Sharma & M.P. Poonia,	Environmental Studies	Khanna Publishing House, New Delhi
10	Rao, M. N. Rao, H.V.N,	Air Pollution	Tata Mc-Graw Hill Publication, New Delhi, 1988, ISBN: 0-07- 451871-8.
11	A I Vogel	Text book of Quantitative Inorganic Analysis	Longman Group Ltd Longman House, Burnt Mill, Harlow Esses CM202JE, England ISBN 0582407303
12	Metcalf & Eddy,	Waste Water Engineering,	Mc-Graw Hill, New York, 2013, ISBN: 077441206
13	Nazaroff, William, Cohen, Lisa	Environmental Engineering Science	Willy, New York, 2000, ISBN 10: 0471144940
14	Bagotsky V.S.	Fundamental of Electrochemistry	John Wiley & Sons, Inc., Hoboken, New Jersey – ISBN 13978-0-471-70058-6
15	G.F. Liptrot	Morden Inorganic Chemistry	Unwin Hyman, London ISBN 9780713521832
16	Peter Atkin	Physical Chemistry	Oxford University Press ISBN 9780198814740
17	J D Lee	Concise Inorganic Chemistry	Wiley India Edition ISBN8126515546

XII. Learning Websites and Portals:

Sr. No.	Link/Portal	Description
1	www.visionlearning.com	Atomic structure and chemical bonding
2	www.chem1.com	Atomic structure and chemical bonding
3	https://www.wastewaterelearning.com/elearning/	Water Treatment
4	www.wqa.org	Water Treatment
5	www.chemcollective.org	Virtual Labs, simulation
6	https://www.ancient-origins.net/history-famous-pepole/india	IKS Philosophy of atom by Acharya Kanad