

SC-104: ENGINEERING CHEMISTRY

Course Title	Engineering Chemistry	Course Code	SC-104
Year	I Year	Course Group	Basic Science
Teaching Scheme in Periods(L:T:P)	120:30:0	Credits	3.0
Methodology	Lecture + Tutorial	Total Contact Periods	150
CIE	60 Marks	Year End Exam (YEE)	40 Marks

Pre requisite:

Basic knowledge of chemistry in secondary education.

Course objective: After studying this course the student will be able to understand and appreciate the role of chemistry and environmental studies in different spheres of industries.

Course Outcome: On successful completion of the course, the students will have ability to attain following Course Outcomes (CO):

CO1	Understand the fundamental chemical concepts and apply the problem-solving abilities for various engineering and industrial applications.
CO2	Identify the hardness and degree of hardness of water and apply the relevant water treatment methods to solve domestic and industrial problems.
CO3	Use the knowledge of metallurgical processes in the extraction of metals and in making alloys and apply the knowledge of corrosion to protect the metal.
CO4	Understand the applications and environmental impacts of engineering materials, and fuels to explore sustainable options.
CO5	Understand the basic concepts of electrochemistry and apply for preparation of chemicals, electroplating, electrolytic refining and for construction of various batteries
CO6	Understand the concept of ecosystem, pollution impacts, conservation of bio diversity, principles of green chemistry and apply for sustainable practices in engineering/technical fields

CO-PO-Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	-	-	1	-	2
CO2	3	1	-	-	2	-	2
CO3	3	-	-	-	1	-	2
CO4	3	1	-	-	1	-	2
CO5	3	1	-	-	1	-	2
CO6	3	-	-	-	3	-	3

COURSE CONTENTS:**UNIT-I: FUNDAMENTALS OF CHEMISTRY****DURATION:L20 + T5 Periods**

Atomic structure - Atomic number – Mass number- Bohr's Atomic Theory- Orbitals - Shapes of s, p and d orbitals – Aufbau principle - Hund's rule, Pauli's exclusion principle-Electronic configuration of elements

Chemical bonding– Electronic theory of valency - Types of chemical bonds - Ionic, Covalent, Co-ordinate covalent and Metallic bond- Properties of ionic and covalent compounds.

Oxidation-Reduction: Electronic concept of Oxidation, Reduction and Redox reaction. Oxidation number - Calculations.

Solutions –Atomic weight - Molecular weight, Equivalent weight - Mole concept – Molarity – Normality - Numerical problems on mole, molarity and normality – Colloids - Types of colloids - Properties of Colloids -Industrial applications of colloids - Arrhenius theory of acids and bases- Ionic product of water - pH and related numerical problems- Buffer solutions - buffer action - Applications of buffer solutions - Ostwald's theory of indicators.

UNIT-II: WATER TECHNOLOGY**DURATION:L20+ T5 periods**

Introduction - Soft and hard water - Causes of hardness –Types of hardness-Disadvantages of hard water using in industries-Degree of hardness-Softening methods-Soda - Lime Process, Permutit process, Ion exchange process– Osmosis - Reverse Osmosis - Advantages of Reverse osmosis – Desalination by Electro dialysis- Drinking water - Municipal treatment of water for drinking purpose.

UNIT -III: METALLURGY AND CORROSION**DURATION:L20 + T5 Periods**

Characteristics of metals - Distinguish between metals and non-metals - Mineral, Ore, Gangue, Flux, Slag -Concentration of ore - Methods of extraction of crude metal - Roasting, Calcination, Smelting - Extraction of Al, and Fe – Alloys-Purpose of making alloys – Composition and uses of Brass, Nichrome and Duralumin.

Corrosion - Factors influencing the rate of corrosion – Electrochemical theory of corrosion – Composition cell, Stress cell and Concentration cell - Rusting of iron and its mechanism - Prevention of corrosion – Protective coatings - Cathodic protection - Paints– Constituents of paint – Functions of constituents of paint.

UNIT-IV: ENGINEERING MATERIALS AND ENERGY RESOURCES:

DURATION:L20+ T5 Periods

Polymers - Polymerization - Types of polymerization – Addition polymerization, Condensation polymerization, Co-polymerization - Plastics - Types of plastics - Advantages of plastics over traditional materials - Disadvantages of using plastics- Preparation and uses of the following plastics: 1. Polythene 2.PVC 3. Urea formaldehyde resin 4. Bakelite - Natural rubber –Vulcanization of natural rubber - Elastomers – Preparation and uses of Buna-s, Neoprene rubber - Biodegradable polymers - preparation and uses.

Glass – Properties - Manufacturing of glass - Melting, forming and shaping - Annealing – Finishing.

Nano materials: Introduction – preparation of nanotubes by Arc Discharge method - Properties and applications of nanotubes.

Liquid crystals: Introduction –Applications

Lubricants– Classification and functions of lubricants.

Definition and classification of fuels - Calorific value - Advantages of Gaseous fuel – Composition, calorific value, and uses of gaseous fuels - a) CNG b) LPG c) Producer gas.

UNIT-V: ELECTROCHEMISTRY

DURATION:L20+ T5 Periods

Conductors, insulators, electrolytes –Types of electrolytes - Arrhenius theory of electrolytic dissociation – Electrolysis – Electrolysis of fused NaCl and aqueous NaCl - Applications of electrolysis - Faraday's laws of electrolysis - Numerical problems.

Galvanic cell – Standard electrode potential – Reference electrodes – Electro chemical series –

EMF of cell – Batteries -Types of batteries – Leclanche' cell, Lead storage battery, Lithium - ion

Battery – H₂-O₂ Fuel cell.

UNIT-VI: ENVIRONMENTAL STUDIES

DURATION:L20+ T5 periods

Introduction - Environment – Segments of environment - Important terms - Concept of ecosystem - Producers, consumers and decomposers –Biodiversity, definition, threats to Biodiversity - Green chemistry – e-waste –Management of e-waste.

Air pollution - Classification of air pollutants based on origin and states of matter, Causes, effects, and controlling methods - Water pollution – Causes, effects, controlling methods – Soil pollution – Causes, General effects,- Controlling methods – Carbon credit and carbon trading - Sustainable development

Reference Books:

Engineering chemistry–Jain &Jain –Dhanpat Rai Publishing Company.

A Text book of Engineering Chemistry–S.S. Dara – S. Chand Publications.

Environmental Studies –A.K. De.

Environmental Studies, R. Rajagopalan,2nd Edition,2011, Oxford University Press

Intermediate Chemistry I and II–Telugu Academy TS

Engineering chemistry– Prasanta Rath, B.Ramadevi, Ch. Venkataramana Reddy & Subhendu Chakroborty–CENGAGE

E- Learning links:

<https://iupac.org>, <https://www.khanacademy.org>, www.nptel.ac.in.

Learning outcome: Upon completion of this course the student will be able to

CO1: FUNDAMENTALS OF CHEMISTRY

- 1.1 Define and explain atomic number and mass number.
- 1.2 State the postulates of Bohr's atomic theory and its limitations.
- 1.3 Define an orbital and explain the shapes of s, p and d orbitals.
- 1.4 Define electronic configuration and apply Aufbau principle, Hund's rule, and Pauli's exclusion principle in writing electronic configuration of elements up to atomic number 30.
- 1.5 Explain the postulates of electronic theory of valency.
- 1.6 Define chemical bond and list the types of chemical bonds.
- 1.7 Define ionic bond and explain the ionic bond formation in NaCl and MgO molecules.
- 1.8 Define and explain the covalent bond formation in homo atomic molecules: H₂, O₂, N₂
- 1.9 Define co-ordinate covalent bond and explain the bond formation in ammonia boron trifluoride.
- 1.10 Define metallic bond and explain with free electron theory/ electron sea model.
- 1.11 Compare the properties of ionic compounds and covalent compounds
- 1.12 Define and explain the electronic concept of oxidation, reduction and redox reaction.
- 1.13 Define oxidation number and list the rules for calculation of oxidation number.
- 1.14 Find the oxidation number of C, N, S, P, Cr and Mn in their compounds.
- 1.15 Define the terms: solution, solute and solvent with examples.
- 1.16 Define atomic weight, molecular weight and equivalent weight
- 1.17 Find the molecular weight and the equivalent weight of acids, bases and salts.
- 1.18 Explain mole concept and solve the numerical problems on mole concept.
- 1.19 Define and explain molarity and normality.
- 1.20 Solve numerical problems on molarity and normality.
- 1.21 Define colloids and types of colloids (lyophilic colloid and lyophobic colloid).
- 1.22 Compare the properties of lyophilic colloid and lyophobic colloid
- 1.23 Explain the general properties of colloids such as a) Tyndall effect b) Brownian movement and c) Coagulation
- 1.24 Explain industrial applications of colloids (any five in brief).
- 1.25 Explain the postulates and limitations of Arrhenius theory of acids and bases.
- 1.26 Define and explain the ionic product of water and solve numerical problems.
- 1.27 Define pH and solve numerical problems on pH.
- 1.28 Define buffer solution and explain the buffer action of acidic (acetate buffer) and basic (ammonium buffer) buffers.
- 1.29 Explain the general applications of buffer solutions.
- 1.30 Explain Ostwald's theory of indicators with phenolphthalein and methyl orange indicators as examples.

CO2: WATER TECHNOLOGY

- 2.1 List the various sources of water.

- 2.2 Types of impurities present in water i) suspended impurities ii) dissolved impurities iii) microorganisms.
- 2.3 Define the terms soft water and hard water.
- 2.4 Define hardness of water and name the salts responsible for hardness.
- 2.5 Define and explain the types of hardness of water – temporary and permanent hardness
- 2.6 Identify the disadvantages of using hard water in industries: i) Laundry, ii) Textile industry, iii) Paper industry, iv) Sugar industry v) Pharmaceutical industry and vi) Boilers
- 2.7 Sludge and scale formation in boilers i) reasons ii) disadvantages and iii) prevention
- 2.8 Define degree of hardness and explain different units of hardness– ppm, mg/L, $^{\circ}\text{Cl}$ and $^{\circ}\text{Fr}$
- 2.9 Relationship between different units of hardness of water.
- 2.10 Solve the numerical problems on degree of hardness of water.
- 2.11 Removal of temporary hardness by i) Boiling ii) Clark's method.
- 2.12 Removal of total hardness by i) Soda-lime method ii) Permutit process iii) Ion exchange process.
- 2.13 Define osmosis and reverse osmosis (RO).
- 2.14 Explain the process of conversion of sea water into drinking water by reverse osmosis.
- 2.15 List the applications and advantages of reverse osmosis.
- 2.16 Define and explain the desalination of sea water by electro dialysis process
- 2.17 List the essential qualities of drinking water.
- 2.18 Explain the method of municipal treatment of water for drinking purpose with diagram.
a) Screening b) sedimentation c) coagulation d) filtration, e) sterilization by chlorination, bleaching powder and ozonisation,

CO3: METALLURGY AND CORROSION

- 3.1 List the characteristics of metals.
- 3.2 Explain the differences between metals and non-metals.
- 3.3 Define and explain the terms 1.Mineral 2.Ore 3.Gangue, 4.Flux and 5.Slag -with examples
- 3.4 List the minerals and ores of iron, and aluminium.
- 3.5 Methods for the concentration of ore i) Hand picking, ii) Levigation, iii) Froth floatation and iv) Electromagnetic separation
- 3.6 Explain the metallurgical processes -roasting, calcination and smelting.
- 3.7 Extraction of aluminium from bauxite (Flow chart only).
- 3.8 Extraction of iron from hematite (flow chart only)
- 3.9 Define an alloy and explain the purpose of making alloys.
- 3.10 Explain the composition and uses of the following alloys i) Brass ii) Nichrome iii) Duralumin

- 3.11 Define corrosion
- 3.12 Explain the factors influencing the rate of corrosion based on i) Nature of metal and ii) Environment of metal.
- 3.13 Explain the electrochemical theory of corrosion.
- 3.14 Explain the formation of a) Composition cell b) Stress cell and c) Concentration cell.
- 3.15 Define rust and explain the mechanism of rusting of iron with chemical equations.
- 3.16 Explain the following methods of prevention of corrosion:
 - a) Protective coatings i) Metallic coatings (anodic and cathodic coatings) ii) Inorganic coatings and iii) Organic coatings
 - b) Cathodic protection i) Sacrificial anode method and ii) Impressed voltage method
- 3.17 Define the term paint.
- 3.18 Explain the characteristics of a good paint.
- 3.19 List the constituents of paint (pigment, vehicle or drying oil, thinner, drier, filler and plasticizer) and explain the functions of constituents of paint.

CO4: ENGINEERING MATERIALS AND ENERGY RESOURCES

- 4.1 Define polymer and polymerization
- 4.2 Explain the types of polymerization (addition polymerization, condensation polymerization and co-polymerization) with examples.
- 4.3 Define the term plastic
- 4.4 Summarize the advantages of plastics over traditional materials
- 4.5 Explain the disadvantages of using plastics on environment.
- 4.6 Explain the types of plastics (thermo and thermosetting plastics) with examples.
- 4.7 Identify the differences between thermo plastics and thermosetting plastics
- 4.8 Explain a preparation method and uses of the following plastics: a) Polythene, b) Poly vinyl chloride, c) Urea formaldehyde resin and d) Bakelite (flow chart for Bakelite i.e. without chemical equations).
- 4.9 Define the term natural rubber
- 4.10 Explain the chemical structural formula of natural rubber
- 4.11 Explain the process of vulcanization of natural rubber with chemical equations.
- 4.12 Compare the characteristics of natural rubber and vulcanized rubber
- 4.13 Define the term elastomer.
- 4.14 Explain the preparation and uses of the following elastomers - a) Buna-S b) Neoprene rubber.
- 4.15 Define a biodegradable polymer and explain a method of preparation and uses of following biodegradable polymers – a) polylactic acid and b) polycaprolactone.
- 4.16 Explain the general characteristics of glass.
- 4.17 Explain the method of manufacture of glass -melting, forming and shaping-annealing - finishing,
- 4.18 Introduction to nano materials
- 4.19 Preparation of carbon nanotubes by arc discharge method
- 4.20 List the properties and applications of carbon nanotubes.

- 4.21 Define liquid crystals and explain the applications of liquid crystals.
- 4.22 Define and classify the lubricants based on physical state.
- 4.23 Explain the functions of lubricants
- 4.24 Define fuel and classify the fuels based on their occurrence and physical state with examples.
- 4.25 Define calorific value
- 4.26 Explain the advantages of gaseous fuels
- 4.27 Explain the chemical composition, calorific value and uses of a) CNG b) LPG c) producer gas

CO5: ELECTROCHEMISTRY

- 5.1 Define the terms – a) conductor, b) insulator, c) electrolyte and d) non-electrolyte
- 5.2 Classify the electrolytes - strong and weak electrolytes with examples.
- 5.3 Compare the metallic conductors and electrolytic conductors.
- 5.4 Explain the Arrhenius theory of electrolytic dissociation.
- 5.5 Define electrolysis.
- 5.6 Explain the electrolysis of fused NaCl and aqueous NaCl (Nelson Cell).
- 5.7 Explain the process of electrolytic refining of copper and electroplating.
- 5.8 State and explain Faraday's laws of electrolysis
- 5.9 Define chemical equivalent, electrochemical equivalent and find the relationship between them
- 5.10 Numerical problems based on Faraday's first law and second law of electrolysis.
- 5.11 Define galvanic cell.
- 5.12 Explain the construction and working of Daniel cell.
- 5.13 Distinguish between electrolytic cell and galvanic cell.
- 5.14 Explain electrode potential, oxidation potential, reduction potential and standard electrode potential.
- 5.15 Define reference electrode and give examples.
- 5.16 Explain the construction and working of standard hydrogen electrode (SHE).
- 5.17 Explain the construction and working of calomel electrode
- 5.18 Define electrochemical series and explain its significance.
- 5.19 Define and explain the EMF of galvanic cell and solve the numerical problems.
- 5.20 Define battery and explain the types of batteries (primary and secondary battery) with examples.
- 5.21 Explain the construction, working and applications of a) Dry cell (Leclanche' cell), b) Lead storage battery and c) Lithium - ion battery.
- 5.22 Explain the construction, working and advantages of Hydrogen - Oxygen fuel cell

CO6: ENVIRONMENTAL STUDIES

- 6.1 Define and explain different segments of environment: i) Atmosphere, ii) Hydrosphere, iii) Lithosphere and iv) Biosphere

- 6.2 Define the terms: i) Pollutant, ii) Contaminant iii) Pollution, iv) Receptor, v) Sink, vi) Particulates, vii) Threshold limit value (TLV), viii) Dissolved oxygen (DO), ix) BOD and x) COD
- 6.3 Define Ecosystem. Explain the biotic and abiotic components of ecosystem
- 6.4 Define and explain the following biotic components with examples:
 - a) Producers, b) Consumers and c) Decomposers
- 6.5 Define biodiversity and explain the threats to biodiversity
- 6.6 Explain the methods of conservation of biodiversity
- 6.7 Define green chemistry and list the principles of green chemistry
- 6.8 Define e-waste and explain the sources of e-Waste
- 6.9 Explain the effect of e-waste on environment and human beings
- 6.10 Explain the management of e-waste-a) Land filling, b) Incineration and c) Recycling.
- 6.11 Define air pollution
- 6.12 Classify the air pollutants based on origin and states of matter
- 6.13 Explain the causes of air pollution
- 6.14 Explain the effects of air pollution on human beings.
- 6.15 Explain greenhouse effect, its consequences and control methods
- 6.16 Explain acid rain, its consequences and control methods
- 6.17 Explain ozone layer depletion, its consequences and control methods
- 6.18 Explain the controlling methods of air pollution
- 6.19 Define water pollution
- 6.20 Explain the causes of water pollution
- 6.21 Explain the effects of water pollution on living and non-living things
- 6.22 Explain the controlling methods to water pollution.
- 6.23 Define soil pollution.
- 6.24 Explain the causes of soil pollution.
- 6.25 Explain the general effects of soil pollution.
- 6.26 Explain the methods of control of soil pollution.
- 6.27 Understand the concept of carbon credits and carbon trading (elementary level only)
- 6.28 Understand the advantages and disadvantages of carbon trading
- 6.29 Sustainable development a) Environmental sustainability b) Social sustainability c) Economic sustainability

**BOARD DIPLOMA EXAMINATIONS (C-26) FIRST
YEAR EXAMINATION MID – I
SC – 104, ENGINEERING CHEMISTRY**

Time: 1 hour

Max. Marks: 20

PART – A

Instructions: Answer all questions. Each question carries one mark

4 x 1 = 4 marks

1. State Hund's rule.
2. Define mole.
3. Define soft water.
4. What is osmosis.

PART – B

Instructions: Answer the following questions. Each question carries three marks.

2 x 3 = 6 marks

- 5a) Classify the solutions based on their physical state.
(OR)
- 5b) Explain the limitations of Arrhenius theory of acids and bases?
- 6a) Outline any three disadvantages of using hard water in industries?
(OR)
- 6b) Write any six advantages of reverse osmosis?

PART – C

Instructions: Answer the following questions. Each question carries five marks.

2 x 5 = 10 marks

- 7a) Identify and explain the chemical bonding in MgO and O₂ molecules.
(OR)
- 7b) Calculate the molarity of 500 ml of aqueous solution containing 2 grams of NaOH.
- 8a) Explain the process of removal of hardness of water by ion exchange process.
(OR)
- 8b) How to utilize the electro dialysis process for desalination of seawater? Explain with a neat diagram.

BOARD DIPLOMA EXAMINATIONS (C-26)
FIRST YEAR EXAMINATION MID – II
SC – 104, ENGINEERING CHEMISTRY

Time: 1 hour

Max. Marks: 20

PART – A

Instructions: Answer all questions. Each question carries one mark

4 x 1 = 4 marks

1. Define mineral.
2. Define the term paint.
3. Define polymerization.
4. What are elastomers?

PART – B

Instructions: Answer the following questions. Each question carries three marks.

2 x 3 = 6 marks

- 5a) Explain the process of roasting with examples.
(OR)
- 5b) Explain the formation of composition cell formed during corrosion.
- 6a) Out line any three differences between thermoplastics and thermosetting plastics.
(OR)
- 6b) Classify the fuels based on physical state.

PART – C

Instructions: Answer the following questions. Each question carries five marks.

2 x 5 = 10 marks

- 7a) Build a flow chart for extraction of iron from hematite.
(OR)
- 7b) Explain sacrificial anode method of prevention of corrosion.
- 8a) Explain the vulcanization of natural rubber with equations.
(OR)
- 8b) Identify and explain any five functions of lubricants.

BOARD DIPLOMA EXAMINATIONS (C-26)

FIRST YEAR END EXAMINATION

SC – 104, ENGINEERING CHEMISTRY

Time: 2 hours

Max.Marks: 40

PART – A

Instructions: Answer all questions. Each question carries one mark

8 x 1 = 8 marks

1. Define atomic number.
2. Define fuel.
3. Define particulate.
4. List the chemicals that causes temporary hardness
5. What is electrolyte?
6. Define galvanic cell.
7. Define green chemistry.
8. Define soil pollution

PART – B

Instructions: Answer the following questions. Each question carries three marks.

4 x 3 = 12 marks

- 9a) Explain the formation of chemical bonding in NaCl.
(OR)
- 9b) Explain the construction and working of standard hydrogen electrode.
- 10a) Explain the mechanism of rusting of iron with equations.
(OR)
- 10b) Explain the biotic components of ecosystem with examples.
- 11a) What is electrochemical series and explain its significance.
(OR)
- 11b) Compare the galvanic cell and electrolytic cell.
- 12a) Classify air pollutants based on origin.
(OR)
- 12b) Explain the reasons for greenhouse effect, its consequences and controlling methods.

PART – C

Instructions: Answer the following questions. Each question carries five marks.

4 x 5 = 20 marks

- 13a) Find out the pH value of 100 ml of aqueous solution containing 0.0365 grams of HCl.
(OR)
- 13b) Making use of the electrolytic refining process, explain the purification of copper.

14a) What are biodegradable polymers? Explain the method of preparation and uses of polylactic acid.

(OR)

14b) Choose the methods of conservation of biodiversity and explain.

15a) Calculate the weight of copper deposited when 2 amperes of electric current is passed for two hours through CuSO_4 solution. (Atomic weight of Cu is 63.5)

(OR)

15b) Explain the construction and working of lead storage battery with equations.

16a) Identify any five controlling methods of air pollution and explain.

(OR)

16b) Select and explain any three management methods of e-waste.