26UCHECV12	Chemistry for Civil Stream	(42-0-28-50) 3

Total Hours: 120

Course Learning Objectives (CLOs): This course focuses on the following learning perspectives:

- To enable students to acquire knowledge on principles of chemistry for engineering applications.
- To develop an intuitive understanding of chemistry by emphasizing the related branches of engineering.
- To provide students with a solid foundation in analytical reasoning required to solve societal problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-11)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the terms and processes involved in scientific and engineering applications.	1	-	2,3,6,11
CO-2	Explain the phenomena of chemistry to describe the methods of engineering processes.	1	-	2,3,7
CO-3	Solve for the problems in chemistry that are pertinent in engineering	1	6	2,3,7,11
CO-4	Apply the basic concepts of chemistry to explain the chemical properties and processes.	1	7	2,3
CO-5	Analyse properties and processes associatedwith chemical substances in multidisciplinary	1	6	2,3,7,9,11

POs	1	2	3	4	5	6	7	8	9	10	11
Mapping Level	3	1	1	-	-	1.6	1.2	-	1	-	1

Contents:

Unit-I

Electrochemistry: Introduction, electrode potential, overview of Nerns't equation, concentration cell, numerical problems on concentration cells.

Energy systems: Introduction, principal component of batteries, classification of batteries, characteristics of battery-capacity, power density, cell balancing and cycle life. Construction, working, and applications of Lead-acid and Lithium-ion battery. Fuel cell-definition, advantages and limitations. Construction, working and applications of solid-oxide fuel cells.

Green Fuels: Introduction, production of green hydrogen by photocatalytic water splitting by TiO_2 catalyst and construction, working, advantages and disadvantages of silicon solar cell.

Self-learning: Galvanic cells, Derivation of Nernst equation, reference electrodes and solar panels. **08Hrs**

Unit-II

Polymer: Introduction, Number average and weight average molecular weight of polymer-numerical problems. synthesis, properties and engineering applications of chlorinated polyvinyl chloride (CPVC), polymethyl methacrylate (PMMA), ABS polymer and polycarbonate. Preparation, properties and industrial applications of graphene oxide by Hummer's method.

Composite Polymer: Preparation, properties and applications of Kevlar and carbon fiber**. Biopolymers**: Introduction, synthesis, properties and applications of polylactic acid (PLA).

Self-Learning: Classification of polymers, method of polymerization, carbon nanotubes as fillers, and conducting polymers. **8 Hrs**

Unit-III

Metals and Alloys: Introduction, classification of metals: ferrous and non-ferrous. Composition, properties, applications of iron alloys - wrought iron, cast iron, pig iron and steel; aluminium alloys-Duralumin and Magnalumin.

Nanomaterials: Introduction, size dependent properties-surface area, catalytic property and thermal properties. Concrete as composite material, composition of nano- concrete, synthesis of TiO_2 nanoparticles by sol-gel method for sensor applications.

Cement: Introduction, composition, manufacturing process of cement**-**wet process, process of setting and hardening of cement, special cement-composition, properties and applications.

Geopolymer concrete: Introduction, mechanism of geopolymerization and manufacturing process of geopolymer concrete.

Piezoelectric cement composites: Introduction, piezoelectric materials in cement composites and its applications in civil engineering.

Self-Learning: Dry processes, co-precipitation method, spiropyran as photochromic coating, working principle with chemical reactions and applications in constructions.

9 Hrs

Unit-IV

Corrosion: Introduction, electrochemical theory of corrosion of steel in concrete, factors affecting rate of corrosion-Nature of the metal, nature of the corrosion product, anodic and cathodic area, pH, temperature and conductance of the medium, types of corrosion-differential metal corrosion, differential aeration corrosion-waterline and pitting corrosion and stress corrosion in civil structures. Corrosion control by galvanization, anodization and sacrificial anode method. Corrosion penetration rate (CPR)-introduction and numerical problems.

Metal finishing: Introduction, technological importance of metal finishing, electroplating of chromium-decorative and hard chromium. Electroless plating of copper taking PCB as an example Difference between electro electroless plating.

Self-learning: Tinning processes and voltage impressive method. **8 Hrs**

Unit-V

Water Chemistry: Introduction, water quality parameters (pH, turbidity, dissolved oxygen, fluoride, nitrate and alkalinity). Estimation of chloride by argentometric method. Estimation of sulphite by gravimetric method. Hard water: Introduction, types, determination of total hardness by EDTA method and numerical problems. Determination of dissolved oxygen by Winkler's method and determination of chemical oxygen demand (COD) and numerical problems.

Analytical techniques: Potentiometric sensors: Principle, instrumentation and application in the estimation of iron in industrial effluents. Conductometric sensors: Principle, instrumentation and application in the determination of acid mixture in industrial effluents. Colorimetric sensor: Principle, instrumentation and application in the estimation of copper in brass alloy.

Self-learning: Source of water, impurities in water, expected problems in boiler: Scale and sludge, priming & foaming and boiler corrosion. Determination of alkalinity and BOD.

9 Hrs

PRACTICAL MODULE

1. Estimation of total hardness of given water sample by EDTA method.
2. Estimation of percentage of CaO in cement by complexometric method.
3. Determination of chemical oxygen demand (COD) of industrial effluents.
4. Determination copper in brass by iodometric method.
5. Estimation of iron in Haematite ore solution by external indicator method.
6. Estimation of Chloride by argentometric method.
7. Determination of alkalinity of water sample by HCl method.
8. Estimation of acid mixture using conductometric sensor.
9. Estimation of iron in rust sample using potentiometric sensor.
10. Determination of pKa value of vinegar solution using pH sensor.
11. Estimation of copper present in e-waste (WPCB) by optical sensor (Colorimetry).
12. Determination of viscosity coefficient of green fuel using Ostwald's viscometer.
13. Estimation of percentage of iron in steel industry effluent by using optical sensor.
14. Estimation of Li/Na/K by using Flame photometer.

Reference Books:

1. R.V. Gadag and Nityananda Shetty, A Textbook of Engineering Chemistry, , I. K. International Publishing house. 2nd Edition, 2016.

2. Dhanpat Rai, Engineering Chemistry: Jain & Jain, Publisher: Publishing Company, ISBN: 978-9353161181

3. Harvey, James A., Smart Materials:. Handbook of materials selection, 2002, John Wiley & Sons Canada, Limited, ISBN: 9780471359241.

4. S. K. Malik, Materials Science Publisher: New Age International Publishers, ISBN: 978- 8122418713.

5. Dr. K. K. Rajeshwar, Electrochemical Energy System: (IIT Madras), Publisher: IIT Madras Open Courseware (Free PDF & videos), ISBN: N/A (Open Educational Resource)