I Semester

ENGINEERING CHEMISTRY			
Course Code	**21CHE12/22**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3Hour

Course Objectives: The course will enable the students to

1. **CLO1:** Impart the basic knowledge of chemistry and its principles involved in electrochemistry, energy storage devices, and its commercial applications.
2. **CLO2:** Understand the basic principles of corrosion and its prevention, metal finishing, and its technological importance
3. **CLO3:** Master the knowledge of synthesis, properties, and utilization of engineering materials like polymer, lubricants, and refractories.
4. **CLO4:** Apply the knowledge of Green Chemistry principles for the production of chemical compounds. understanding the concepts of synthesis and characterization of nanomaterials.
5. **CLO5:** Understand the theory, basic principle, and applications of volumetric analysis and analytical instruments.

Teaching-Learning Process (General Instructions):

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain methods of synthesis of nanomaterials.
3. Encourage collaborative (Group Learning) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in multiple representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Electrochemistry and energy storage systems:

Introduction, EMF of the cell, Free Energy, Single electrode Potential-Derivation of Nernst equation, Numerical problems based on Nernst Equation.

Reference Electrodes: Introduction, construction, working and applications of calomel electrode, ion-selective Electrodes-Glass electrode, determination of pH using a Glass electrode.

Energy Storage Systems: Introduction, Classification of batteries (primary, secondary, and reserved batteries). Construction, working, and applications of Li-ion batteries. Advantages of Li-ion battery as an electrochemical energy system for electric vehicles. Recycling of Lithium-ion batteries.

Teaching - Learning Process	Electrochemistry and energy systems-chalk and talk method, PowerPoint presentation, Practical topic: Determination of pKa value of weak acid using a glass electrode. Energy storage Systems-Power point presentation, YouTube videos for Li-ion battery construction and working. Self-study material: Construction and working of classical batteries like Zn-MnO_2 and Pb-

	PbO_2 batteries. Solar Energy and Fuel cells-you tube videos, chalk, and talk method.

Module-2

Corrosion and its control:
Introduction, Electrochemical theory of corrosion, Factors affecting the rate of corrosion: ratio of anodic to cathodic areas, nature of corrosion product, nature of the medium – pH, conductivity and temperature. Types of corrosion - Differential metal and differential aeration (pitting and waterline). Corrosion control: Anodizing – Anodizing of aluminum, Cathodic protection – a sacrificial anode and impressed current methods, Metal coatings – Galvanization and tinning. Corrosion Penetration Rate (CPR), numerical problems on CPR.
Metal finishing: Introduction, Technological importance. Electroplating: Introduction, principles governing Electroplating-Polarization, decomposition potential, and overvoltage. Electroplating of chromium (hard and decorative). Electroless plating: Introduction, the distinction between electroplating and electroless plating processes. Electroless plating of copper.

Teaching-Learning Process	Chalk and talk method and PowerPoint presentation - Electrochemical theory of corrosion, Factors affecting the rate of corrosion, Types of corrosion and corrosion control. Technological importance. Electroplating: Introduction, principles governing electro-plating-Polarization, decomposition potential, and overvoltage. Videos: Electroplating of chromium, electroless plating of nickel & copper Self-learning material: Organic coatings: Paint, components of paints, and their functions. Varnish, definition, differences between paints varnishes.

Module-3

Engineering Materials

Cement: types of cement, constituents, hardening and setting, deterioration of cement

Polymers: Introduction, Synthesis, and applications of Polyurethane. Polymer Composites-Kevlar Fibre,

Conducting Polymers: Synthesis & Mechanism of conduction in polyaniline and factors influencing conductivity of organic polymers.

Biodegradable polymers: Introduction and their requirements. Synthesis and properties of Polylactic acid.

Nanomaterials:

Introduction, size-dependent properties (Surface area, Electrical, Optical, and Catalytic properties). Synthesis of nanomaterials: Top-down and bottom-up approaches, Synthesis by Sol-gel, precipitation and chemical vapor deposition, Nanoscale materials: Fullerenes, Carbon nanotubes, and graphene's – properties and applications.

Teaching - Learning Process	Chalk and talk method and PowerPoint presentation- Polymers, Conducting Polymers, Insulators Videos: Lubricants Practical topic Determination of CaO in cement. Self-learning material: Insulators- Introduction, thermal insulators, and electrical insulators or dielectrics.

Module-4

Green Chemistry and alternative energy resources
Introduction, definition, Major environmental pollutants, Basic principles of green chemistry. Various green chemical approaches – Microwave synthesis, Bio catalyzed reactions, Phase transfer catalysis. Supercritical conditions for solvent-free reactions. Synthesis of typical organic compounds by conventional and green route; i) Adipic acid ii) Paracetamol
Atom economy – Synthesis of Ethylene oxide & Methyl Methacrylate. Industrial applications of green

chemistry, Numerical problems on Atom economy.

Green fuel: Hydrogen-production (Photo electrocatalytic and photocatalytic water splitting) and applications in hydrogen fuel cells. Construction, working and applications of Methanol-Oxygen fuel cell (H_2SO_4 as electrolyte).

Solar Energy:

Introduction, construction, working, and applications of a photovoltaic cell.

Teaching - Learning Process	Chalk and talk/powerpoint presentation - Basic principles of green chemistry, size dependent properties of nanomaterials. Nanoscale materials: Fullerenes, Carbon nanotubes and graphenes – properties and applications. Videos: Various green chemical approaches, Synthesis of nanomaterials: Top-down and bottom-up approaches, Synthesis by Sol-gel, precipitation and chemical vapor deposition. Self-study material: Atom economy

Module-5

Water chemistry:

Introduction, sources, and impurities in water, Potable water; meaning and specifications (as per WHO standards), Hardness of water, types, determination of hardness using EDTA titration, numerical problems on the hardness of the water. Biological oxygen demand (BOD) and Chemical Oxygen Demand (COD), Numerical problems on COD.

Methods of Chemical Analysis:

Volumetric Analysis: Introduction, principles of titrimetric analysis, the requirement of titrimetric analysis, the definition of equivalent weight, acidity, basicity, primary and secondary standards. Requirement of a primary standard solution, units of standard solutions (normality, molarity, molality, mole fraction, ppm).

Instrumental methods of analysis:

Introduction, Theory, Instrumentation, and applications of colorimetry, Flame Photometry, Atomic Absorption Spectroscopy, Potentiometry, Conductometry (Strong acid with a strong base, a weak acid with a strong base, a mixture of strong acid and a weak acid with a strong base)

Teaching-Learning Process	Chalk and talk/PowerPoint presentation – principles of titrimetric analysis, the requirement of titrimetric analysis, Classification of titrimetric analysis, Ostwald's theory of acid-base indicator taking phenolphthalein and methyl orange as examples. Instrumental methods of analysis. Practical topic: Volumetric titrations, instrumental methods. Self-study material- Types of volumetric titrations (Neutralization, redox, and complexometric)

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. **CO1**: Discuss the electrochemical energy systems such as electrodes and batteries.
2. **CO2:** Explain the fundamental concepts of corrosion, its control, and surface modification methods namely electroplating and electroless plating
3. **CO3:** Enumerate the importance, synthesis, and applications of cement, polymers. Understand the properties and application of nanomaterials.
4. **CO4:** Describe the principles of green chemistry, understand properties and application of alternative fuels.
5. **CO5:** Illustrate the fundamental principles and applications of volumetric and analytical instrumentation.

Assessment Details (both CIE and SEE)

1. The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Uppal M.M, Jain and Jain. Engineering Chemistry, Khanna Publishers, 35th Edition, 2013.
2. P.C. Jain and Monica Jain, A test Book of Engineering Chemistry, Dhanpat Rai Publications, New Delhi, 12th Edition, 2012.
3. SS Dara & Dr. SS Umare. -A Text book of Engineering Chemistry, S Chand & Company Ltd., 12th Edition, 2011.
4. R.V. Gadag and Nithyananda Shetty-A Text Book of Engineering Chemistry, I.K. International Publishing house. 2nd Edition, 2016.
5. B.S. Jai Prakash, R. Venugopal, Sivakumaraiah& Pushpa Iyengar.,- Chemistry for Engineering Students", Subash Publications, Bangalore.5th Edition, 2014
6. F.W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, 4th Edition, 1999.
7. M.G. Fontana, N.D. Greene, Corrosion Engineering, McGraw Hill Publications, New York, 3rd Edition, 1996.
8. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma & M.S. Pathania, S. Nagin Chand & Co., 41 Edition, 2004.
9. G.A. Ozin & A.C. Arsenault, "Nanotechnology A Chemical Approach to Nanomaterials". RSC Publishing, 2005.

Weblinks and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1bb3X-9IbHrDMjHWWh
- https://www.youtube.com/watch?v=j5Hml6KN4TI
- https://www.youtube.com/watch?v=X9GHBdyYcyo
- https://www.youtube.com/watch?v=1xWBPZnEIk8

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- https://www.vlab.co.in/broad-area-chemical-sciences
- https://demonstrations.wolfram.com/topics.php
- https://interestingengineering.com/science