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

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

Pedagogy (General Instructions):

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to explain methods of synthesis of nonmaterial's.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. 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 systems:

Introduction, EMF of cell, Free Energy, Single electrode potential-Nernst equation, Numerical problems. Reference Electrodes: Introduction, Construction, working and applications of Calomel electrode, Ion selective electrodes-Glass electrode, determination of pH using Glass electrode. Electrolytic Concentration Cells: Introduction, numerical problems

Energy storage Systems: Introduction, Classification. Construction, working and applications of Li-ion battery and recycling of Lithium-ion batteries.

Battery technology for electric vehicles (Energy devices for electric vehicles), components, construction and working of battery and recycling of Li-ion battery).

Solar Energy:

Introduction, construction, working and applications of photovoltaic cell.

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

Pedagogy	Electrochemistry and energy systems-chalk and talk method, power point presentation, Practical topic: Determination of pKa value of weak acid using glass electrode. Energy storage Systems-Power point presentation, youtube videos for Li-ion battery construction and working. Self-study material: recycling of Lithium-ion batteries. Construction, working and applications of Methanol-Oxygen fuel cell (H_2SO_4 as electrolyte) Solar Energy and Fuel cells-you tube videos, chalk and talk method.

Module-2

Corrosion and it's control:
Introduction, Electrochemical theory of corrosion, Factors affecting the rate of corrosion: ratio of anodic to cathodic areas, nature of corrosion product, nature of medium – pH, conductivity and temperature. Types of corrosion - Differential metal and differential aeration - pitting and water line). Corrosion control: Anodizing – Anodizing of aluminum, Cathodic protection - sacrificial anode and impressed current methods, Metal coatings – Galvanization, Organic coatings: Paint, components of paints and their functions. Varnish, definition, differences between paints varnishes. Numerical problems on Corrosion Penetration Rate (CPR) and Weight loss method.
Metal finishing: Introduction, Technological importance. Electroplating: Introduction, principles governing electroplating-Polarization, decomposition potential and overvoltage. Electroplating of chromium (hard and decorative). Electroless plating: Introduction, electroless plating of nickel &

Pedagogy	Chalk and talk method and power point presentation - Electrochemical theory of corrosion, Factors affecting the rate of corrosion, Types of corrosion and corrosion control. Technological importance. Electroplating: Introduction, principles governing electroplating-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

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 Poly lactic acid. Applications of biodegradable polymers in medical industry.

Lubricants: Introduction, Classifications, Properties- Viscosity index, Flash point, Drop point test and applications of lubricants.

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

Refractories: Introduction, Properties, brief account of steps involved in manufacturing with examples and applications.

Insulators: Introduction, thermal insulators and electrical insulators or dielectrics.

Pedagogy	Chalk and talk method and power point presentation- Polymers, Conducting Polymers, Insulators Videos: Lubricants Practical topic Determination of CaO in cement.

Module-4

Green Chemistry
Introduction, definition, Major environmental pollutants, Basic principles of green chemistry. Various green chemical approaches – Microwave synthesis, Bio catalysed reactions, Phase transfer catalysis.

Super critical 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 & Mehtyl Methacrylate. Industrial applications of green chemistry, Numerical problems on Atom economy.

Nanomaterials:

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

Pedagogy	Chalk and talk/power point 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 vapour 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 hardness of water. Biological oxygen demand (BOD) and Chemical Oxygen Demand (COD), Numerical problems on COD.

Volumetric Analysis:

Introduction, principles of titrimetric analysis, requirement of titrimetric analysis, 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 strong base, weak acid with a strong base, mixture of strong acid and a weak acid with a strong base)

Pedagogy	Chalk and talk/power point presentation – principles of titrimetric analysis, 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- 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)

Course outcome (Course Skill Set)

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

CO1: Discuss the electrochemical energy systems such as electrodes, batteries and fuel cells.

CO2: Explain the fundamental concepts of corrosion, its control and surface modification methods namely electroplating and electroless plating

CO3: Enumerate the importance, synthesis and applications of Polymer, Lubricant and Refractories.

CO4: Describe the principles of green chemistry, understand properties and application of nanomaterials.

CO5: Illustrate the fundamental principles and applications of volumetric and analytical instrumentation.

Assessment Details (both CIE and SEE)

(methods of CIE need to be define topic wise i.e.- MCQ, Quizzes, Open book test, Seminar or micro project)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods suggested: Test, Open Book test, Written Quiz, Seminar, report writing etc.
2. The class teacher has to decide the topic for closed book test, open book test, Written Quiz and Seminar. In the beginning only teacher has to announce the methods of CIE for the subject.

Semester End Examination:

Theory SEE will be conducted by University as per scheduled time table, with common question papers for subject

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 Nitthyananda 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.

Web links 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=1xWBPZnEJk8
- https://www.youtube.com/watch?v=wRAo-M8xBHM.

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

ENGINEERING CHEMISTRY LABORATORY			
Course Code	**21CHEL16/26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	3hrs

Course objectives:

CLO1 Quantitative analysis of materials by volumetric and chemical method.

CLO2 Instrumental methods for developing experimental skills in building technical competence

Sl.NO	Instrumentation Experiments
1	Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution.
2	Conductometric estimation of acid mixture.
3	Determination of Viscosity coefficient of a given liquid using Ostwald's viscometer
4	Colorimetric estimation of copper.
5	Determination of pKa value of a given weak acid using pH meter
	Volumetric experiments
1	Estimation of Total hardness of water by EDTA complexometric method.
2	Estimation of CaO in cement solution by rapid EDTA method.
3	Determination of percentage of copper in brass using standard sodium thiosulphate solution.
4	Determination of Chemical oxygen demand of industrial wastewater.
5	Estimation of percentage of iron in the given rust solution using standard Potassium Dichromate solution (External indicator method)
	Demonstration Experiments (For CIE)
1	Flame photometric estimation of Sodium & Potassium.
2	Synthesis of nanomaterial by Precipitationmethod.

Course outcomes (Course Skill Set):

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

CO1 Determine the pKa and coefficient of Viscosity of a given organic liquid.

CO2 Estimate the amount of substance present in the given solution using Potentiometer Conductometric and Colorimetricanalysis

CO3 Determine the total hardness and chemical oxygen demand in the given water sample by volumetric analysis method

CO4 Determine the percentage of Cao, copperand Iron in the given analyte solution by titration method.

CO5 Demonstrateflame photometric estimation of sodium &potassium and the synthesis of nanomaterials by Precipitation method.

Assessment Details (both CIE and SEE)

Continuous Internal Evaluation (CIE): The CIE marks awarded in case of Practical shall be based on the weekly evaluation of laboratory journals/ reports after the conduction of every experiment and one practical test.

Semester End Evaluation (SEE): The practical examinations to be conducted as per the time table of University in a batch wise with strength of students not more than 10-15 per batch.

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Suggested Learning Resources:

Text Books:

1. Vogel's A.I. A text book of quantitative analysis, 35th edition, 2012.
2. Willard, Merit, Dean and Settle, A text book of Instrumental analysis, 6th edition 2012.

Reference books:

1. G.H Jeffery, J Bassett, J Mendham and R.C. Denney Vogel's A.I. A text book of quantitative analysis, Dorling Kindersley (India) Pvt., Ltd. 35th edition, 2012.
2. Gary D Christian, Analytical Chemistry, Wiley India, 6th edition, 2015.
3. T. Pradeep, A Text book of Nanoscience and Nanotechnology, McGraw Hill Education (India) Pvt., Ltd., 1st edition, 2015