Semester:	I/II	**Course Type:**	IASC		
Course Title: Applied Chemistry for Environmental Sustainability in Structures & Materials					
Course Code:	25CHI12/22C			**Credits:**	4
Teaching Hours/Week (L:T:P:S)			3:0:2:1	**Total Hours:**	40+ Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- 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.

II. Teaching-Learning Process (General Instructions):

These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching–Learning more effective

a)Tutorial &remedial classes for needy students
b)Conducting Makeup classes/Bridge courses for needy students
c)Demonstration of concepts either by building models or by industry visit
d)Experiments in laboratories shall be executed in blended mode(conventional or non-Conventional methods)
e)Use of ICT–Online videos, online courses

Use of online platforms for assignments/Notes/Quizzes(Ex. Google classroom)

III. COURSE CONTENT

III(a). THEORY PART

Module-1: Sustainable Chemistry for Energy Devices — **8 Hours**

Electrode System: Introduction: Ion selective electrode – definition, construction, working and applications of glass electrode. Concentration cell – Definition, construction and numerical problems.
Next-Generation Energy Systems - Introduction, battery characteristics(Voltage, Cycle life, Power density and shelf life) , Classification of batteries. Construction, working and applications of Li-ion battery and flow battery (Vanadium redox flow battery) for EV application. Construction and working of solar photovoltaic cell, advantages, and disadvantages. Ultra-small asymmetric super capacitor: Introduction, advantages and its applications in IoT/wearable devices.
Energy Sources: Introduction, definitions of CV, LCV, and HCV. Determination of calorific value of solid/liquid fuel using bomb calorimeter, numerical problems. Octane and cetane number- Definition and

its importance in rating of fuel.

Textbook:Chapter:sections
1)Engineering Chemistry by R V Gadag: Chapter 6:Section:6.3,6.4,6.5,6.6,6.7
2) Engineering Chemistry by Jain & Jain Chapter 2 Section 3,4,5,6

Pre-requisites (Self Learning)
STypes of electrode, Na-ion battery, power alcohol, unleaded petrol, Real-world case studies that highlight the application of next-generation energy systems

RBT Levels: L1,L2,L3

Module-2: Corrosion science and E-waste Management	**8 Hours**

Corrosion: Introduction,Electrochemical corrosion of steel in concrete, Types of corrosion - Differential metal and differential aeration (pitting and water line). Corrosion Penetration Rate (CPR), numerical problems on CPR.
Corrosion Control: Anodizing – Anodizing of aluminium, Cathodic protection - Sacrificial anode , Metal coatings – Galvanization. Introduction, technological importance, electroplating - electroplating of chromium; hard and decorative, electroless plating - electroless plating of Nickel, difference between electroplating and electroless plating.
E-Waste: Introduction, sources of e-waste, effects of e-waste on environment and human health, Artificial intelligence in e-waste management and its applications, extraction of gold from e-waste by bioleaching method, direct recycling method of lithium-ion batteries.

Textbook:Chapter:sections-
1)Engineering Chemistry by R V Gadag:Chapter 1,2,3,4:Section 1.5,2.3,3.11,3.12,4.6
2)E-Waste Management Challenges and Opportunities in India by VarshaBhagat-Ganguly: Chapter 1,4,6: Section 1.1,4.1,6.1

Pre-requisites (Self Learning)
GGalvanic series, stress corrosion Real-world case studies that highlight the application of waste management in industry

RBT Levels: L1,L2,L3

Module-3: Green Materials	**8 Hours**

Green Principles: Discussion on 12 principles of green chemistry, numerical problems on atom economy. Properties and applications of green solvents for server heat management, Synthesis of typical organic compounds by green route; Adipic acid –green synthesis from glucose. Advantages of green approach over conventional method.

Green fuel: Hydrogen-production -electrolysis of water (Alkaline water electrolysis), photocatalytic water splitting and its advantages. Biodiesel- Preparation and Advantages. Construction, working principle, applications and limitations of solid-oxide fuel cell (SOFCs)

Biomaterials: Definition and classification of biodegradable polymers. Polylactic acid-synthesis and its application. synthesis and properties of Alginate Hydrogel for Brain-Computer Interfaces (BCIs) applications.

Textbook: Chapter: sections
1)An Introductory Text on Green Chemistry by Indu Tucker Sidhwani: Chapter 1,2,4,6:Section 1.1,2.1-2.13,4.5.2-4.5.3,6.2,6.3
2) Handbook of Biodegradable Polymers by Lendlein & Sisson: Chapter:1,7 Section 1.1,7.1

Pre-requisites (Self Learning)
Sustainability, Eco Design , Smart Cities, Eco communication. Real-world case studies that highlight the application of green materials in industry and research.

RBT Levels: L1,L2,L3

Module-4:Water Chemistry and Sensors in Analytical Techniques	**8 Hours**

Water Chemistry: Hardness of water, types and determination of hardness using EDTA titration, numerical problems on hardness of water. Definition of Biological oxygen demand (BOD) and Chemical Oxygen Demand (COD), determination of COD of waste water sample and Numerical problems on COD.
Sensors in Analytical Techniques: Sensors: types and its applications in modern world.Sensor for the measurement of Dissolved Oxygen (DO). Principle and instrumentation of Colorimetric sensors; its application in the estimation of copper in PCB, principle and instrumentation of Potentiometric sensors;

principle and instrumentation of its application in the estimation of iron in steel, Conductometric sensors; its application in the estimation of acid mixture.

Textbook:Chapter: sections: 1)Engineering Chemistry by R V Gadag: Chapter 8: Section: 8.1,8.2,8.4, Chapter 10:10.1, 10.3,10.5, 10.6
2) "Handbook of Water, Air and Soil Analysis" (International Science Congress) by S. Chaurasia and A.D. Gupta: Chapter 1: Section: 17,28.29
3)Engineering Chemistry,Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher, Bengaluru, ISBN 978-93-85155-70-3, 2022

Pre-requisites (Self Learning)
Water treatment , industrial water standards (WHO, BIS, EPA), Display Sensors. Real-world case studies that highlight water treatment. Sewage water treatment, Reverse osmosis

RBT Levels: L1,L2,L3

Module-5: Structural Materials	**8 Hours**

Cement: Introduction, manufacturing process of cement (Wet Process**)**, setting and hardening of cement.
Piezoelectric cement composites: piezoelectric materials in cement composites and its applications in civil engineering.
Geopolymer Concrete: Introduction, manufacturing process of Geopolymer concrete. Advantages over ordinary portland cement Concrete.
Polymer: Introduction, synthesis, properties and engineering applications of CPVC, PMMA, molecular weight of polymers: number average and weight average molecular weight of polymers, numericals, properties and industrial applications of carbon-based reinforced composites-graphene/carbon nano-tubes as fillers.
Nanomaterials: Introduction, size dependent properties viz; surface area, water absorption, permeability, thermal properties and antimicrobial activity, composition of nano-concrete, synthesis of TiO_2 nanoparticles by sol-gel method for sensor applications.

Textbook: Chapter: Sections- 1)Concrete Technology by A.R. Santhakumar: Chapter 2:Section: 2.1,2.2,2.3
2)Geopolymer Concrete: Principles, Characteristics, Testing, and Applications by Kiran Kumar Poloju & Kota Srinivasu: Chapter 1,4,5,6: Section 1.1,4.2,4.4,5.1,5.2,5.3,6.2,6.3
3)Materials Science and Engineering by Callister & Rethwisch: Chapter 14,15:Sections 14.1–14.6, 15.3

Pre-requisites (Self Learning)
Ordinary Portland cement (OPC) and concrete applications , types of polymerization ,photochromic coating. Real-world case studies that highlight application of sustainable construction Materials

RBT Levels: L1,L2,L3

III(b). PRACTICAL PART

Sl. No.	Experiments / Programs / Problems
1	Estimation of acid mixture using Conductometric sensors.
2	Estimation of iron in rust sample using Potentiometric sensors.
3	Determination of pKa of vinegar using pH sensor (Glass electrode).
4	Estimation of Copper present in electroplating effluent by optical sensor (colorimetry).
5	Determination of Viscosity coefficient of lubricant (Ostwald's viscometer).
6	Estimation of total hardness of water by EDTA method.
7	Estimation of percentage of CaO in cement by EDTA method.
8	Estimation of iron in TMT bar by diphenyl amine/external indicator method.
9	Determination of Chemical Oxygen Demand (COD) of industrial waste water sample.
10	Estimation of Alkalinity (OH^-,CO_3^{2-},&HCO_3^-) of water using standard HCl solution.

11	Data analysis of pka of a weak acid and its interpretation using origin software (Demonstration experiment).
12	Synthesis of nanomaterial by Precipitation method(Demonstration experiment)

Instructions for conduction of practical part:

Instructions for conduction of practical part: Instructions for conduction of practical part:

- Strict discipline should be maintained inside the laboratory.
- Lab batches will be allotted at the beginning of the semester.
- Student should enter into the lab by wearing Apron and having the Lab Manual along with a calculator and observation notebook.
- The student should conduct one experiments in the specified time of 2hrs duration in regular lab sessions
- All entries of the observation should be done by using black pen only. Avoid writing by pencil and overwriting
- **The short procedure for the experiment must be prepared for writing in data sheet by the student before coming to the laboratory** All calculations pertaining to the experiments should be completed in the laboratory. The results must be got corrected by the batch teacher only Then entry should be made in the record and also enter the marks in index book before leaving the laboratory.
- Please remember that practical records are evaluated during regular class hours. Therefore it is imperative that each student takes care to see that experiments are well conducted and recorded.

IV. COURSE OUTCOMES

CO1	Use the concepts of electrode systems, energy sources, corrosion mechanisms, and e-waste management to solve real world problems.
CO2	Apply the principles of green chemistry and green materials to design sustainable solutions for energy and environmental applications.
CO3	Utilize the knowledge of chemistry to investigate chemical species in environmental and engineering applications.
CO4	Analyze the properties of sustainable construction materials and assess their environmental impact and performance in buildings.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	1				1	2					1				
CO2	3	1				1	2					1				
CO3	3	1		1		1	2					1				
CO4	3	1				1	1					1				

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 2

Continuous Internal Evaluation (CIE): Refer Annexure section 2

Semester End Examination (SEE): Refer Annexure section 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Green Chemistry: Theory and Practice	Paul T. Anastas, John Charles Warner	01-Jan-2000	Oxford University Press
2	Green Chemistry: Environmentally Benign Reactions	V.K. Ahluwalia	02-Jul-2021	Springer Nature

3	Nanotechnology A Chemical Approach to Nanomaterials	G.A. Ozin& A.C. Arsenault	2005	RSC Publishing
4	Linden's Handbook of Batteries	Kirby W.Beard	Fifth Edition, 2019.	McGraw Hill,
5	Corrosion Engineering	M.G.Fontana, N.D.Greene	3rd Edition, 1996	McGrawHill Publications, NewYork
6	Wiley Engineering Chemistry	Wiley	2nd Edition-2013	Wiley India Pvt.Ltd. NewDelhi
7	Engineering Chemistry	P. C. Jain & Monica Jain	17th Edition-2015	Dhanpat Rai Publishing Company, New Delhi
8	Concrete Technology	A.R. Santhakumar	2nd Edition (2018)	Oxford University Press
9	Handbook of Biodegradable Polymers	Lendlein & Sisson	1st Edition- 2011	Wiley-VCH
VII(b): Reference Books:				
1	Engineering Chemistry	O.G.Palanna	Fourth Reprint 2017	Tata McGraw Hill Education Pvt. Ltd. New Delhi
2	Engineering Chemistry	Shubha Ramesh et.al.	1st Edition, 2011	Wiley India
3	Fundamentals of Analytical chemistry	Douglas A. Skooget.al.	Eighth edition-2004	Thomson Asia pte Ltd
4	OLED Display Fundamentals and Applications	TakatoshiTsujimura	2012	Wiley–Blackwell
5	Super capacitors: Materials, Systems, and Applications	Max Lu, Francois Beguin,ElzbietaFrackowiak	1st edition, 2013	Wiley-VCH
6	Geopolymer Concrete: Principles, Characteristics, Testing, and Applications	Kiran Kumar Poloju & Kota Srinivasu	2025	Springer
7	Materials Science and Engineering: An Introduction	William D. Callister Jr. & David G. Rethwisch	10th Edition (2018)	Wiley
8	Textbook of Polymer Science	Fred W. Billmeyer	3rd Edition (May 1984)	John Wiley & Sons, Ltd (Wiley)

VII(c): Web links and Video Lectures (e-Resources):

http://libgen.rs/
https://nptel.ac.in/downloads/122101001/
https://nptel.ac.in/courses/104/103/104103019/
https://ndl.iitkgp.ac.in/
https://www.youtube.com/watch?v=faESCxAWR9k
https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1bb3X9IbHrDMjHWWh
https://www.youtube.com/watch?v=j5Hml6KN4TI
https://www.youtube.com/watch?v=X9GHBdyYcyo
https://www.youtube.com/watch?v=1xWBPZnEJk8

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Seminar, Assignments, Quiz, Industry visit, self-study activities, case studies group discussions, etc