DEPARTMENT OF CHEMISTRY

Choice Based Credit System (CBCS)

SEMESTER – I/II

Materials Chemistry for Energy and Data Processing (3:0:1) 4

CSE Stream

(Effective from the academic year 2024-25)

Course Code	**BCHECS12/22**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Understand and apply the knowledge of materials to be used in memory devices.
2. Understand the characteristics of materials for application in fabrication of advanced display systems.
3. Understand the basic concepts of electrochemistry and its application in fabrication of sensors.
4. To apply the knowledge of electrochemistry and materials in the development of energy storage systems.
5. Understand the materials characterization to enhance the durability of materials for sustainable E waste management.

Preamble: To enable the students to acquire knowledge in the concepts of chemistry for engineering applications and to familiarize the students with different application-oriented topics like energy storage devices, materials for memory devices, storage and instrumental methods of analysis etc., Also familiarize the students with topics like sensors, corrosion mitigation, advanced display materials and E-waste management etc., which enable them to develop abilities and skills that are relevant to the study and practice of engineering chemistry.

Module – 1

Materials for Memory Devices:

Memory devices: Introduction, Basic concepts of electronic memory. Classification of electronic memory devices. Types of organic memory materials: Small organic molecules: acene derivatives (Pentacene and perfluoropentacene), charge transfer complexes (Cu-TCNQ). Polymeric materials: Functional polyimides, and polymer containing metal complexes (Ferrocene polymer complex). Organic-inorganic hybrid materials: Au nanoparticle with 8-hydroxy quinoline.

Self-study: Other Types of organic memory materials: naphthalene, anthracene, tetracene and ZnPc: Zn(II) pthalocyanine complex.

(8 Hours)

Module – 2

Materials for Display Systems:

Display Systems: Introduction to Photoactive and electro active materials, Nanomaterials and organic materials used in optoelectronic devices. Liquid crystals (LCs): Introduction, classification, properties and application in Liquid Crystal Displays (LCD s) Differences between liquid crystal and solid/liquid. Properties and application of Organic Light Emitting Diodes (OLED s) and Quantum Light Emitting Diodes (QLED, Light emitting electrochemical cells.

Self-Study: Properties and functions of Silicon (Si), Germanium (Ge), copper (Cu), Aluminium and Brominated flame retardants in computers.

(8 Hours)

Module – 3

Introduction to Electrochemistry, Smart Sensor Systems and Devices:

Introduction to Electrochemistry: Introduction, Types of electrode systems with examples. Reference electrodes: Advantages of secondary electrodes over SHE. Construction, working and application of calomel electrode to determine electrode potential. Concentration cells: Definition, types, construction and working of electrolyte concentration cell, Numerical problems on concentration cell.

Smart Sensors and Devices: Introduction, types of sensors (Piezoelectric and electrochemical), Nanomaterials for sensing applications: Gas sensors (NOx and SOx), and biosensors (Glucose sensors)

RFID and IONT materials: Synthesis, properties and applications in logistic information and intelligent packaging systems (Carbon nanotubes and polyaniline).

Self-study: Types of sensor systems, and classification of sensor systems.

(8 Hours)

Module – 4

Energy storage system:

Battery technology: Introduction to batteries, Classifications: Primary, Secondary and Reserve batteries with examples. Introduction to redox flow batteries: Classification based on components, construction, working and applications of Vanadium based redox flow batteries. Secondary batteries: Construction, working and applications of Lithium-ion batteries. Introduction to next generation sodium ion batteries and its applications. Advantages of Na –ion batteries with Li-ion battery. Overview of Battery technology for E-mobility and IoT-Based Battery Monitoring System for Electric Vehicle.

Battery management system: Li-ion battery hazardous, Electrochemical recovery of Li from Li spent batteries, best storage and handling practices of Li ion batteries, and their Safe disposal. Temperature sensing for battery management systems using thermocouple technology.

Self-study: E-waste Management: Introduction, sources of e-waste, e-waste management. Health hazards due to exposure to e-waste, recycling and recovery. Extraction of gold metal from e-waste.

(8 Hours)

Module – 5

Management of Computer Metal Components:

Corrosion science and its mitigation: Introduction to corrosion, Electrochemical corrosion (rusting of iron)-Differential metal and differential aeration corrosion with examples. Corrosion Control - Cathodic Protection-Sacrificial anode method and Impressed Current Method, Protective Coatings- Vapour Corrosion Inhibitor and its applications to protect computer circuit boards. Thermal management system of CPU using liquid cooling systems.

Electroless plating: Introduction, Principle, electroless plating in copper for double sided PCBs.

E-waste management: Sources, Hazards and toxicity. Segregation and recycling (Hydrometallurgy, pyrometallurgy and direct recycling). Extraction of valuable metals from E-waste: Extraction of Au.

Self-study: Self- Study: Consequences of corrosion, Inorganic Coating-Anodization, Technological importance of metal plating. Differences between electroplating and electroless plating.

(8 Hours)

Practical component

List of Experiments

A-Demonstration experiments (Any one experiment):

A1	Chemical structure drawing using software: Chem Draw/Avogadro/Chem Sketch.
A2	Determination of rate of corrosion in mild steel by weight loss method.
A3	Synthesis of metal oxide nanoparticle by combustion method.
A4	Determination of CaO in cement by rapid EDTA method

B-Exercise (All experiments compulsory):

B1	Conductometric estimation of acid mixture using standard NaOH solution
B2	Potentiometric estimation of FAS using standard K2Cr2O7.
B3	Determination of pKa of vinegar using pH meter.
B4	Estimation of Copper present in PCBs by colorimetery.

C-Structured Enquiry (All experiments compulsory):

C1	Determination of COD of wastewater sample.
C2	Determination of viscosity of oil sample by Ostwald's viscometer.
C3	Determination of percentage of iron in steel using external indicator method.
C4	Determination of hardness of water by complexometric titration.

D-Open ended experiments (All experiments compulsory):

D1	Determination of percentage of copper in printed circuit boards-based E-waste solution using redox titration.
D2	Estimation of percentage of available chlorine in the given sample of bleaching powder (Iodometric method).
D3	Determination of fluoride in drinking water by SPANDS method.
D4	Determination of total alkalinity of water samples.

Course Outcomes:

The students will be able to:

CO1: Understand and apply the knowledge of materials to be used in memory devices.

CO2: Understand the characteristics of materials for application in fabrication of advanced display systems.

CO3: Understand the basic concepts of electrochemistry and its application in fabrication of sensors.

CO4: To apply the knowledge of electrochemistry and materials materials in the development of energy storage systems.

CO5: Understand the materials characterization to enhance the durability and sustainable E waste management.

Text Books:

1. A Textbook of Engineering Chemistry, R.V. Gadagand Nityananda Shetty, I. K. International Publishing house. 2ndEdition,2016.
2. Textbook of Polymer Science, F.W. Billmeyer, JohnWiley&Sons,4thEdition,1999.
3. Handbook of Electronic Waste Management, International Best Practices and Case Studies, 1st Edition - November 21, 2019
4. A Textbook of Engineering Chemistry, SS Dara & Dr. SSU mare, S Chand & Company Ltd., 12thEdition, 2011.

References:

1. Battery Technologies: Materials and Components *2021 by Jianmin Ma*
2. Battery Technology Crash Course: A Concise Introduction *2020 by Slobodan Petrovic*
3. Applied Chemistry, Sunita Rattan, Kataria5.Engineering Chemistry, Baskar, Wiley
4. Engineering Chemistry–I, D. Grour Krishana, Vikas Publishing
5. Optical, electronic and magnetic Materials: Advanced memory technology: Functional materials and devices, volume1, DOI: https://doi.org/10.1039/9781839169946, ISN:978-1-83916-994-6, Special Collection: 2023 ebook collection, Series: Optical, Electronic and Magnetic Materials, No. of Pages:752,Publisher :RSC.

Alternate Assessment Tools (AATs) suggested:

- Power point presentations/ Seminar
- Scientific report writing
- Industrial visit-report writing
- Minor project
- Assignment

Web links / e–resources:

https://aissmsioit.org/wonders-of-chemistry-in-engineering/
https://leverageedu.com/blog/engineering-chemistry/