Code: 1BCHEE202 **Course: Applied Chemistry for Electrical and Electronics Engineering**

Credits: 3 **CIE: 50 Marks**
L:T:P: 2:2:0 **SEE: 50 Marks**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	**NA**
Learning objectives	To impart a strong foundation in the principles of chemistry with emphasis on application-oriented topics relevant to Electrical & Electronics Engineering and allied branches

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Impart the knowledge of semiconductors and insulating materials for electrical and electronic applications.	Understand Apply
CO2	Apply the knowledge batteries, hydrogen fuel, solar cells, and fuel cells for technological applications.	Understand Apply
CO3	Apply the principle of e-waste management for various engineering fields.	Understand Apply
CO4	Apply the concepts of sensors and display systems in electronics applications.	Understand Apply, Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	PSO3	PSO4
CO1	3	2			2		2						3			
CO2	3	2			2		2						3			
CO3	3	2			2		2						3			
CO4	3	2			2		2						3			

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

	Applied Chemistry for Electrical and Electronics Engineering	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module-1: Materials for electrical and electronics applications			
1.1	**Semiconductors:** Introduction, classifications, band theory of materials. Production of silicon by union carbide process, electronic grade silicon by Czochralski (CZ) process, Float zone (FZ) method.	2	0	0
1.2	Semiconductor grade silicon by Chemical Vapor Deposition (CVD). Epitaxy method and Ion implantation - basic concepts and process.	1	1	0
1.3	**Wide bandgap semiconducting materials:** Chemistry of SiC, and GaN, properties and application in power electronics system.	1	1	0
1.4	**Solar Energy:** Introduction, construction and working of photovoltaic cell (PV cells), and Quantum dots sensitized solar cells (QDSSC's), advantages, and disadvantages of PV cells.	1	1	0
	Module-2: Energy Systems for Electric Vehicles			
2.1	**Batteries:** Introduction, materials for anode, cathode and electrolyte. Classification of batteries, construction, working and applications of Li-ion, Lithium polymer (LiPo) and Na-ion battery.	2	0	0
2.2	**Battery Performance Metrics**: Voltage, current density, capacity, power density, energy density, cycle life and shelf life.	1	1	0
2.3	Factors affecting battery performance: Temperature, charging/discharging rates, and aging mechanisms.	1	1	0
2.4	**Battery Testing:** Cell Balancing, importance, thermal management, state of charge and state of health, estimation, and recycling of batteries.	1	1	0
	Module-3: Hydrogen Energy and Fuel cells			
3.1	**Hydrogen as a fuel:** Introduction to hydrogen as a fuel, green hydrogen, generation of hydrogen by electrolysis of water. Alkaline water electrolysis and Proton Exchange Membrane electrolysis (PEM), storage and transportation, advantages and limitations of hydrogen.	2	0	0
3.2	**Fuel cells** – Introduction, classification, construction, working principle and applications of fuel cells.	1	1	0
3.3	Polymer electrolyte member fuel cells (PEMFCs), Alkaline fuel cells (AFCs), Phosphoric acid fuel cells (PAFCs), Solid oxide fuel cells (SOFCs),	1	1	0
3.4	Molten carbonate fuel cells (MCFCs), Direct methanol fuel cells (DMFCs), Zinc air fuel cells (ZAFCs) and biological fuel cells (BFCs).	1	1	0
	Module-4: Display Systems and E-Waste Management			
4.1	**Liquid crystals** (LC's) - Introduction, classification, properties, and application of Liquid Crystals in Displays (LCD's).	1	1	0

4.2	Properties and applications of Organic Light Emitting Diodes (OLED's) and Quantum Light Emitting Diodes (QLED's).	1	0	0
4.3	**E-waste Management:** Introduction, sources, types, effects of e-waste on environment and human health. Recycling: Different approaches of recycling - separation by Eddy currents, magnetic, optical sorting, density-based separation, recovery and disposal of e-waste.	2	1	0
4.4	**Process of metal extraction**: Hydrometallurgical and Pyrometallurgical extraction methods. Extraction of copper and gold from e-waste.	1	1	0
Module-5: Sensors and Insulation Materials in Engineering Applications				
5.1	**Sensors:** Introduction, working principle and applications of electrochemical sensors (potentiometric sensors for the estimation of iron in industry waste). Optical sensors: Estimation of copper in PCB effluent by colorimetric sensors, and thermometric and smart sensors.	2	0	0
5.2	Principle, working and applications of conductometric sensors for the estimation of acid and acid mixtures in effluent, p^H sensors for the determination of p^H/p^{Ka} in water quality monitoring.	2	1	0
5.3	**Insulation Materials:** Introduction, composition, properties and applications of Rubber, plastics (PVC, Cross-linked polyethylene), ceramics (porcelain and glass), mica, silicone rubber, Fluoropolymers (Teflon, FEP). Composite materials- Fiberglass-Reinforced Polymers (FRP), Epoxy Composites in power electronics	1	1	0
5.4	**Insulation liquids and gases:** Mineral oil, silicone oil, natural and synthetic esters used in transformers, Sulfur hexafluoride gas in power systems	1	0	0
	Total No. of Lecture Hours	**26**		
	Total No. of Tutorial Hours/ sessions		**14**	**-**
	Total No. of practical sessions			**0**
	Total No. Hours/sessions			**40**

Self-learning topics:

1. Case study: 1 Materials for electrical and electronics industry
2. Case study: 2 Energy Systems for Electric vehicles
3. Case study: 3 Hydrogen as a fuel and fuel cells
4. Case study: 4 Display systems and e-waste management
5. Case study: 5 Sensors and insulation materials in Engineering Applications

Textbooks:

1. Applied Chemistry for Electrical And Electronics Engineering and Allied Branches, C Manasa, Dr. Srikantamurthy N, Dr. Vrushabendra B, Publisher Astitva Prakashan
2. Engineering Chemistry, Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher, Bengaluru, ISBN 978-93-85155-70-3, 2022.
3. Engineering Chemistry: Fundamentals and Applications by By Shikha Agarwal, Cambridge University Press, 23 May 2019

Reference Books:

1. A Textbook of Engineering Chemistry, By S S Dara & S S Umare, Aruna M Sudame, S, Chand and company limited
2. Textbook of Engineering Chemistry by Shashi Chawla, Publisher: Dhanpat Rai, Edition: 6, 2022, Pages: 828.
3. Engineering Chemistry, 3rd edition, by R.V. Gadag, A. Nityananda Shetty, Publisher: Dreamtech Press