VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)

ACCREDITED BY NAAC WITH A++ GRADE

DEPARTMENT OF CHEMISTRY

MATERIAL CHEMISTRY

(For CSE, CSE (AI & ML) and IT branches)

Instruction : 3 Hrs / week	Semester End Exam Marks : 60	Subject Reference Code : U22BS210CH
Credits : 3	Continuous Internal Exam Marks : 40	Duration of semester End Exam : 3H

COURSE OBJECTIVES:	**COURSE OUTCOMES**
The course will enable the students to:	**At the end of the course, students should be able to:**
1. Study types of conductance, variation of electrode potential and EMF and to acquaint with applications of Galvanic Cell. 2. Classify and compare various types of batteries and fuel cells. 3. Get acquainted with different types of polymers and their applications 4. Appraise few engineering materials.	1. Construct a galvanic cell and calculate its EMF and pH wherever applicable. 2. Describe the construction, chemistry and applications of the selected primary, secondary batteries and fuel cells. 3. Classify the macro molecules and discuss the synthesis and applications of a few macro molecules. 4. Get expose to basic concepts of engineering materials such as composites and liquid crystals. 5. Familiarise with the classification, synthesis, characterization, properties and applications of nanomaterials.

CO-PO MAPPING FOR MATERIAL CHEMISTRY

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	-	-	-	-	-	-	-	-	-	1
2	3	1	-	-	-	-	2	-	-	-	-	2
3	3	1	-	-	-	-	2	-	-	-	-	1
4	3	1	-	-	-	-	1	-	-	-	-	1
5	3	1	-	-	-	-	1	-	-	-	-	2

UNIT-I: ELECTRODICS AND ITS APPLICATIONS (9)

Introduction, conductance, types of conductance – specific, equivalent, molar conductance and their interrelationship - numericals. Principle and applications of conductometric titrations – strong acid *vs* strong base, weak acid *vs* strong base and mixture of acids *vs* strong base.

Concept of electrode potential, Helmholtz electrical double layer theory, electro motive force (EMF). Electrochemical series – applications. Nernst equation – derivation, applications and numericals. Concentration cells – numericals.

Types of electrodes- construction and working of calomel electrode (CE), quinhydrone electrode and glass electrode (GE). Determination of pH using glass electrode and quinhydrone electrode. Applications of potentiometry – acid base and redox titration (Fe(II) Vs $KMnO_4$).

UNIT-II: CHEMISTRY OF BATTERIES (9)

Introduction – definition of cell and battery – Types of cells (reversible and irreversible cells). Battery characteristics: free energy change, electromotive force of battery, power density, energy density – numericals.

Primary batteries: Types-acidic, alkaline and reserve batteries. Construction and electrochemistry of Zn-C, Ag_2O-Zn battery and lithium-V_2O_5 battery.

Secondary batteries: Construction and working of lead-acid, Ni-metal hydride, and lithium ion battery – advantages, limitations and applications.

Fuel cells: Concept, types of fuel cells and merits. Construction, working and applications of methanol-oxygen, phosphoric acid fuel cell and molten carbonate fuel cell.

UNIT-III: MACRO MOLECULES (9)

Introduction, degree of polymerization, functionality of monomers and its effect on the structure of polymers. Classification of polymers – a) homo and co-polymers; b) homo chain and hetero chain polymers; c) plastics, elastomers, fibers and resins.

Types of Polymerization - Addition and condensation polymerization.

Glass transition temperature (Tg), factors affecting Tg.

Molecular weight- number average and weight average molecular weight, numericals.

Plastics: Thermoplastics and thermosets - preparation, properties and applications of a) Aramid (Kevlar); b) Phenol-formaldehyde (Bakelite); and c) Poly carbonate

Elastomers: Natural rubber- structure – chemistry of vulcanization and its advantages.

Artificial rubbers: Preparation, properties & uses of Buna-S and neoprene.

Biodegradable polymers: Concept, preparation and uses of ploy lactic acid.

Conducting polymers: Definition- classification, mechanism of conduction in polyacetylene and applications.

UNIT-IV: ENGINEERING MATERIALS (7)

Composite materials:

Introduction, constituents of composites, advantages over conventional materials. Applications of composites. Types of composites based on matrix and dispersed phases. Fiber reinforced composites: glass, carbon and aramid reinforced composites. Layered composites- applications. Manufacturing techniques – Hand layup, Resin transfer, pulltrusion and filament winding methods.

Liquid Crystals:

Introduction, classification of liquid crystals – Thermotropic and Lyotropic liquid crystals – Chemical constitution and liquid crystalline behavior. Molecular ordering in liquid crystals – Nematic, Smectic and Cholesteric liquid crystals – Applications.

UNIT-V: NANOMATERIALS (8)

Introduction – Concept of nanomaterials – quantum confinement and surface volume ratio.

Properties of nanomaterials: Catalytic, electrical, mechanical and optical properties.

Types of Nanomaterials**:** Zero dimensional (0-D), One dimensional (1-D), Two dimensional (2-D), Three Dimensional(3-D).

Characterization of nanomaterials- Principle and block diagram of Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM).

Synthesis of nanomaterials: Top down and bottom-up approaches – mechanical grinding by ball milling and sol-gel method.

Graphene: Introduction, synthesis of graphene by chemical vapor deposition (CVD).

Carbon Nanotubes**:** Classification – single walled carbon nanotubes (SWCNTs – armchair, zig-zag, chiral) and Multi walled carbon nanotubes (MWCNTs- Russian doll and parchment model).

Synthesis of CNTs – Arc discharge and laser ablation methods.

Applications of Nanomaterials (CNTs, Graphene etc.)

Text Books:

1. P. C. Jain, M Jain Engineering Chemistry, Dhanapathi Rai and sons (16th edition), New Delhi.
2. Sashi Chawla, Text book of Engineering Chemistry, Dhanapathi Rai &sons, New Delhi.
3. O. G. PALANNA, Engineering Chemistry, TMH Edition.
4. Wiley Engineering chemistry, Wiley India Pvt. Ltd., II edition.
5. Chemistry in engineering and technology by J.C. Kuriacose and Rajaram.
6. The chemistry of nanomaterials – Synthesis, Properties and Applications by C. N. R. Rao, Wiley India Pvt. Ltd.

Learning Resources:

1. University chemistry, by B. H. Mahan
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
3. Physical Chemistry, by P. W. Atkins
4. S. S. Dara, S Chand and sons, Engineering Chemistry, New Delhi.
5. Puri, Sharma and Pathania Principles of physical chemistry, Vishal Publishing Co.
6. NPTEL Polymer Chemistry Course, D. Dhara, IIT Kharagpur.
7. Polymer chemistry by Gowariker
8. Introduction to Nanoscience, by S m Lindsay, Oxford University press.

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