

SEMESTER –VI
MATERIAL SCIENCE
THEORY

Program: B.Sc.

Course Code: U20/CHE/DSE/603

Course Type: DSE 3

No. of Credits: 3

Max. Hours: 45

Hours per week: 3

Max. Marks: 100

COURSE OBJECTIVES:

- Introduce Materials like Superconductors and Ceramics and their properties and applications to students.
- Acclimate students with the basic language of polymer chemistry, and the synthetic techniques by which polymers can be prepared.
- Understand the types of Non degradable and Degradable polymers and to differentiate between them.
- Introduce students to the importance of nanoparticles, their properties and applications.

COURSE OUTCOMES:

- CO 1:** Classify different Materials and understand their properties and applications.
- CO 2:** Describe the basic language of polymer chemistry, and the synthetic techniques by which polymers can be prepared.
- CO 3:** Categorize Polymers based on Structure – Property relationship
- CO 4:** Develop a sense of community responsibility by becoming aware of environmental issues related to polymers.
- CO 5:** Apply the knowledge on Nanotechnology to synthesize, characterize Nanoparticles and explain their properties.

MODULE 1: INTRODUCTION TO MATERIAL SCIENCE**(11 Hrs)****SUPERCONDUCTORS AND COMPOSITES****(5 Hrs)**

Classification of materials- classification as metals, ceramics, organic polymers, composites, biological materials etc. The property of super conductivity of materials. Super conducting materials- elements, alloys and compounds. Properties of super conductors- zero resistivity, Meisener effect and thermal properties. Composites- meaning of composites, advanced composites, classification –particle rein forced, fiber reinforced and structural composites general characters of composite materials-Particle- reinforced composites – large particle and dispersion- strengthened composite. Fiber reinforced composites (continuous and discontinuous fiber composites).

TYPES AND APPLICATIONS OF CERAMICS**(6 Hrs)**

Classification of Ceramics based on their application- clay products, refractories, abrasives, cements, and advanced ceramics. Clay products: Structural clay products and the white wares. Refractories: Compositions of four Common Ceramic Refractory Materials, fireclay, silica, basic refractories eg. MgO and special refractories eg. Alumina and Zirconia Cements- Classification, preparation of cement and the setting process; quick setting cements; applications.

MODULE 2: POLYMER SCIENCE I**(12 Hrs)****INTRODUCTION TO POLYMERS****(4 Hrs)**

Classification of polymers based on structure, chemistry of polymerisation, addition polymerisation, copolymerisation, condensation polymerisation, coordination polymerisation, Ziegler-Natta catalyst, polymerisation mechanisms, degree of polymerisation, physical properties, weight average number average molecular weight, experimental determination.

PROPERTIES OF POLYMERS**(6 Hrs)**

Determination of crystalline melting point and degree of crystallinity. Factors affecting crystalline melting point. Structure - property relationship of polymers. Glass Transition temperature (T_g). Factors affecting glass transition temperature.

RUBBERS**(2 Hrs)**

Natural rubbers, draw backs of natural rubber, vulcanization, rubber compounding, foamed rubbers, gutta-percha rubber, properties and applications of synthetic rubbers- poly isoprene, poly buta- diene, poly styrene butadiene, neo prene rubbers, nitrile rubbers, poly sulphide rubbers.

MODULE 3: POLYMER SCIENCE II (11 Hrs)**PLASTICS** (3 Hrs)

Thermosetting and thermoplastics. Thermoplastics: poly olefins, poly styrene, PVC, teflon, their preparation, structure and applications. Thermosetting plastics: phenolic resins, amino resins, poly ester resins, epoxy resins - preparation, structure and applications. Laminates and fabrication of plastics.

FIBERS (2 Hrs)

Natural and synthetic fibers, study of synthetic fibers- poly amides, poly esters, poly acrylates. Study of silicones, adhesives- types and properties. (2 Hrs)

Introduction to conducting polymers (2 examples) (2 Hrs)

BIODEGRADABLE POLYMERS (2 Hrs)

Introduction, biodegradation mechanism and properties for starch based polymers, poly esters, and water soluble polymers. Environmental impacts, applications of biodegradable polymers in agriculture, medicine and food & packaging industry. Biopolymers.

MODULE 4: NANO TECHNOLOGY (11 Hrs)

Nanotechnology: Introduction, types of crystalline nano materials, synthesis of nano materials- physical, chemical and biological methods (one method each).

Characterization of nano particles using electron microscope, tunnelling microscope and X-ray diffraction. (Elementary treatment only)

Properties of nano materials-structure of nano materials, mechanical, electrical conductivity, optical, melting point, luminescence, magnetic properties

Special nano materials- fullerenes, carbon nano tubes, porous silicon, zeolites, aerogels, self assembled nano particle, their preparation and structure.

Applications-- Electronics, energy, automobiles, fuel cells, home appliances, Nanolithography, defence, medicine, nanotechnology and environment.

Text Books:

1. Dr Mudvath Ravi, Gopu Srinivas, Putta Venkat Reddy, Vuradi Ravi Kumar, Battini Ushaiah. A Text Book On 'Materials And Their Applications', First Edition.
2. William D. Callister, Jr. John Wiley & Sons Materials Science And Engineering An Introduction.
3. Kakani And Kakani Material Science New Age International Pvt. Ltd, 2004
4. Gurdeep R. Chatwal Chemistry And Industry.
5. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International, 1986.
6. Vermani.O.P. Narula.A.K.(2004),Industrial Chemistry, New Delhi, Galgotia Publications Pvt Ltd.
7. Gopalan.R, Venkappayya & Nagarajan.S, (2005), Textbook Of Engineering Chemistry (3rd Edition)New Delhi,Vikas Publishing House Pvt. Ltd.
8. Jain And Jain , Engineering Chemistry Dhanpat Raj Publishing Company
9. Kulkarni. K.S, (2011), Nanotechnology- Principles & Practises Co-Published By Springer International Publishing Company, Switzerland, New Delhi, Capital Publishing Company.
10. Poole Jr. C.P & Owens. J.F (Copy Right, Reprint, 2006). Introduction To Nanotechnology, New Delhi, Wiley India(P) Ltd.

Reference Books:

1. M. V. Gandhi And B. S. Thompson, —Smart Materials And Structures, Chapman And Hall, London, First Edition, 1992.
2. <https://www.electrical4u.com/properties-of-superconductors/>
3. Consultants And Engineers Niir Board, (2006),The Complete Book On Biodegradable Plastics & Polymers, New Delhi,Asia Pacific Business Press.
4. T. Pradeep Nano: The Essentials , Mcgraw-Hill Education.
5. Cnr Rao Et.Al. Chemistry Of Nanomaterials: Synthesis, Properties And Applications
6. Gurdeep R. Chatwal Chemistry And Industry
7. <https://www.electrical4u.com/properties-of-superconductors/>
8. Poole Jr.C.P &Owens.J.F(Copy Right,Reprint,2006).Introduction To Nanotechnology,New Delhi,Wiley India(P) L

MATERIAL SCIENCE
MODEL QUESTION PAPER
THEORY

Course Code: U20/CHE/DSE/603

Max. Marks: 60

Credits: 3

Max Time: 2 Hrs

SECTION - A

I. Answer the following **4 x 10 = 40 M**

1. Explain Superconductivity and give the characteristic properties of Superconductors?
(CO1) 10M

OR

2. What are composite materials? Discuss briefly about Fiber reinforced and particle reinforced composites. (CO1) 10M
3. Outline the mechanism of free-radical addition polymerization and Co-ordination polymerization. (CO2) 10M

OR

4. a) What is Glass Transition temperature (T_g). Explain the factors affecting glass transition temperature.(CO2) 5M
b) Write the preparation, properties and applications of poly isoprene and poly styrene butadiene rubbers.(CO2) 5M
5. a) Differentiate between thermoplastics and thermosetting plastics giving suitable examples.(CO3) 5M
b) Write the applications of Bio-degradable polymers. (CO4) 5M

OR

6. Write about the preparation, structure and applications of
i) Nylon-6, 6 ii) PVC iii) Phenol resins (CO3) 10M
7. a) Give two methods for synthesis of Nanoparticles. (CO1) 5M
b) Write a note on carbon nanotubes and fullerenes (CO5) 5M

OR

8. a) Emphasize the importance of Nanolithography (CO5) 5M
b) Explain the principle and working of STM. (CO1) 5M

SECTION - B**II. Answer any FOUR.****4 x 5 = 20 M**

9. Explain Setting and Hardening of cement. (CO1)
10. Vulcanization incorporates desirable properties. Justify (CO2)
11. List out the advantages of using Zeigler-Natta catalyst with mechanism. (CO3)
12. Evaluate the impact of polymers on Environment. (CO4)
13. What is porous silicon and how are they prepared? (CO1)
14. Give any four applications of Nanomaterials. (CO5)