MATERIAL SCIENCE FOR CHEMICAL ENGINEERS

(Professional Elective-I)

Course Code : 15CH1113

L	T	P	C
3	0	0	3

Course Outcomes:

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

CO 1 Identify various crystal systems.

CO 2 Calculate parameters for simple crystal structures predict the behavior of crystal systems due to imperfections.

CO 3 Predict the properties of simple alloys and steels based on their phase diagrams, phase transitions and heat treatment.

CO 4 Describe the mechanical behavior, failure and strengthening mechanisms of various metals, alloys and plastics.

CO 5 Identify various types of corrosion, illustrate methods to mitigate corrosion and select suitable material for various chemical processes

UNIT-I (10 Lectures)

INTRODUCTION AND CRYSTAL GEOMETRY:

Classification of Engineering Materials – Fundamental Blocks of Matter. A brief review on Atomic (micro) Structure and Atomic Bonding- Energy of the Atomic system . Ionization potential, Electron

Affinity- Ionic radii and Equilibrium Distance, Bond Length, $\triangle$HCrystal, $\triangle$HLattice , Ionic , Covalent and metallic Bonding , Secondary bonding-Property relation to Bond characteristics. Space lattice, Unit cell- Primitive cell, Double Cell, Triple Cell, Multiple

Cell- Crystal and Crystalline Substance, Amorphous Material-Bravais lattices, Crystal systems and their characteristics with suitable examples. Lattice points –Lattice Co-ordinates, Miller indices for directions and planes, Miller-Bravais indices, Linear and Planer Densities, Slip Directions and slip Planes , Packing efficiencies and fractions Close Packed Structures(CPS) , C/A ratio for HCP Structures

UNIT-II (10 Lectures)

CRYSTAL STRUCTURE DETERMINATION AND CRYSTAL DEFECTS:

Bragg's law of X-Ray Diffraction and determination of Cubic Crystal structure, Lattice Constant and identification of metals using powder method, problems relating to these topics. What is a crystal defect and how does it arise in Crystal point (Zero dimensional and one dimensional defect) Types of point Defect, configurational Entropy, Determination of defect concentration , expression for one and two –dimensional defect concentration , Significance of point defects in the determination of properties of materials- Dislocations, Line defects-Edge and Screw Dislocations, Burgers Vector, Burgers Circuit , Dislocation motion – Dislocation reactions– Role of Dislocations on the properties of materials , dislocation density- surface defects, dislocation Energy , stress required to move a dislocation , multiplication of dislocation – Frank read source and mechanism of dislocations.

UNIT-III (10 Lectures)

BASIC THERMODYNAMIC FUNCTIONS :

Free Energy of Transformation – Criteria for transformation – Nucleation and Growth – Homogeneous and Heterogeneous nucleation and their applications. Solid Solutions- Polymorphs – Types of Solid Solutions – Temp – Time – Cooling curves for different systems – Solid – Solid phase equilibrium – Tie Line, Lever Rule and its application. Phase Rule, Phase Changes and its application to Thermal Equilibrium diagrams or Phase Diagrams of Unary System, - Binary Systems – Eutectic Eutectoid alloys – Cu-Ni, Bi-Cd, Pb-Sn, Fe-Fe3C systems. Phase transformations in steels – Modifications in structure of Steel by Heat Treatment – Time – Temperature –

Transformation Curves for Eutectoid Steel – Classification of Steels and Cast Irons – Types and their properties. Alloys of Steel and their uses in Chemical Industry.

UNIT-IV **(10 Lectures)**

Mechanical behavior of metals and alloys- Elastic, Plastic and anelastic behavior of materials. Viscoelastic materials, behavior of polymers and plastics. Critical Resolved Shear strength, Schmidt's Law and prediction of Tensile Strength of materials, Strengthening mechanisms – Work Hardening or Strain Hardening, Alloying – Cold and Hot working – Recovery and Recrystallization, Grain Growth, Grain Size and Yield Strength, Age hardening of Aluminum alloys – Al-Cu system. Composite Materials and their mechanical behavior, expressions for Tensile Strength and strains in Composite Materials – Fracture of Materials Ductile, Brittle, Creep and Fatigue fractures – Simple Problems related to these topics.

UNIT-V **(10 Lectures)**

Corrosion- Materials in the service of Chemical and Marine Environments – Basics of corrosion , Corrosion reactions and Mechanisms of Corrosion – Eight forms of Corrosion- Uniform Corrosion , Galvanic , Differential Aeration Corrosion , Stress corrosion Cracking, Intergranular Corrosion, Localized Corrosion and Fatigue Corrosion . Corrosion of Stainless steel- Oxidation, Tarnishing, behaviour of non-ferrous materials used in Chemical Industry – Effect of environmental factors on corrosion. Corrosion Prevention , Pilling – Bedworth ratios Conventional methods – Estimation of Corrosion rates, different Corrosion rate expressions, Remedial measures for Galvanic, Stress Corrosion Cracking , Intergranular and Pitting Corrosion , Anodic and Cathodic protection techniques, Conventional methods on organic and Inorganic coatings, Electroplating , Alloying – Cladding- Design Procedures of chemical equipment and structure to mitigate or completely prevent corrosion in Chemical Plants.

TEXT BOOKS:

1. Raghavan V., *"Materials Science and Engineering: A first course"*, 5th Edition, Prentice Hall of India Pvt.Ltd., 2009.
2. Fontana M.G., *"Corrosion Engineering"*, 3rd Edition, Tata McGraw Hill, 2005.

REFERENCES:

1. Manas chanda, *"Science of Engineering Materials Vol. 1 & 2"*, McMillan Company of India Ltd. 1981.
2. Van Vlack, L.H, *"Elements of Materials Science and Engineering"*, 6th Edition, Pearson Educational India, 2008.

NANO TECHNOLOGY
(Professional Elective-1)

Course Code: 15CH1114

L	T	P	C
3	0	0	3

Course Outcomes:

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

CO 1 Define and classify the various nanomaterials.

CO 2 State the applications of nanomaterials

CO 3 Select different techniques in practice for analyzing the nanomaterials.

CO 4 Discuss the different synthesis methods for producing the nanomaterials.

CO 5 Revise the properties and their importance in applications.

UNIT-I (10 Lectures)

Introduction to Nano Technology, Carbon NanoTubes (CNTs), Porous Silicon, Aerogels, Zeolites, Ordered Porous Materials Using Micelles as Templates, Self Assembled Nanomaterials, Core- Shell Particles.

APPLICATIONS:

Electronics, Energy, Automobiles, Sports and Toys, Textiles, Cosmetics, Domestic Appliances, Biotechnology and Medical Fields, Space and Defense, Nanotechnology and Environment.

UNIT-II (10 Lectures)

STRUCTURE AND BONDING:

Arrangement of Atoms, Two Dimensional Crystal Structures, Three Dimensional Crystal structures, Some Examples of Three Dimensional Crystals, Planes in the Crystals, Crystallographic Directions, Reciprocal Lattice, Quasi Crystals, Bonding in Solids.