MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSH 403: **ELEMENTS OF MATERIALS SCIENCE – I** (4 Credits)

Objectives: The course helps to understand the relationship between different types of crystal structures with the properties of materials. The physical properties of condensed matter is intimately related to their electronic structure and crystal structure. It serves as a foundation for understanding the structure-property correlation in materials.

Expected course outcomes: On completion of this course, it is expected that a student understands why materials behave the way they do. It equips them with all the basics required for a deeper understanding of the properties of metals, semiconductors and insulators which will be dealt with separately in the other courses offered in subsequent semesters.

Unit I

Formation and Structure of Materials: Condensed state of matter-crystalline and amorphous states. Ionic, covalent, metallic and molecular bindings-Bond angle, bond length and bond energy. Hybridisation - Delocalised chemical bonding. Lattice energy - Madelung constant. Inert gas crystals - van der Waals interaction - Lennard Jones' potential. Simple crystal structures - Sodium Chloride, Cesium Chloride, Diamond and Zinc sulphide structures. Close packed structures - packing efficiency and density of materials.
18 hours

Unit II

Crystal Geometry and Structure Analysis - Crystal morphology - symmetry elements - Crystal systems. Point group symmetry - derivation of point groups. space groups and Bravais lattices. Crystal planes and directions - miller indices - interplanar separations. Structure analysis by X-rays - Atomic scattering factor. Laue conditions for diffraction and Bragg's law - Geometrical structure factor - systematic absences. Reciprocal lattices - of cubic systems - Ewald's construction. Laue, Rotation and Powder methods of X-ray analysis.
18 hours

Unit III

Conductors, Resistors and Semiconductors – Types of metals - The resistivity range - free electron theory of metals - heat capacity and paramagnetism of metals - electrical and thermal conductivity of metals - Wiedemann -Franz law. Applications of conductors and resistors. Energy gap in solids - band theory of solids - effective mass and holes. Intrinsic and extrinsic semiconductor materials - carrier density . Hall effect and mobility. Simple semiconductor devices - photoconductors, IR detectors, Magnetometers, thermoelectric generators, thermistors, strain gauges.
18 hours

References

1. Elements of Materials science and Engineering – Lawrence H van Vlack (Addision Wesley,1975)

2. Materials Science and Engineering – V Raghavan (Prentice Hall India, 1993)

3. The Structure and Properties of Materials-Vol.I-IV -Rose, Shepard and Wulff (Wiley easterrn, 1987)

4. The Nature of Chemical Bond – L Pauling (Oxford & IBH, 1960)
5. Introduction to solids – L V Azaroff (McGraw Hill, 1960)
6. X-Ray Crystallography – M J Buerger (John Wiley, 1942)
7. Introduction to Solids – A J Dekker (McMillan India, 1981)
8. Solid State physics – R L Singhal (Kedarnath Ramnath, 1988)
9. Semiconductor Devices – James Brophy (McGraw Hill, 1964)
10. Electronic Processes in Materials – L V Azaroff and J.J. Brophy (McGraw Hill, 1963)
11. Materials Science and Technology – A comprehensive treatment – R W Cahn, P Haasen & E J Kramer - Electronic and Magnetic properties of metals and ceramics, Vol. -3A & -3B (VCH Weinheim, 1992 & 1994)