Vis-NIR spectroscopy, Photoluminiscence, IR spectroscopy, Raman spectroscopy. Zeta potential measurements. Micro SQUID Magnetometry. 14 hours

References:

1.The Science and Engineering of Microelectronic Fabrication – S A Campbell (Oxford, 1996)
2. Nanoscale Materials - (Ed) L M Liz Marzan and P V Kamat, (Kluwer, 2003)
3. Nanostructured Materials and Nanotechnology (Ed) – H S Nalwa (Academic, 2002)
4. Colloidal and Surface Chemistry - M Satake, Y Hayashi, Y Mido, S A Iqbal, M S Sethi (Discovery, 1996)
5. Colloid Chemistry – S Voyutsky (MIR, 1978)
6. Introduction to Nanotechnology – C P Poole and F J Owens (Wiley- Intersci., 2006)
7. Nanotechnology and Nanoelectronics – W R Fahrner (ed) (Springer, 2006)
8. Quantum Dots – L Jacak, P Hawrylak, A Wojs, (Springer, 1997)
9. Physics of Low Dimensional Structures – J H Davis, (Cambridge, 1998)
10. Sol-Gel Science – Scherrer and Brinker (Academic Press, 1990)

MSE 459: SCIENCE OF MATERIALS IN DAILY LIFE (open elctive-1) (3 Credits)

Objectives: Objectives of this course is to (i) provide elementary idea about materials science to the interested students in the open elective system. (ii) introduce different properties and applications of metals, semiconductors, polymers, composites and ceramics. (iii) teach the relevance of these materials in technologically important applications.

Expected course outcomes: By the end of the course, students will be able to (i) distinguish the different classes of materials used in daily life. (ii) explain the nature of bonding in different materials and their properties. (iii) explain how manufacturing processes can bestow materials with different/desirable properties.

Unit I

Conductors: metals, alloys, semiconductors- Definition, elementary ideas of electrical properties, optical properties, mechanical properties, thermal properties. Specific examples of metals- copper, aluminium, iron, gold, silver. Uses of metals. Drawbacks of metals. Alloys- advantages of alloying-brass, bronze, steel, stainless steel, gold alloys, silver alloys and their uses.

Semiconductors: Elemental semiconductors- silicon, germanium. Doping- n-type and p-type semiconductors, p-n junctions, I-V characteristics- diode equation. Qualitative ideas of devices- diodes to ICs. Compound semiconductors. 14 hours

Unit II

Polymers and composites: Plastics- Introduction. Types of plastics. Rubber- types of rubber. Vulcanization of rubber. Thermoplastics and thermosets. Fibres- different types of natural and synthetic fibres – cellulose acetate fibres. Resins, adhesives and polymer coatings. Physical, chemical, mechanical properties and applications of polymers. Recycling of polymers.

Composites- introduction, types. Wood, concrete, FRP and some advanced composites. Properties and applications. 14 hours

Unit III

Ceramics- Introduction, classification, raw materials, fabrication methods, properties and applications. Types of ceramics- oxide and non-oxide ceramics. Allotropes of carbon- graphite, diamond and fullerene – structure dependent properties. Primary refractory materials.

Glasses- introduction, raw materials, manufacture of glass, properties and applications. Types of glasses, properties and applications. Photochromic and photosensitive glasses. 14 hours

References:

1. The Physics of Materials: How Science Improves Our Lives, Solid State Sciences Committee, (National Research Council, 1997)
2. The Science of World Around Us, Solid State Sciences Committee, (National Research Council, 2007)
3. Materials Science and Engineering – V Raghavan (Prentice Hall India, 1993)
4. Introduction to Solids – A J Dekker (McMillan India, 1981)
5. Plastics-How Structure Determines Properties – G Gruenwald (Hanser)
6. Understanding Materials Science – R E Hummel (II Ed.) (Springer, 1993)
7. Materials Science – Nagpal (Khanna, 1983)
8. Polymer Science – V R Gowarikar, N V Viswanath, Jayadev Sridhar (Wiley Eastern, 1987)
9. Composite Materials Engineering & Science – F L Mathews & R D Rawlings (Chapman & Hall, 1990)
10. Introduction to Ceramics – W D Kingery, H K Bower and U R Uhlman (John Wiley, 1960)
11. Glasses and Vitreous State – J Zarzycki (Cambridge University Press, 1982)

III SEMESTER

MSH 501 DIELECTRIC MATERIALS (4 Credits)

Objectives: The objectives of this course are to (i) introduce the students to a class of important insulating materials, viz: dielectrics, (ii) explain the physics behind dielectric behaviour of insulating materials. (iii) classify dielectric materials and their applications. (iv) discuss the optical properties of the dielectrics including colour of crystals, excitons. (vi) study the thermal properties of dielectrics including the concept of heat transport, phonons and the influence of elastic properties on thermal behaviour.

Expected course outcomes: At the end of the course, students will be able to (i) distinguish between dielectric materials and other insulators. (ii) recognize how these differences will be attributed to specific applications (iii) summarize the understanding of lattice dynamics.(iv) develop dielectric materials for energy applications

Unit I

Dielectric polarisation and atomic forces - electronic polarisation. Dielectric law and the generalisation. Atomic or ionic polarisation, orientational polarisability. Static dielectric constant of materials. Determination of dielectric constants. Lorentz internal field. Clausius-Mosotti relation. Polarisation catastrophe. electromechanical coupling - dielectric breakdown - electric energy stored in dielectrics. General