MANGALORE UNIVERSITY

TWO YEAR M.Sc. DEGREE PROGRAMME IN MATERIALS SCIENCE

(CHOICE BASED CREDIT SYSTEM)

COURSES AND SYLLABUS

I SEMESTER

Course code	**Title**	Credits
MS 401	Elements of Materials Science – I	4
MS 402	Mathematical Methods and Statistical Physics`	4
MS 403	Electromagnetic Theory and Electronics	4
MS 404	Thermodynamics and Chemistry of Metals	4
MS 405	Materials Science Lab. – I	4
MS 406	Materials Science Lab. – II	4
MS 407	Seminar	1
Total credits		25

II SEMESTER

Course code	**Title**	Credits
MS 451	Elements of Materials Science – II	4
MS 452	Materials Testing and Characterization	4
MS 453	Introduction to Quantum Mechanics	4
MS 454	Surface Phenomena and Electrochemistry	4
MS 455	Materials Science Lab. – III	4
MS 456	Materials Science Lab. – IV	4
MS 457	Seminar	1
Total credits		25

III SEMESTER

Course code	Title	Credits
MS 501	Choice Based Course Science of Materials in Daily Life	4
MS 502	Dielectric Materials	4
MS 503	Electronic and Engineering Materials – I	4
MS 504	Two Dimensional Materials	4
MS 505	Polymer Science	4
MS 506	Materials Science Lab. - V	4
Total credits		24

IV SEMESTER

Course code	Title	Credits
MS 551	Magnetic Materials and magnetic Resonance	4
MS 552	Electronic and Engineering Materials - II	4
MS 553	New Materials and Technologies	4
MS 554	Composite Materials	4
MS 555	Materials Science Lab. - VI	4
MS 556	Materials Science Lab. - VII	4
MS 557	Mini Project	2
Total credits		26

MS 401 ELEMENTS OF MATERIALS SCIENCE – I (4 Credits)

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)

MS 402 MATHEMATICAL METHODS AND STATISTICAL PHYSICS

(4 Credits)

Unit I

Complex Variables: Analytic functions. Series expansion - Laurent's Theorem. Residue Theorem and evaluation of simple contour integrals. Evaluation of Improper integrals and Integrals involving trigonometric functions by the method of residues.

Group Theory: Basic concepts - multiplication tables - subgroups - direct product. Properties of groups. Representations of finite group - reducible and irreducible representations and example of $C4_v$ group. 18 hours

Unit II

Matrices: Matrices as operators. Symmetric, Orthogonal, Hermitian and Unitary matrices. Eigen values and eigen vectors of a matrix. Simiarity, Orthogonal, Unitary and Congruent transformations. Diagonalisation of a real symmetric matrix.

General Curvilinear Co-ordinates: Expressions for line, surface and volume elements in general curvilinear co-ordinates. Gradient, Curl, Divergence and Laplacian - Orthogonal curvilinear co-ordinates.

Tensors: Definition - Contravariant, Covariant and Mixed tensors.Sum, inner and outer products - Contraction - Quotient law. The line element and the metric tensor. Length of a vector. Raising and lowering of indices. Christoffel symbols and covariant differentiation of tensor. Stress and strain tensors.

18 hours

Unit III

Statistical Mechanics: Phase space - Ensembles - Thermodynamic probability - Maxwell - Boltzmann distribution - Partition functions - translational, vibrational and rotational partition functions - applications to specific heats.

Quantum Statistics: Inadequacy of classical statistics - spectra of black - body radiation. Indistinguishability of identical particles. Bosons and Fermions - Bose - Einstein statistics - black - body radiation and Bose condensation. Fermi - Dirac Statistics-degenerate electron gas. 18 hours

References:

1. Mathematical Methods for Physicists – G Arfken (Academic Press,1968)
2. Elements of Group Theory for Physicists – A W Joshi (Wiley Eastern, 1975)
3. Symmetry Groups and their applications – W.Miller
4. Mathematics of Physics and Chemistry – H Margenau and G M Murphy (Affiliated East West Press,1966)
5. Matrices and Tensors in Physics – A W Joshi (Wiley Eastern,1975)
6. Tensor Analysis – I S Sokolnikoff (John Wiley, 1974)
7. Statistical Physics – L D Landau and E M Lifshitz (Pergamon,1968)
8. Statistical Mechanics and Properties of Matter – E S R Gopal (McMillan India, 1976)
9. Statistical Physics: Berkeley Physics(5) – F Reif (McGraw Hill,1967)
10. The Feynman Lectures on Physics – R P Feynman, R B Leighton and M Sands (Addison Wesley/Narosa,1986)

MS 403 ELECTROMAGNETIC THEORY AND ELECTRONICS (4 Credits)

Unit I

Electromagnetic Theory: Maxwell's equations and material equations - the wave equations and velocity of light - Boundary conditions at a surface of discontinuity - Fresnel's laws of reflection and refractions - Fresnel's rhomb. Standing waves-Wiener's experiments - Lippman's colour photography.

Propagation of light in a medium: Dispersion in dielectric – Sellmeir's formula - propagation in metal - Hagen formula. Propagation in crystals - wave vector surface - ray theory - ray velocity - double refraction - optical activity - Faraday rotation.

18 hours

Unit II

Electronics: Active and passive components - Diodes, transistors, SCR, FET. Resistors - carbon resistors, wire wound resistors, IC resistors - thick and thin film resistors. Capacitors - Tantalum, electrolytic, oxide capacitors, junction capacitors, IC capacitors - thick and thin film capacitors. Inductors. Power supplies - Rectification and filter action - Types of voltage regulators, shunt and series regulators using transistors. Applications - SMPS, 3 pin IC regulators, voltage stabilizers (servo, CVT). Amplifiers: Types of transistor amplifiers - small signal amplifiers-design calculation, power amplifiers. Oscillators: Feed back concepts - negative and positive. Phase shift oscillators, crystal oscillators, LC oscillators - Hartly and Colpitt's oscillators. 18 hours

Unit III

Wave shaping circuits: Different types of waveforms. Integrating and differentiating circuits. Clipping circuits - diode clipper- positive and negative clippers, biased clippers - double diode clipper. Clamping circuits - positive and negative clamping, partial clamping. Multivibrators: Astable, bistable, and monostable multivibrators. Schmitt trigger.

Operational Amplifiers: Introduction - Characteristics. Applications - inverting, non-inverting, difference, and summing amplifier. Differentiation and integration circuits using opamp. 18 hours

References

1. Introduction to Modern Optics – G R Fowles (Rinehart & Winstar Inc., 1968)
2. Optics – A N Mateev (MIR, 1988)
3. Optics – Ajoy Ghatak (Tata McGraw-Hill, 1995)
4. Electromagnetics – J D Krans (McGraw Hill, 1987)
5. Semiconductor Devices – J Brophy (George Allen, 1964)
6. Solid State Electronic Devices – Ben G Streetman (Prentice-Hall, 1995)
7. Electronic Devices and Circuits – A Mottershead (Prentice-Hall, 1991)
8. Integrated Electronics – Millman and Halkias (McGraw Hill, 1995)
9. Digital Principles and Applications – A P Malvino and Lach (McGraw-Hill, 1986)
10. Microprocessors:Principles and applications – C M Gilmore (McGraw-Hill, 1995)
11. Introduction to microprocessors – A P Mathur (Tata McGraw-Hill, 1995)

MS 404 THERMODYNAMICS AND CHEMISTRY OF METALS (4 Credits)

Unit 1

Thermodynamics: Basic concepts - Thermodynamic equilibrium, thermodynamic reversibility. Laws of thermodynamics - Zeroth law, First law - Internal energy, heat, work in various systems, heat capacities, enthalpy, flow processes, second law - Carnot theorem, Clausius inequality, entropy calculations for various processes, T-S diagram, engineering applications. Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behavior of simple compressible substances ideal and real gases, equation of state, compressibility factor. Free energy functions and thermodynamic potentials - Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equations. General conditions for equilibrium, thermodynamic potential functions-Maxwell relations. Applications: Tds equations, energy and heat capacity equations, Joule-Thomson coefficient, compressibilities and expansion coefficient. Phase transitions: Condition for equilibrium between phases, first, second, third and higher order phase changes with specific examples interpretations, Claperon and Clausius Claperon equation. specific heat and latent heat anomalies.

18 hours

Unit II

Phase rule-Introduction, cooling curves, phase diagrams of binary alloy systems-Mixtures, Solidsolution,Compound, Eutectic, peritectic and eutectoid reactions,Microstructural changes during cooling, Lever rule, Typical systems-Ag-Pb, Cu-Ni., Pb-Sn, Iron- Carbon, Ag-Pt, Cu-Zn, TTT and CCT diagrams, Martensitic transformation. Free energy-composition diagrams, Ternary alloy systems.

Phase transformation-Free energy changes, Nucleation and grain growth, kinetics Application - Transformation in steel, Precipitation process, solidification and crystallization, glass transition.

18 hours

Unit III

Metals-Coordinate bond and metal complexes, Valence bond theory- Formation of octahedral complex-outer and inner orbital complex-Formation of tetrahedral and square planar complexes – Limitation of valence bond theory Crystal field theory – important features-crystal field splitting of d-orbitals in octahedral, tetrahedral, and square planar complexes applications of CFT-Distortion of octrahedral complex and Jahn – Teller theorem- Crystal field stabilisation energy and its uses – Limitations of CFT. Molecular orbital theory – comparison of different theories.

Theoretical principles of extraction of Metals – Ellingham diagram. Extraction of Iron, Preparation of steel, Effect of alloying elements. Heat treatment Processes – Annealing, Normalising, Hardening, Quenching, Tempering- Heat treatment of steel.

18 hours

References

1. Heat and thermodynamics – Mark W. Zemansky, (McGraw-Hill, 1968)
2. Thermodynamics of solids – Richard A Swalin, (John Wiley & Sons. 1972)
3. Equilibrium thermodynamics – C J Adkins (Cambridge University press, 1983)

4. Solid state phase transformation – V Raghavan (Prentice Hall, 1992)
5. Principles of Materials Science & Engineering – W F Smith (McGraw Hill,1988)
6. Chemistry in Engineering and Technology (Vol 1&2;) – J C Kuriacose and J. Rajaram (Mcgraw Hill, 1988)
7. Materials Science and Engineering – V Raghavan (Printice Hall,1995)
8. An introduction to Metallurgy – A H Cottrell (Edward Arnold,1971)
9. Materials Science and Processes – B S Narang (CBS, 1983)
10. Advanced physical chemistry – Gurdeep Raj (Goel, 1992)
11. Inorganic chemistry – Mallik, Tuli and Madan (S Chand & Co,1990)
12. Chemistry of Transition elements – Atkin & Holiday (Oxford 1985)
13. Text book of Materials Science and Metallurgy – O P Khanna (Dhanpat Rai & Sons 1984)
14. Physical Metallurgy – V Raghavan (Printice Hall,1989)
15. Engineering Chemistry – Jain & Jain (Dhanpat Rai & Sons,1993)
16. Elements of Materials Science – L H Van Vlack (Addison-Wesley, 1989)
17. Phase Rule – Gurdeep Raj (Goel pub., 1991)

MS 405 MATERIALS SCIENCE LAB.- I (4 Credits)

1. Thermistor Thermometer
2. Energy Gap of a Semiconductor - Four Probe Method
3. Hall Effect
4. SCR Characteristics
5. Full Wave Rectifier and Regulated Power Supply
6. R.C.Coupled Amplifier
7. R.C. Coupled Phase Shift Oscillator
8. Operational Amplifier
9. Verification of Fresnel's Laws
10. Diffraction using He-Ne laser

MS 406 MATERIALS SCIENCE LAB.- II (4 Credits)

1. Birefringence of Mica
2. Determination of Heat of Solution
3 Phase Diagram of Two Component System
4. Phase diagram of Three component system
5. Analysis of Bronze
6. Thermal Conductivity of a Metal Bar
7. Thermal Conductivity of Insulators
8. Thermal Conductivity of Amorphous Solids
9. Analysis of Brass

MS 451 ELEMENTS OF MATERIALS SCIENCE – II (4 Credits)

Unit I

Crystal Imperfections: Point imperfections - configurational entropy - Schottky and Frenkel defects - equilibrium concentrations. Line imperfections - edge and screw dislocations - Buerger's vector in cubic crystals. Surface imperfections - grain boundary - tilt and twin boundaries.

Diffusion in solids: Fich's laws of diffusion - solutions to Fich's second law - Gaussian and error function solutions. Determination of diffusion coefficient - diffusion couple. Applications based on second law. Atomic model of diffusion - other diffusion processes - electrical conductivity of ionic crystals.

18 hours

Unit II

Elastic Behaviour of Materials: Atomic model of elastic behaviour - the modules as a parameter in design - rubber like elasticity - Anelastic behaviour - Viscoelastic behaviour. Fracture of materials - ductile and brittle fracture. Ductile-brittle transition. Protection against fracture.

Analysis of strain tensor of an elastic medium - Navier's conditions of equilibrium. Symmetric stress tensor – generalized Hooke's law – elastic constants of an isotropic homogeneous media - equations of motion - elastic waves - velocity of longitudinal and transverse waves. 18 hours

Unit III

Plastic Deformation in Crystalline Materials: The tensile stress-strain curve - Plastic deformation by slip - the shear strength of perfect and real crystals - CRSS - the stress to move a dislocation. interactions between dislocations - multiplication of dislocations during deformation – Frank- Reed Source. Work hardening and dynamic recovery. Strengthening against plastic deformation – strain hardening – grain refinement – solid solution – precipitation strengthening.

Creep in Crystalline Materials - Mechanism of creep and creep resistant materials.

18 hours

References

1. Materials Science and Processes – S K Hajra Chaudhary
2. Elements of Materials science and Engineering – Lawrence H van Vlack (Addision Wesley, 1975)

3. Materials Science and Engineering – V Raghavan (Prentice Hall,1993)
4. Materials Science and Processes – B S Narang (CBS,1983)
5. Introduction to solids – L V Azaroff (McGraw Hill, 1960)
6. Introduction to Solid State Physics – C Kittel (II Ed. Asia publishing House, 1965)
7. The Structure and Properties of Materials-Vol.I-IV – Rose, Shepard and Wulff (Wiley Eastern,1987)
8. Physical Metallurgy – V Raghavan (Printice Hall, 1989)
9. Materials Science and Metallurgy – O P Khanna (Dhanpat Rai & Sons, 1984)
10. Solid State Physics Source Book – Sybil P Parker (McGraw Hill, 1987)
11. Materials Science and Technology – A comprehensive treatment – (ed.) R W Cahn, P Haasen & E J Kramer – Electronic and Magnetic properties of metals and ceramics, Vol – 3A & -3B (VCH, 1992 & 1994)

MS 452 MATERIALS TESTING AND CHARACTERIZATION (4 Credits)

Unit I

Fundamentals of Vacuum Techniques: Basic concepts of pumping: Ideal gas - pressure, density, mean free path. Regions of gas flow. Conductance of a pipework - fundamental equation of vacuum technology. Vacuum pumps: Operating limits of a pump. Rotary, Vapour diffusion, Turbomolecular and Cryogenic pumps - a brief survey of working principles. Vacuum measurement: Thermal conductivity gauges - Pirani and thermocouple gauges.Ionisation gauges-Hot and cold cathode ionisation gauges- working principle and operating limits. Vacuum materials. 18 hours

Unit II

Non- Destructive Testing of Materials : Ultrasonics: Principles - Ultrasonic receivers and oscillators - transducers, probes. Reference and calibration blocks. Identification and seizing of defects.

X-Ray Radiography: Principles -Factors affecting contrast and resolution.

Neutron Radiography: Neutron sources and detectors. Methods- Criteria for evaluating flaw detection by neutron radiography method. Factors limiting the contrast. Comparison of X-ray and neutron radiography methods.

Mechanical Testing of Materials: Tensile and Compression tests- Brittle and ductile failure- Universal Testing Machine. Hardness test - Indentation hardness- Brinell, Vicker and Rockwell hardness numbers. Impact test - Izode and Charpy tests. Fatigue test - A brief discussion. 18 hours

Unit III

Materials Characterisation - Electron Microscopy- Transmission Microscopy(TEM) - Principles, sample preparation. Kinamatic theory of contrast. Scanning Microscopy(SEM) - Principles, beam diameter, image contrast. Applications to microstructure determination.

Atomic and Molecular Spectroscopies: Atomic Absorption, Infra - Red, and Raman spectroscopies for the determination of impurities. Low Energy Electron Diffraction (LEED), X-ray Photoelectron Spectroscopy (XPS/ESCA) and Auger Electron Analysis - Principles and applications for surface studies. Electron Probe Micro analysis (EPMA) and Energy Dispersive Analysis of X-Rays (EDAX) - Principles and applications for compositional analysis. 18 hours

References

1. Fundamentals of Vacuum Techniques – A Pipco et al (MIR, 1984)
2. Ultrasonics – B Carlin (Mc Graw Hill, 1960)
3. Handbook on Ultrasonic Testing of Materials – Ramesh B Parikh (Electronic & Engineering Co., 1984)
4. Principles of Neutron Radiography – N D Tyufyakov and A S Shtan (Amerind, 1979)
5. Modern Metallographic Techniques and Their Applications – V A Phillips (Wiley Interscience, 1971)
6. Applied X-Rays – George L Clark (Mc Graw Hill, 1955)
7. Testing of Metallic Materials – A V K Suryanarayana (Prentice Hall India, 1990)
8. Physical Metallurgy Part 1 – R W Cahn and P Haasen (Ed) (North Holland, 1983)
9. Instrumental Methods in Chemical Analysis – G W Ewing (Mc Graw Hill, 1975)

MS 453 INTRODUCTION TO QUANTUM MECHANICS (4 Credits)

Unit I

Quantum Physics: Matter waves. Uncertainty principle. Interpretation of the wave particle dualism and complimentarity

Wave Equation and Operators: The Schroedinger equation - free particle in one and three dimensions - the operator correspondence and commutating relations. Normalization of wave functions and statistical interpretation - Box normalization the Dirac delta functions - expectation values - Ehrenfest's theorem. Stationary states - the time independent Schroedinger equation - particle in one dimensional square well potential, potential barriers - transmission and reflection coefficients. 18 hours

Unit II

Special Functions: Bessel functions of the first kind -derivation of the basic form-Recurrence relations - Fraunhofer diffraction and vibrations of bars and membranes. Legendre and Associated Legendre functions - Recurrence relations and differential equations. Legurre and Associated Legurre functions – differential equations. Hermite functions - Recurrence relations – differential equations. 18 hours

Unit III

Eigen values and Eigen functions; One dimensional simple harmonic oscillators - the angular momentum operator - the eigen value equation for the square of the angular momentum - orbital angular and magnetic quantum numbers - the hydrogen atom - solution of the radial equations - Rigid rotator – energy eigen values. 18 hours

References

1. Applied X-rays – G W Clark (McGraw Hill, 1955)
2. Quantum Mechanics – L I Schiff (McGraw Hill, 1968)
3. Qauntum Mechanics – Sokolov (Holt Rinehart and Winston Inc., 1966)
4. Quantum Mechanics – Mathews and Venkatesan (Tata McGraw Hill, 1981)
5. Quantum Mechanics – Powel and Craseman (Oxford & IBH, 1985)
6. Mathematical Methods for Physicists – G Arfken (Academic Press, 1968)

MS 454 SURFACE PHENOMENA AND ELECTROCHEMISTRY (4 Credits)

Unit I

Surface phenomena - Adsorption, characteristics of adsorption, classification of adsorbents, molecular interactions in adsorption, energetic and desorption, physical and chemical adsorption, adsorption isotherms (Freunlich, Langmuir, BET), determination of surface area of adsorbent, application of adsorption.

Catalysis: Characteristics of catalytic reaction, Classification of catalyst, Kinetics of homogeneous and heterogeneous catalytic reactions, Application of catalysis.

Solid-state chemical reactions: Introduction, Classification, and thermodynamics.

Chemical transport reaction in solid state Experimental methods to study solid state reactions, kinetic features, diffusion mechanism, factors affecting the reactivity of solid state reaction. 18 hours

Unit II

Electrochemistry - Electrolytic conduction- Debye Huckel theory of Interionic attraction-Debye Huckel Limiting Law- Energetics of electrochemical reactions-Electrode potential and EMF-Application of EMF measurements-Potentiometric titration-Electrochemical devices: Galvanic cells (primary and secondary)-concentration cells and fuel cells, polarisation, over voltage, decomposition potential and electrodeposition techniques. 18 hours

Unit III

Corrosion - Introduction and importance of corrosion studies-Theories of corrosion-factors influencing corrosion-Forms of corrosion, Corrosion control measures through Paints, metal coatings, anodic and cathodic protection, Polarization studies-corrosion rate measurement, Tafel extrapolation, passivity, analysis of corrosion failure.

18 hours

References

1. Principles of Material science and Engineering – William.F Smith (McGraw Hill, 1988)
2. Material science and Engineering – V.Raghavan (Printice Hall, 1998)
3. An introduction to Metallic Corrosion and its prevention – Raj Narayan (Oxferd and IBH, 1983)
4. Introduction to Electrochemistry – S Glasstone (East West, 1942)
5. Advanced Physical Chemistry – Gurudeep Raj (Goel, 1992)
6. Solid state Chemistry – Hannay (Printice Hall, 1967)
7. Text Book of Material science and Metallurgy – O P Khanna (Dhanpat Rai & Sons, 1984)
8. Engineering Chemistry – Jain & Jain (Dhanpat Rai and Sons, 1993)
9. Solid state Chemistry – Ram Prakash (Radha Publications, 1989)
10. Adsorption – J Oseik (Chichester: Ellis Horwood, 1982)

MS 455 MATERIALS SCIENCE LAB. – III (4 Credits)

1. Energy band gap in p-n junctions
2. Young's modulus of glass
3. Activation energy of point defects
4. Creep in materials
5. Strain gauge measurement of Young's modulus
6. Refractive index of liquids using He-Ne laser
7. Electrical conductivity of amorphous solids
8. Estimation of Cr and Ni in stainless steel by spectrophotometry
9. Study of temperature dependence of Hall coefficient

MS 456 MATERIALS SCIENCE LAB. – IV (4 Credits)

1. Conductivity of ionic salts
2. Poisson's ratio of rubber
3. Diffraction from powder particles- diameter of lycopodium powder
4. Corrosion studies
5. Conductometric titration
6. Determination of molar absorption coefficient
7. pH measurement
8. Potentiometric titration
9. Youngs modulus of polymer
10. Adsorption studies

MS 501 CHOICE BASED COURSE (Syllabus given at the end)

MS 502 DIELECTRIC MATERIALS (4 Credits)

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. Lorentz internal field. Clausius-Mosotti relation. Polarisation catastrophe. electromechanical coupling - dielectric breakdown - electric energy stored in dielectrics. general applications of dielectric materials. The complex dielectric constant, dielectric losses and relaxation time - Debye equations - theory of electronic polarisation and optical absorption. Optical Phenomena in Insulators Colour of crystals - Excitons - weakly bound and tightly bound excitons. Colour centers – F-centers and other electronic centers in alkali halides. 18 hours

Unit II

Ferroelectrics: General characteristics - piezoelectric, pyroelectric and ferroelectric materials - transducer and detector applications. Classification of ferroelectrics and representative materials. Structure of KDP and explanation for its ferroelectric behaviour. Barium titanate and its ferroelectric behaviour. Crystal structure and theory of spontaneous polarisation in barium titanate. Zeroes and poles of the dielectric function – Lyddone-Sachs-Teller relation. Ferroelectric domains. Thermodynamics of ferroelectric phase transitions. Remarks on antiferroelectric materials - Materials with paired properties like ferroelectric-ferroelastic, ferroelectric-ferromagnetic etc. 18 hours

Unit III

Thermal Properties of Insulators: Heat capacity - Einstein's model - quantisation of lattice vibration - continuum model - Debye's theory. Vibrations of monoatomic lattice - specific heat of one dimensional lattice of identical atoms. Phonon spectra of diatomic lattice and phonon modes - optical properties in infra-red region and their applications. Scattering of electromagnetic waves and neutrons by phonons. Thermal conductivity of insulators - lattice thermal resistivity - Umklapp process. Thermal expansion: Potential wells in crystal binding - anharmonic interactions and thermal expansion of insulators. 18 hours

Reference

1. Introduction to Properties of Materials – D Rosenthal and R M Asimov (East West, 1974)
2. Elements of Materials Science and Engineering – L H van Vlack (Addison Wesley, 1975)
3. Introduction to Solid State physics – C Kittel (II & IV Ed. Wiley & sons, 1961 & 1964)
4. Solid State Physics – A J Dekker (McMillan, 1971)
5. Advances in Solid State Physics, Vol.II & V – Seitz and Turnbull (Ed) (Academic, 1957)
6. Physics of Dielectric Materials – B Tareev (MIR, 1979)
7. Crystal Structures - Vol.1-3 – W G Wyckoff (Interscience,1963)
8. Electronic Properties of Materials – Hummel (Springer-Verlag, 1985)
9. Solid State Physics Source Book – Sybil P Parker (Ed) (McGraw Hill, 1987)

MS 503 ELECTRONIC AND ENGINEERING MATERIALS – I (4 Credits)

Unit I

Metals: Band structure - Brillouin zones- Wigner Seitz approximation. Fermi surface - F.C.C & B.C.C- De Haas van Alphen effect. Electronic properties of metals - Electrical conductivity, thermal conductivity, Galvanomagnetic effects, thermionic and field emission in metals.

Elements of Physical Metallurgy: Fracture in metals – Ductile fracture, ductile brittle transition, brittle fracture-Griffith theory. Notch effect, Compressive and tensile strength - size effect, stress intensity factor, toughness measurements. Fatigue failure - Characteristic of fatigue failure-statistical nature of fatigue-correlation of fatigue strength and plastic properties. Factors affecting fatigue strength. Tribology: wear of metals–mechanisms, factors influencing wear, wear resistance-protection against wear. Metallurgical microscopes, sample preparation, grain size measurements of typical ferrous and non-ferrous alloys. 18 hours

Unit II

Alloys: Long range order theory-Super lattices and transitions. Diffusion in alloys - Darken's equations, determination of diffusion coefficient. Some special alloys - ferrous and non-ferrous. Super alloys.

Nuclear materials: General aspects of reactor design. Fissile materials used in different types of reactors- Moderator and coolant and cladding materials. Radiation effects in materials - Swelling, He-embrittlement, induced radioactivity. Erosion and fretting corrosion-stress corrosion cracking, H_2-embrittlement. 18 hours

Unit III

Superconductivity: Nature and properties of superconducting materials - Type I and II superconductors - Phenomenological theories - BCS theory – concept of energy gap. Superconducting tunneling phenomena: metal-insulator-superconductor (MIS) and superconductor-insulator-superconductors (SIS). AC and DC Josephson effect. Applications - superconducting magnets, super density switches, SQUID and magnetic levitation. superconducting composites. Nb_3Sn/Cu. High temperature (High T_c) superconductors: material preparation - ceramic and thin film technique, structure.

Liquid Crystalline Materials: Introduction - classification of thermotropic liquid crystals. Elementary ideas on material. Properties of liquid crystals - birefringence, dielectric anisotropy, viscosity, conductivity anisotropy and elasticity of liquid crystals, electro-optic, thermo-optic effects and LCD devices and applications.

18 hours

Reference

1. Introduction to properties of Materials – Daniel Rosenthal and Robert M Asimow (Affiliated East-West Press, 1974)
2. Physical Metallurgy Principles – R E Reed Hill (Affiliated East –West Press, 1974)
3. Physical Metallurgy – S H Avner (Tata McGraw-Hill 1997)
4. Mechanical Metallurgy – George R Dieter (McGraw-Hill, 1988)
5. Solid State Physics – A J Dekker (McMillan, 1985)
6. Solid State Physics – C Kittel (Wiley Eastern, 1993)
7. Nuclear Reactor Engineering – S Glasstone and A Sesonske (CBS Pub., 1986)
8. Introduction to superconductivity – A C Rose-Innes and E H Rhoderick (Pergamon Press, 1978)

9. Superconductivity and Superconducting Materials – A V Narlikar and S N Ekbote (South Asian Pub., 1983)
10. Physics of high T_c superconductors – J C Phillips (Academic Press, 1989)
11. Liquid Crystals – S Chandrasekhar (Cambridge University Press, 1977)
12. The Physics of Liquid Crystals – P G de Gennes (Oxford, 1975)

MS 504 TWO DIMENSIONAL MATERIALS (4 Credits)

Unit I

Preparation of Thick and Thin Film Materials: Definition of thick and thin films. Physical Vapour Deposition(PVD) - thermal evaporation - Knudsen cosine law. Sputtering- DC Glow discharge and Low pressure sputtering. Chemical Vapour Deposition(CVD). MBE, MOCVD methods of preparing device grade films. Spray pyrolysis and other chemical methods of film preparation for large area applications. LB films and their applications. Thickness measurement techniques- electrical, and mechanical methods. Optical methods- spectrophotometric and interference methods. Microbalance methods – Quartz crystal oscillator technique. 18 hours

Unit II

Nucleation and Growth of Thin Films: Theories of nucleation-Capillarity theory, effect of deposition parameters. atomistic theory and rate equation approach of nucleation. Growth of thin films- Mechanisms and influence of deposition parameters. Epitaxial growth - theory of epitaxial nucleation. Durability of films - Adhesion and Internal stress.

Optical Properties of Thin Films: Reflection and Transmission at interface between isotropic transparent media. Reflectance and Transmitance in thin films. Methods for determining optical constants - spectrophotometer and polarimetric methods. Antireflection coatings - theory and design of single layer coatings. Double and multilayer coatings - brief description. 18 hours

Unit III

Electron Transport Phenomena in Thin Films: Electrical conduction in discontinuous metal films - Quantum mechanical tunneling model. Conduction in continuous metal films- Size effect and specular scattering. Thermoelectric power in metal films. Electrical conduction in semi-conductor and insulator films - Hybrid micro circuits, thin film resistors, thermopiles. Quantum Hall Effect- Quantum well devices.

18 hours

References

1. Handbook of Thin Film Technology – L I Maissel and R Glang (Ed) (McGraw Hill, 1970)
2. Vacuum Deposition of Thin Films – L Holland (Wiley, 1956)
3. Thin Film Phenomena – K L Chopra (Mc Graw Hill, 1969)
4. Physics of Thin Films Vol.1 - 4 - G Hass and R E Thun (Ed) (Academic, 1963)
5. Electrical Conduction in Thin Metal Films – T J Coutts (Elsevier, 1974)
6. Optical Properties of Thin Solid Films – O S Heavens (Dover, 1955)
7. Thin Film Technology and Applications – K L Chopra and L K Malhothra (Ed) (Tata Mc Graw Hill, 1985)

MS 505: POLYMER SCIENCE (4 Credits)

Unit I

Introduction - Monomers, polymers-Linear, branched, cross linked, stereo regular, thermoplastic, thermoset, copolymers, crystalline & amorphous polymers, degree of crystallinity, molecular interactions & chemical bonding, flexibility, free volume, free volume & packing density- WLF parameters & free volume, configuration and conformation, dimensions of polymer coil, polymer melting &glass transition, polymer blends & interpenetrating network.

Molecular weight distribution-weight, number & viscosity average molecular weight, determination-end group, viscosity, light scattering, ultracentrifuge, gel permeation chromatography.

Criteria of polymer solubility-thermodynamics of polymer dissolution, solubility parameter, Flory Huggins theory, Newtonian & nonnewtonian flow, size & shape of polymer in solution, application of phase rule to polymer systems.

18 hours

Unit II

Synthesis & Processing - Chain polymerization-Free radical, cationic, anionic, coordination- Mechanism & Kinetics Step polymerization - polyaddition, polycondensation –Mechanism & Kinetics, Copolymerisation - Kinetics, reactivity ratios.

Methods of polymerization - bulk, suspension, solution, emulsion, condensation Processing-moulding-compresson, injection, blow, extrusion, casting, spinning Synthesis, properties & applications of thermoplastics-vinyl polymers, polyvinilidine chloride, polycarbonate, polyamide, polyimide, polyurethanes, Rubber – natural and synthetic – processing, vulcanization, properties and applications. Cellulose and its derivatives. Thermosets- phenolic, amino, epoxy, polyester, silicone polmers Liquid crystal polymers, Biomaterials, Biomedical polymers, different types of packaging materials and applications, polymer adhesives. 18 hours

Unit III

Physical properties and Charecterization - Mechanical properties- Tensile testing- stress-strain plots of different types of polymers Viscoelastic behavior, Rubber elasticity, factors influencing the strength of polymer Electrical properties- Dielectric relaxation, theory & mechanism of electrical conduction, semiconducting & conducting polymers, applications.

Optical properties- refractive index, birefringence, UV, IR Spectroscopy.

Thermal properties - Heat capacity of amorphous & crystalline polymers, polymer degradation, Thermal analysis – DSC, TMA, TG.

Acoustic properties- Dynamic modulus of elasticity, loss modulus, velocity of propagation and absorption coefficient of elastic waves in polymers, experimental determination of modulus of elasticity of solid polymers. 18 hours

References

1. Polymer Science –V R Gowarikar, N V Viswanath, Jayadev Sridhar (Wiley Eastern, 1987)
2. Polymer Chemistry – Bill Meyer Fred (Wiley Interscience, 1984)
3. Polymer Chemistry - An introduction – Raymond B Seymour & Charles E carraher Jr (Marcel Dekker, 1987)
4. Polymer Chemitry – M Mishra (Wiley Eastern, 1993)
5. Physical Chemistry of Polymers – A Tager (Mir Pub., 1978)
6. An introduction to Polymer Physics – I I Perepechko (Mir Pub., 1978)
7. Principles of Polymer Science – F Rodrigues (Mcgraw Hill, 1974)
8. Acoustic Methods of investigating polymers – I I Perepechko (Mir Pub., 1975)
9. Polymer Science and technology – Joel R Fried (Printice Hall, 1993)

MS 506 MATERIALS SCIENCE LAB. – V (4 Credits)

1. Study of junction capacitance and it's variation
2. Electrical conductivity of metals and estimation of Fermi energy
3. Energy gap of CdS thin films
4. Dielectric constant of ferroelectric materials
5. Thickness of thin films
6. Determination of molecular weight by viscosity measurement
7. Functional group analysis of polymer
8. Glass transition temperature
9. Dimension of polymer coil

MS 551 MAGNETIC MATERIALS & MAGNETIC RESONANCE

(4 Credits)

Unit I

Introduction to magnetic materials – magnetic susceptibility and permeability. Classification – dia- para- and ferro-magnetic materials. Amperian concepts. Langevin's theory of diamagnetism. Origin of magnetic moments. Quantum theory of paramagnetism- Curie law- Effective number of Bohr magneton- Quenching of orbital magnetic moments- Experimental determination of diamagnetic and paramagnetic susceptibility- anisotrophy in susceptibility. Cooling by adiabatic demagnetization. Ferromagnetism – Characteristic features- hysteresis loop. Weiss concepts- Curie-Weiss law. 18 hours

Unit II

Exchange interaction and spontaneous magnetization in ferromagnetic materials - temperature dependence- Heisenberg's theory- gyromagnetic experiments. Ferromagnetic domains - origin of domains - anisotropy energy - Bloch wall - magnetostriction. Hard and soft magnetic materials – iron loss – applications - Transforamers, Electromagnets, permanent magnets – magnetic recording - memory devices.

Antiferromagnetism - sub lattice model - Neutron diffraction in magnetic structure analysis – Super-exchange phenomena - Ferrimagnetism and structure of ferrites and their applications. Spin waves - quantisation of spin waves - magnons.

18 hours

Unit III

Magnetic Resonance and material analysis - Nuclear Magnetic Resonance - Elements of theory - rate of energy absorption – Spin-lattice and spin-spin relaxation processes - Bloch equations – Wide line NMR – applications of NMR – Paramagnetic resonance – principles and comparison of PMR with NMR. Electron spin resonance - areas of applications.

Mossbauer effect - Elements of theory – Mossbauer spectroscophy – centre shift, chemical shift, Zeeman shift, Experimental techniques and applications.

18 hours

References

1. Modern Magnetism – L F Bates (Cambridge University Press, 1963)
2. Elements of Materials Science and Engineering – L H van Vlack (Addison Wesley, 1975)
3. Introduction to Properties of Materials – D Rosenthal and R M Asimov (East West, 1974)
4. Introduction to Solid State physics – C Kittel (II & IV Ed. Wiley & sons, 1961 & 1964)
5. Solid State Physics – A J Dekker (McMillan, 1971)
6. Advances in Solid State Physics, Vol.II & V – Seitz and Turnbull (Ed) (Academic, 1957)
7. Mossbauer Effect and its Applications – V G Bhide (Tata McGraw Hill,1973)
8. Magnetic Resonance – C P Slichter (Harper and Row , 1985)
9. Solid State Chemistry – C N R Rao (Ed) (Marcel Dekker, 1974)
10. Solid State Physics Source Book – Sybil P Parker (Ed) (McGraw Hill, 1987)
11. Materials Science and Technology – A comprehensive treatment – (ed.) R W Cahn, P Haasen & E J Kramer - Electronic and Magnetic properties of metals and ceramics, Vol 3A & 3B (VCH Weinheim, 1992 & 1994)

MS 552 ELECTRONIC AND ENGINEERING MATERIALS – II (4 Credits)

Unit I

Semiconductors: Crystal growth – Introduction, Methods - Bridgman, Czochralski, zone melting/refining techniques. Contact phenomenon- metal-semiconductor, semiconductor-semiconductor contacts. Preparation of semiconductor devices - Fabrication of junctions- wafer preparation, diffusion and ion implantation methods. IC technology: monolithic IC- masking and etching - elements of lithography- resist systems and patterning. 18 hours

Unit II

Lasers and applications: Spontaneous emission - stimulated transitions and rate equation balance, amplifications in a medium, population inversion methods, oscillation threshold, optical resonator theory. Gas lasers - applications.

Solid state lasers: Semiconductor lasers – absorption-direct and indirect band gaps, material requirement, conditions for laser oscillations, homojunction and heterojunction lasers - applications.

Photovoltaic and solar cells: material requirement, efficiency, efficiency limits, spectral response, types of solar cells-conventional tandem-junction solar cells, heterojunction solar cells, thin film solar cells, amorphous silicon solar cells.

18 hours

Unit III

Ceramics: Ceramics and their structure- silicate structure - polymorphism and allotrophy: Processing - Recrystallization and grain growth, sintering, hot pressing, fire shrinkage. Basic refractory materials.

Glasses: Preparation and structure - Types of glasses -borate glasses, silicate glasses, oxide glasses, metallic and semiconducting glasses. Properties of glasses – electrical, optical, thermal, mechanical properties, Applications - photo sensitive, photochromic glasses, optical fiber- principle of fiber communication.

Optical properties: Luminescence: Frank Condon principle, excitation process - thermoluminescence and electroluminescence. Luminescent materials and industrial applications. 18 hours

References

1. Electronic Materials and devices – D K Ferry (Academic Press, New York, 2001)
2. Semiconductor Physics – P S Kireev (MIR Publishers, 1978)
3. Physics of Semiconductors Devices – S M Sze (Wiley Eastern, 1991)
4. Solid State Devices – Ben G Streetman (Prentice-Hall, 1995)
5. High efficiency silicon Solar Cells – M A Green (Tran. tech., 1987)
6. Solid State and Semiconductor Physics – John Mckelvey (John Wiley, 1976)
7. Introduction to Ceramics – W D Kingery, H K Bower and U R Uhlman (John Wiley, 1960)
8. Glasses and vitreous state – J Zarzycki (Cambridge University Press, 1982)
9. Materials Science and Technology Vol. 9: Glasses and amorphous materials, (Ed.) R W Cahn, P Haasen, E J Kramer, (VCH Weinheim, 1991)
10. Optical fiber communications – G Keiser (McGraw-Hill, 2000)

MS 553: NEW MATERIALS AND TECHNOLOGIES (4 Credits)

Super alloys and Smart Materials :

Types of super alloys – iron based – nickel based – cobalt based super alloys – fabrication – their characteristic features – areas of application.

Introduction to smart materials – shape memory effect and martensitic transformation –SME and Superelasticity. Ti - Ni SM Alloys − Cu - based SM Alloys. Ferrous SM alloys. Fabrication of SM Alloys. Characteristic fundamental properties − Shape memory ceramics and polymers. General applications of Smart materials − design of actuators − medical and dental applications.

18 hours

Conducting Polymers :

Introduction to conducting polymers. Structural features − factors affecting conductivity of polymers - (semiconducting, superconducting) − preparation of conducting polymers − band structures of polymers −charge transport in conducting polymers − nature of charge carriers (soliton, polaron, bipolarons) − models of charge transport − structure - property relationship. Mechanisms of conduction in doped polyheterocyclics, polyaromatics, conducting co-polymers. − molecular designing of Novel conducting polymers − substitution / fusion, ladder structure formation − copolymerisation − donar - acceptor polymer formation − practical applications of conducting polymers − electronic, electrochemical, photonic applications, sensors, medical applications.

18 hours

Nano-materials :

Introduction − nanostructural materials − metals, semiconductors and ceramics. Synthesis of nanoparticles− inert gas evaporation − laser pyrolysis − sputtering techniques, plasma techniques. Various Chemical methods of synthesis. Functionalized metal nanoparticles- synthesis, characterization, organization and applications. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanoastructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclustures. Nanostructured films.

Charaterisation of nanoaprticles and nanostructures− Optical spectroscopy, Electron Microscopy, Atomic Force Microscopy, X-Ray diffraction of nanoscale materials. 18 hours

References:

1. The Science and Engineering of Micro electronic Fabrication, S. A. Campbell (Oxford,1996).
2. Intrinsically conducting polymers : An emerging technology, M. Aldissi(editor), (Kluwer, 1993).
3. Quantum Chemistry Aided Design of Organic Polymers, J. M. Andre, J. Delhalle & J. L. Bredas (World Scientific, 1991).
4. Electrical properties of polymers : Chemical principles, C. C. Ku and Leilpens, (Hanser, 1987).
5. Science and applications of conducting polymers, W. R. Salaneck, D. T. Clark, E. J. Samuelson, (Adam Hilger, 1991).
6. Special polymers for Electronics and optoelectronics, J. A. Chilton, M. T. Goosey, (Chapman and Hall, 1995).

7. Longmuir - Blodgett films - Gareth Roberts (Ed), (Oxford, 1989).
8. D. Chakravorty and A. K. Giri in Chemistry of Advanced Materials (C. N. R. Rao. ed), (Blaclwell, 1992).
9 . P. Jena, B. K. Rao and S. N. Khanna (eds). Physics and Chemistry of Small Clusters (Plenum Press, 1986).
10. Physics and Chemistry of Finite Systems : From Clusters to Crystals, (Kluwer, 1992).
11. Selection of Engineering Materials, G. Lewis, (Prentice Hall, 1990).
12. Engineering Materials and their applications, R. A. Flinn and P. K. Trojan, (Jaico,1998).
13. Fundamentals of Ceramics, M. W. Barsoum, (McGraw – Hill, 1997).
14. Shape Memory Materials, K. Otsuka and C. W. Wayman, (Cambridge, 1998).
15. Nanoscale Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)
16. Nanostructured Materials and Nanotechnology, (Ed) H.S.Nalwa, (Academic, 2002).

MS 554: COMPOSITE MATERIALS (4 Credits)

Unit I

Introduction - Classification, Matrix materials, Reinforcing materials, Interfaces in composites, micromechanics of composites - Density, Mechanical properties – prediction of elastic constants, Thermal properties – Heat capacity, longitudinal and transverse conductivity, thermal expansion coefficient, Mechanism of load transfer from Matrix to fiber – (fiber elastic – matrix elastic , fiber elastic- matrix plastic).
Strength, Fracture and fatigue: Tensite strength, Compression Strength, Fracture m odes in Composite, Designing with Composite Materials. 18 hours

Unit II

Reinforcing Materials - Fabrication, Structure, Preparation, application of glass, Carbon, aramid and ceramic fibers Concrete making Materials - Structure, Composition, properties and applications, special concrete, Reinforced and prestressed concrete. Polymer matrix composites- Fabrication, structure, interface, properties and applications. Advanced thermoplastic composites, Wood-microstructure, properties, wood-plastic composites, polymer-concrete composites.

18 hours

Unit III

Metal matrix composites- Fabrication, interface, properties and applications, Dispersion strengthened, particle reinforced, fiber and laminate reinforced composites, fiber reinforced super alloy composites, Superconducting composites-Introduction type and fabrication.

Ceramic matrix composites - Fabrication, interface, properties and applications

Carbon fiber composites- Fabrication, interface, properties and applications, Advanced C-C composites. 18 hours

References

1.Composite Materials-Engineering & Science – F L Mathews & R D Rawlings (Chapman & Hall, 1990)

2. Composite Materials- Science & Engineering – K K Chawla (Springer-Verlag, 1987)
3. Principles of Materials Science & Engineering – William F Smith (McGraw-Hill, 1988)
4. A text book of Materials Science & Metallurgy – O P Khanna (Dhanpat Rai pub., 1999)
5. Selection of Engineering Materials – Gladis Lewis (Printice Hall, 1990)
6. Engineering Materials & their applications – R A Flinn & P K Trojan (Jaico pub., 1998)
7. Composite Materials – S C Sharma. (Narosa, 2000)

MS 555 MATERIALS SCIENCE LAB. – VI (4 Credits)

1. Ferromagnetic transition temperature
2. Hardness testing of materials
3. Diamagnetic and Paramagnetic susceptibility using Gouy balance
4. Hysterisis loss and determination of Curie temperature
5. Reverse saturation current and material constant
6. Magnetoresistance
7. Electron spin resonance
8. Junction voltage and band gap
9. Study of shape memory alloys
10. Preparation and Characterization of Nanoparticles

MS 556 MATERIALS SCIENCE LAB. – VII (4 Credits)

1. Crystal Structure Analysis using X-Ray Diffraction
   a) Simple Cubic structure b) Face Centered Cubic structure
   b) Hexagonal structure d) Tetragonal Structure
2. Metallurgical Microscope – Grain Size Measurements
   a) Ferrous alloys b) Non-ferrous Alloys
3. Phase diagram of Pb-Sn system
4. Conducting studies of polyaniline
5. Viscosity of polymer blends
6. Solar cell I-V characteristics
7. F-centre in alkali halides

8. Thermoluminescence activation energy
9. Preparation of Composite Materials

CHOICE BASED PAPER

MS 501: SCIENCE OF MATERIALS IN DAILY LIFE (4 Credits)

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. Examples-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. Qualitative ideas of devices- diodes to ICs. Compound Semiconductors. 18 hours

Unit II

Polymers and composites: Plastics- Introduction. Types of plastics. Rubber- Types of rubber. Vulcanization of rubber. Fibres- Different types of natural and synthetic 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. 18 hours

Unit III

Ceramics and Glasses: 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. Primary refractory materials.

Glasses- Introduction, raw materials, manufacture of glass, properties and applications. Types of glasses, properties and Applications. Photochromic and photosensitive glasses.

18 hours

References:

1. The Physics of Materials: How Science Improves Our Lives, Solid State Sciences Committee, (National Research Council, 1997)
2. The Science of the 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)
7. Materials Science- Nagpal (Khanna, Delhi)
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)