SEMESTER - III

Paper - I : Material Science - I

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Crystal Structure and Mechanical Properties : Diffraction Theory and intensities, Unit cell contents, Determination of atomic arrays, reciprocal lattice (The powder and single crystal and method of diffraction).
Crystal imperfections : Point defects, Frankel and Schottky defects, line defects, slip planes and slip directions, Edge and Screw dislocation, Burgers' vector, cross-ship, slide and climb, jogs, dislocation energy, Planar defects.

UNIT - II

Mechanical Properties : Stress - strain curve true stress and true strain, Elastic deformation, Atomic mechanism of Elastic deformation, Anelastic, viscous and plastic deformation, plastic deformation by slip, stress to move a dislocation and effects of temperature, work - hardening, strengthening from grain boundaries, Solid solution strengthening, Precipitation strengthening.
Creep : Mechanism of creep, creep resistant materials, Fracture, Ductile, fracture, Brittle fracture, fatigue fracture.

UNIT - III

Dielectrics and Ferroelectrics : Maxwell's equation, Polarisation, Depolarisation field E_1, Lorentz field E_2, Field of dipoles inside cavity E_3, dielectric constant and electronic polarisability, Structural phase transitions, classification of ferroelectric crystals, polarization catastrophe.

UNIT - IV

Displacive transitions : Soft optical phonons,Landau theory of the phase transition, First order and second order transition, Antiferroelectricity, Ferroelectric domains, Piezoelectricity, Ferroelectricity.
Barium titanate above curie temperature, Theory of sponstaneous polarisation of $BaTiO_3$.

References

1. Introduction to Solids - L.V. Azaroff.
2. Materials Science - J. C. Anderson et al
3. Introduction to Solid State Physics - C. Kittle (VI Ed. 1997).
4. Solid state physics - N.W. Ashcrofts and N.D. Mermin.

SEMESTER - III

Paper - II : Microwave Devices

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Wave equation and boundary conditions, Plane monochromatic wave in non-conducting media, Reflection and refraction at the boundary of two non-conducting media, oblique Incidence, reflection from a conducting plane, total internal reflection propagation between parallel conducting plane.

UNIT - II

Wave-guides, Rectangular and Coaxial wave guides, Resonant cavities, Q of a cavity resonator. Transmission lines : Transmission lines equation and solutions, Quarter and Half wavelength lines, Impedence matching using smithchart.

UNIT - III

Klystron-operation, velocity modulation, bunching, output power, beam loading, Reflex Kylstron-operation velocity modulation, power output. Travelling wave tube, Backward wave amplifier and oscillator. Microwave switching devices - Krytron.

UNIT - IV

Transferred Electron devices, Gunn effect diode-operation, Modes of operation. Microwave generation, amplification, LSA, InP and CdTe diodes Avalanche Transit time Devices, (ATD) READ diode, IMPATT diode, TRAPATT diode, BARITT diode. Detector diodes and mounts,

measurements of wavelengths, frequency, impedence, power scattering parameters, Theory and property of scattering parameters, directional couplers, Faraday rotation in ferrites.

Reference

1. Foundations of Electromagnetic theory - J.R. Reitz and Milford, Addition Wesley.
2. Microwave Devices and Circuits - Samuel Y. Liao. PHI Pvt. Ltd.
3. Electronic Communication - Roody and Coolen.
4. Electronic Communication - George Kennedy

SEMESTER - III

Paper - III : Thin Film and Vacuum Techniques

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Thin film deposition processes : Introduction to thin film deposition technology, Thermal evaporation methods : Resistive heating – thermal evaporation sources, multiple component evaporation, Sublimation, Flash evaporation, Arc evaporation, Exploding wire technique, Laser evaporation, RF heating Electron bombardment heating.

UNIT - II

Cathodic sputtering yields. Glow - Discharge sputtering, pressure, Deposite distribution Current and Voltage dependence, Cathode contamination problem, Deposition control, Ion Beam Sputtering Reactive Sputtering, Electro deposition, chemical vapour deposition (CVD) - Thermal decomposition, Hydrogen reduction, Halide dispropartionation, Transfer reaction, polymerization. Techniques for the measurement of thin film thickness.

UNIT - III

Theories of gas flow, basic principles and process for production of vacuum, Construction and working of rotary, Absorption, Diffusion, Cryogenic, Turbomolecular, Getter and Ion pumps, Measurement of vacuum - Principle of vacuum gauges for different vacuum ranges up to UHV, Leak detection.

UNIT - IV

Materials for vacuum system and their characteristics, Vacuum system and their applications in Microelectronics, Optical, Instrumentation, Packaging, Drying, Impregnation, Metallurgy, Space, Pharmaceutical and Cryogenic industries.

References

1. Thin Film Phenomena - Kasturi L. Chopra, McGraw Hill Book Company.
2. Hand Book of Thin Film Technology - Leon
3. Handbook of Analytical Instrumentation - R.S. Khandpur
4. Vacuum Science and Technology - A. Roth.

SEMESTER - III

Paper - IV : Surface Modification and Characterization Techniques

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Ion Implantation: Introduction, Ion implantation process, Basic Features of an ion implanter, Radiation Damage and Ion Ranges, Channeled ion ranges, Ion beam mixing, microstructure of irradiated surfaces, change in mechanical, electrical and optical properties of metals and semiconductor materials due to ion irradiation

UNIT - II

Rutherford back scattering spectrometery (RBS): Principle, Kinematics of elastic collision, Scattering crosssection and impact parameter, The energy width in backscattering, Shape of the backscattering spectrum, Depth Profiles with Rutherford Scattering,
Electron energy loss spectroscopy (EELS): Principle, Spectrum yield, Influence of thin film morphology on electron attenuation, Layer by layer attenuation, single layer plus islanding.
Atomic Force Microscope (AFM): Basic principle, Tip and cantilever, Tapping mode operation, Some typical applications of AFM

UNIT - III

Low energy electron diffraction (LEED): Principle, Schematic of low energy electron diffraction, Leed pattern applications,
Glancing angle X-ray diffraction, Basic concept, Seeman - Bohlin X-ray diffractometer, instrumentation and applications
Scanning electron Microscope (SEM): Principle, Instrumentation, Electron optics, Magnification, Application,

Transmission Electron Microscopy (TEM): Principle, Instrumentation and Applications
Scanning Tunnling Microscope (STM), Principle, Sample scanner, computer interface,

UNIT - IV

Aüger Electron spectroscopy (AES): Principle, Nomenclature, Schematic of the energy level, Instrumentation, Aüger spectrometer, Scanning Auger Microprobe (SAM). Composition analysis, Detection limits, Application of AES in study of ion irradiated samples, depth profile,
X-ray photoelectron spectroscopy (XPS) or ESCA: Principle, Photoemission process, Schematic of the energy level, Instrumentation, Experimental consideration, Electron multiplier, Photoelectron energy spectrum, Chemical shift, Oxidation state, Quantitative analysis and Applications.
Secondary Ion mass Spectroscopy (SIMS): Basic principle, instrumentation, working and applications.

References

1. Ion Implantation by G. Dearnally
2. Ion implantation technology by J. W. Mayers
3. Fundamentals of surface and thin film analysis - Leonard C, Feldman and James W. Mayer, North Holland.
4. Instrumental Methods of Analysis - Willard et al CBS Publishers.
5. Methods of Surface Analysis - Technique and application.
6. Principles of Instrumental Analysis, Douglas A Skoog et al Saunders Golden Sunbrust series.
7. Electron spectroscopy : Theory, techniques and application - C.R. Brundee and A.D. Baker eds. Academic Press.

SEMESTER - III

Paper - V : Radiation Physics

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Radiation and need for its measurement, Physical features of radiation, Conventional sources of radiation,
Exposure to natural radiation: external to the body, Radiation from cosmic rays and solar radiation, Internal exposure to the body, Radioactivity arising from technological development: Possible health hazards from nuclear and laser radiations
Maximum permissible level of radiation. Radiation quantities and units of energy flux, energy fluence, cross-section, linear energy transfer, Specific energy and absorbed dose, Relative effectiveness of radiation, dose equivalent.

UNIT - II

Biological effects of radiation: Dose - response characteristics, Direct and indirect action, Acute effects, Delayed effects, Cumulative effect, Accidental exposure, Radiation induced chemical changes in tissues, Radiation protection procedures (diagnostics and therapy).
Basic radiation safety criteria, Protection from direct radiation, Energy deposition, Effect of distance and shielding, Protection from contamination, Preparation of a safe radiation area,
Radioactive waste disposal and management: Type of radioactive waste, Airborne waste, Solid and liquid waste, Assessment of Hazard.

UNIT - III

Basic Principles of patient monitoring and diagnostic using radiation and isotopes, Principles of radiation therapy. Physics of diagnostic X-rays, Production and Absorption of X-rays, X-ray imaging, X-ray fluroscopy.
Computerised Axial Tomography (CAT), Ultrasound Scanning, Ultrasound picture of the body, Ultrasound to measure motion, Physiological effects of ultrasound in therapy, Electrocardiograhy (ECG), Pacemakers, Gamma Camera, Position Emission Tomography (PET), Magnet Resonance Imaging (MRI).

UNIT - IV

Basic features of radiation dose measurements, Brief introduction and principles of ionization chamber, Generation of charge, Ionization and exposure, Electron equilibrium.
Thermoluminescence : Principles and methods, Basic concepts, Thermoluminescence emission process, characteristic of TL, Glow Curves and Spectra of TL,
Solid state Nuclear Track Detector (SSNTD), Track processing methods, Chemical track etching, track dyeing, Track decoration, Etch track evolution, Plastic detectors.
ESR Dosimeter: basic principle,and application

References

1. Introduction to Health Physics - Herman Cember, Pergamon Press.
2. Introduction to Radiation Protection - Martiz and Harbinsor, John Willey and Sons.
3. Medical Physics - J.R. Cameron, and J.G. Skotronick, John Willy Sons
4. Introduction to Radiobiology and Radiation Dosimetery - F.H. Aurix, John Wiley.
5. Techniques of Radiation Dosimetery - Editors K. Mahesh and DR Vij Wiley Eastern Limited.
6. Nuclear Energy - Raymond L. Murray Pergamon Press, N.Y.