

**Unit I****Chapter 1 : Quantum Physics****1-1 to 1-35**

Syllabus : (Prerequisites : Dual nature of radiation, Photoelectric effect, Matter waves, wave nature of particles, de-Broglie relation, Davisson-Germer experiment) de Broglie hypothesis of matter waves; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg uncertainty principle; non existence of electron in nucleus; Schrodinger's time dependent wave equation; time independent wave equation; Particle trapped in one dimensional infinite potential well, Quantum Computing.

| | | |
|--------|--|------|
| 1.1 | Introduction..... | 1-1 |
| 1.2 | de-Broglie Hypothesis | 1-2 |
| 1.2.1 | de-Broglie Wavelength..... | 1-3 |
| 1.3 | Properties of Matter Waves..... | 1-3 |
| 1.4 | Wave Packet, Group Velocity and Phase Velocity..... | 1-4 |
| 1.4.1 | Wave Packet..... | 1-4 |
| 1.4.2 | Phase Velocity | 1-5 |
| 1.4.3 | Group Velocity..... | 1-6 |
| 1.4.4 | Relation between Group Velocity and Particle Velocity | 1-8 |
| 1.5 | Wave Function and Physical Interpretation of Wave Function..... | 1-9 |
| 1.6 | Uncertainty Principle | 1-18 |
| 1.7 | Electron Diffraction Experiment..... | 1-19 |
| 1.8 | Gamma-ray Microscope Experiments..... | 1-20 |
| 1.9 | Applications of Uncertainty Principle..... | 1-21 |
| 1.10 | One Dimensional Time-dependent Schrödinger Equation..... | 1-23 |
| 1.11 | Reduction of Schrodinger Equation to Time-independent Form..... | 1-25 |
| 1.12 | Eigen Functions and Eigen Values | 1-26 |
| 1.13 | Application of Schrödinger Equation to Free Particle and Particle in a Box | 1-26 |
| 1.14 | Wave Functions, Probability Density and Energy | 1-28 |
| 1.15 | Particle in a Finite Potential Well /Barrier and Tunnelling Effect | 1-30 |
| 1.15.1 | Tunnelling Effect Examples..... | 1-32 |
| 1.16 | Introduction to Quantum Computing | 1-34 |

Unit II**Chapter 2 : Crystallography****2-1 to 2-31**

Syllabus : (Prerequisites : Crystal physics (unit cell, space lattice, crystal structure, simple cubic, body centered cubic, face centered cubic, diamond structure, production of x-rays), Miller indices, interplanar spacing, x-ray diffraction and Bragg's law, determination of crystal structure using Bragg's diffractometer

| | | |
|-------|---|-----|
| 2.1 | Introduction..... | 2-1 |
| 2.2 | Miller Indices..... | 2-2 |
| 2.2.1 | Crystal Planes and Miller Indices | 2-2 |
| 2.2.2 | Interplanar Spacing | 2-6 |



| | | |
|-------|--------------------------------|------|
| 2.2.3 | Directions | 2-7 |
| 2.3 | X-ray Diffraction..... | 2-11 |
| 2.4 | Bragg's Law..... | 2-12 |
| 2.5 | Bragg's Spectrometer..... | 2-14 |
| 2.6 | Solved Problems on X-rays..... | 2-24 |

Unit III

Chapter 3 : Semiconductor Physics**3-1 to 3-41**

Syllabus : (Prerequisites : Intrinsic and extrinsic semiconductors, energy bands in conductors, semiconductors and insulators, semiconductor diode, I-V characteristics in forward and reverse bias)

Direct & indirect band gap semiconductor; Fermi level; Fermi-Dirac distribution; Fermi energy level in intrinsic & extrinsic semiconductors; effect of impurity concentration and temperature on Fermi level; mobility, current density; Hall effect; Fermi Level diagram for p-n junction (unbiased, forward bias, reverse bias); applications of semiconductors: LED, Zener diode and Photovoltaic cell

| | | |
|--------|--|------|
| 3.1 | Introduction..... | 3-1 |
| 3.2 | Direct and Indirect Band Gap | 3-1 |
| 3.3 | Carrier Drift, Drift Velocity, Drift Current Mobility and Diffusion Current..... | 3-4 |
| 3.3.1 | Concept of Holes and Effective Mass | 3-7 |
| 3.4 | Fermi-Dirac Statistics | 3-7 |
| 3.5 | Fermi Energy or Fermi Level..... | 3-8 |
| 3.5.1 | Fermi Level in Conductor | 3-9 |
| 3.5.2 | Fermi Level in Semiconductor..... | 3-11 |
| 3.6 | Intrinsic Semiconductors | 3-11 |
| 3.6.1 | Fermi Level in Intrinsic Semiconductors | 3-12 |
| 3.7 | Extrinsic Semiconductor..... | 3-13 |
| 3.7.1 | n-Type Semiconductors | 3-13 |
| 3.7.2 | p-Type Semiconductors | 3-15 |
| 3.7.3 | Effect of Temperature on n-type Material | 3-17 |
| 3.7.4 | Effect of Temperature on p – type Material..... | 3-18 |
| 3.8 | Effect of Impurity Concentration on Fermi Level | 3-18 |
| 3.9 | P-N Junction | 3-19 |
| 3.9.1 | Depletion Layer and Potential Barrier | 3-19 |
| 3.9.2 | Calculation of Potential Barrier..... | 3-20 |
| 3.10 | Hall Effect and its Applications | 3-21 |
| 3.10.1 | Experimental Determination of Mobility | 3-22 |
| 3.10.2 | Applications..... | 3-23 |
| 3.10.3 | Light Emitting Diodes (LED)..... | 3-23 |
| 3.10.4 | Zener Diode | 3-25 |
| 3.10.5 | Photovoltaic Cell | 3-26 |
| 3.11 | Solved Problems on Mobility, Conductivity and Resistivity | 3-29 |
| 3.12 | Solved Problems on Fermi Level | 3-34 |
| 3.13 | Solved Problems on Hall Effect..... | 3-37 |



Unit IV

Chapter 4 : Interference in Thin Film
4-1 to 4-52

Syllabus : (Prerequisites : Wavefront and Huygens' principle, reflection and refraction, interference by division of wavefront, Young's double slit experiment) Interference by division of amplitude, interference in thin film of constant thickness due to reflected and transmitted light, origin of colours in thin film, wedge-shaped film, Newton's rings Applications of interference - determination of thickness of very thin wire or foil, determination of refractive index of liquid, wavelength of incident light, radius of curvature of lens, testing of surface flatness, anti-reflecting films and highly reflecting film

| | | |
|--------|--|------|
| 4.1 | Interference in a Thin Parallel-sided Film..... | 4-1 |
| 4.2 | Thin and Thick Films | 4-5 |
| 4.3 | Production of Colours in Thin Films | 4-5 |
| 4.4 | Necessity of the Extended Source | 4-6 |
| 4.5 | Film of Non-uniform Thickness (Wedge-shaped Film)..... | 4-7 |
| 4.6 | Spacing between two Consecutive Bright Bands..... | 4-10 |
| 4.7 | Newton's Rings..... | 4-12 |
| 4.8 | Newton's Rings by Transmitted Light..... | 4-16 |
| 4.9 | Characteristics of Newton's Rings..... | 4-17 |
| 4.10 | Newton's Ring with White Light..... | 4-19 |
| 4.11 | Newton's Rings with Bright Centre in Reflected System..... | 4-19 |
| 4.12 | Similarities and Dissimilarities between Newton's Rings and Wedge-shaped Films | 4-20 |
| 4.13 | Solved Problems | 4-20 |
| 4.14 | Determination of Thickness of Very Thin Wire or Foil | 4-33 |
| 4.15 | Determination of Wavelength of Monochromatic Light or Radius of Curvature of Lens by Newton's Rings Method | 4-34 |
| 4.15.1 | Experimental Arrangement | 4-34 |
| 4.15.2 | Determination of Radius of Curvature of Lens | 4-36 |
| 4.16 | Determination of Refractive Index of a Liquid by Newton's Rings | 4-37 |
| 4.17 | Applications of Interference | 4-39 |
| | 4.17.1 Testing the Optical Flatness of Surfaces | 4-40 |
| 4.18 | Concept of Anti-reflecting Coating Non-reflecting Films | 4-41 |
| 4.19 | Highly Reflecting Film..... | 4-43 |
| 4.20 | Solved Problems on Application..... | 4-43 |

Unit V

Chapter 5 : Superconductors and Supercapacitors
5-1 to 5-24

Syllabus : (Prerequisites : Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current, Ohm's law, electrical resistance, V-I characteristics (linear and non-linear), electrical resistivity and conductivity, temperature dependence of resistance)

Superconductors : Critical temperature, critical magnetic field, Meissner effect, Type I and Type II and high T_c superconductors

Supercapacitors : Principle, construction, materials and applications, comparison with capacitor and batteries, energy density, power density

| | | |
|-----|-------------------|-----|
| 5.1 | Introduction..... | 5-1 |
|-----|-------------------|-----|



| | | |
|--------|---|------|
| 5.2 | Temperature Dependence of Resistance of Metal..... | 5-2 |
| 5.3 | Superconductivity and its Properties..... | 5-2 |
| 5.3.1 | Magnetic Field Effect (Critical Field Hc)..... | 5-3 |
| 5.3.2 | Persistent Current | 5-5 |
| 5.4 | Meissner Effect..... | 5-6 |
| 5.5 | Types of Superconductors | 5-7 |
| 5.5.1 | Comparison between Type I and Type II Superconductors..... | 5-8 |
| 5.6 | High TC Superconductivity..... | 5-9 |
| 5.7 | Josephson Effect | 5-10 |
| 5.8 | Applications of Superconductivity..... | 5-12 |
| 5.8.1 | MAGLEV Trains | 5-12 |
| 5.8.2 | Superconducting Magnets (Electromagnets)..... | 5-13 |
| 5.8.3 | Bearings (Superconducting)..... | 5-13 |
| 5.8.4 | Superconducting Quantum Interference Device (SQUID) | 5-13 |
| 5.8.5 | Fast Electrical Switching | 5-14 |
| 5.9 | Solved Problems | 5-15 |
| 5.10 | Introduction..... | 5-19 |
| 5.10.1 | Principle..... | 5-20 |
| 5.10.2 | Construction | 5-20 |
| 5.10.3 | Types or Classification of Supercapacitors..... | 5-21 |
| 5.10.4 | Applications..... | 5-21 |
| 5.11 | Comparison with Capacitor and Batteries,Energy Density, Power Density | 5-22 |

Unit VI

Chapter 6 : Engineering Materials and Applications

6-1 to 6-7

Syllabus : (Prerequisites : Paramagnetic materials, diamagnetic materials, ferromagnetic materials, crystal physics, conductors and insulators, free charges and bound charges inside a conductor, dielectric and electric polarization, capacitors and capacitance) Liquid Crystals : Nematic, smectic and cholesteric phases, liquid crystal displays Multiferroic. : Type I and Type II multiferroics and applications Magnetoresistive oxides : Magnetoresistance, GMR and CMR materials, introduction to spintronics

| | | |
|-------|---------------------------------------|-----|
| 6.1 | Liquid Crystal and Phases..... | 6-1 |
| 6.1.1 | Mesomorphic Phase | 6-1 |
| 6.1.2 | Discotic Phase | 6-3 |
| 6.1.3 | Applications of Liquid Crystals | 6-4 |
| 6.3 | Liquid Crystal Display | 6-4 |
| 6.4 | Multiferroics | 6-4 |
| 6.4.1 | Classification of Multiferroics..... | 6-5 |
| 6.4.2 | Applications of Multiferroics | 6-6 |
| 6.5 | Magnetoresistive Oxides | 6-6 |
| 6.5.1 | Magnetoresistance | 6-6 |
| 6.6 | Introduction to Spintronics..... | 6-7 |

