SEMESTER - II

Paper - IV : Condensed Matter Physics And Nano Technology

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

Lattice Dynamics : Lattice vibrations of 3D solids, Quantization of lattice vibrations, Diffraction of X-rays, electrons and neutrons by a vibrating lattice, Debye-Waller factor, Anharmonicity and thermal expansion, Electronic Energy Bands : Bloch's theorem, Tight-binding method, Orthogonalized plane wave method, Pseudopotential method, Conduction electrons in uniform external magnetic fields and Cyclotron resonance, de Haas-van Alphen effect.

UNIT - II

Surfaces and Interface: Work function and contact potential, Thermoionic emission, Superlattices, Quantum wells, Quantum wires, Quantum dots and Carbon nanotubes. Correlation and Response: Dynamic correlation and linear response functions, Undamped and damped oscillators, Diffusion, Brownian motion and Langevin theory. Electron Gas in Metals: Hartree-Fock theory, exchange charge density and Fermi hole in a free-electron gas, Dielectric screening, Thomas-Fermi theory, Lindhard theory, Random phase approximation.

UNIT - III

Quantum confined system: Nanostructure materials, quantum wells, quantum wires, quantum dots, coupled wells and superlattices. Transport in nanostructures : Tunneling in planar barrier structures - single and double barrier cases, quantized conductance in nanostructures, transport in quantum wave guide structures.

UNIT - IV

Electronic devices: Velocity - modulation and quantum interference transistors, ballistic - injection devices, resonant - tunneling devices. Optical devices: Quantum - well lasers, surface-emitting lasers, quantum - wire lasers, blue quantum-well lasers, quantum - cascade lasers, multiple-quantum-well photo detectors.

References

1. Solid State Physics - N.W. Ashcroft and N.D. Mermin.
2. Principles of condensed matter physics - P.M. Chaikin and T.C. Lubensky
3. Principles of the theory of solids - J.M. Ziman
4. Quantum Heterostructures - Microelectronics and optoelectronic devices - V.V. Mitin, V.A. Kochelap and M.A. Stroscio
5. Transport in Nanostructures - D.K. Ferry and S.M. Goodnick.
6. Quantum Wells - Physics and Electronics of Two-dimensional Systems - A. Shik