M.Sc. Physics Semester-I Paper-IV
Physics of Electronic Devices 22PHY21C4

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would get familiarity semiconductor materials and charge transport in semiconductors
CO2 Students would be able to appreciate the functioning and applications of various optoelectronic and memory devices.
CO3 Students would be able to explain the basic physics and application of different transistor types.
CO4 Students having familiarization with negative resistance devices and will be in a position to design switching circuits involving these device.

Unit I

Charge carriers in semiconductors: Energy bands, metals, Semiconductors and insulators, Direct and indirect band gap semiconductors, Variation of energy bands with alloy composition, Electrons and holes, effective mass, Intrinsic and extrinsic semiconductors, Concept of Fermi level, Electron and hole concentration at equilibrium, Temperature dependence of carrier concentrations, Compensation and space charge neutrality, Conductivity and mobility, Effect of temperature and doping on mobility, Hall effect, Invariance of Fermi level

Unit-II

Carrier transport in semiconductors: Optical absorption and luminescence, Carrier lifetime and photoconductivity, Direct/indirect recombination of electrons and holes, Traps and defects, Steady state carrier generation, Quasi Fermi levels, Diffusion and drift of carriers, Diffusion and recombination, Diffusion length, Haynes Shockley experiment, Gradient in quasi Fermi level, External and internal photoelectric effect

Unit-III

Diode physics and optoelectronic devices: P-N junction diode: Basic structure, Energy band diagram, Built-in potential, Electric field, Space charge width and qualitative description of current flow, Derivation of diode current equation, Zener diode: breakdown mechanisms, Voltage regulator circuit, Power diode, Varactor diode, Optoelectronic devices: Vacuum photodiode, Photo-multipliers tube, P-N junction photodiode, Pin photodiode, Avalanche photodiode, Phototransistor, Solar cell, Light emitting diode (LED), Diode laser: Condition for laser action and optical gain

Unit-IV

Transistors: Bipolar junction transistor (BJT),Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Field effect transistors: Junction field effect transistor (JFET), Metal oxide semiconductor field effect transistor (MOSFET), Negative resistance devices: Tunnel diode, Backward diode, Uni-junction transistor, p-n-p-n devices and their characteristics, Silicon controlled rectifier and switch and their characteristics.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & Reference Books:

[1] Semiconductor Devices - Physics and Technology by S.M. Sze (Wiley).
[2] Solid State Electronic Devices by Ben G. Streetman (PHI).
[3] Semiconductor Physics and Devices by Donald A Neamen (Tata-McGraw Hill).
[4] Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill).
[5] Semiconductor Devices by Kanaan Kano (PHI).
[6] Semiconductor Optoelectronic Devices by Pallab Bhattacharya (Pearson)
[7] Semiconductor Device Fundamentals by Robert F Pierret (Addison-Wesley).
[8] Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson).