FPYC704: PHYSICS OF SEMICONDUCTOR DEVICES

Mark-100

Unit-I: Introduction to the quantum theory of solids:

Formation of energy bands, The k-space diagram (two and three dimensional representation), conductors, semiconductors and insulators. Electrons and Holes in semiconductors: Silicon crystal structure, Donors and acceptors in the band model, electron effective mass, Density of states, Thermal equilibrium, Fermi-Dirac distribution function for electrons and holes, Fermi energy. Equilibrium distribution of electrons & holes: derivation of n and p from D(E) and f(E), Fermi level and carrier concentrations, The np product and the intrinsic carrier concentration. General theory of n and p, Carrier concentrations at extremely high and low temperatures: complete ionization, partial ionization and freeze-out. Energy-band diagram and Fermi-level, Variation of E_F with doping concentration and temperature. Motion and Recombination of Electrons and Holes: Carrier drift: Electron and hole mobilities, Mechanism of carrier scattering, Drift current and conductivity. Motion and Recombination of Electrons and Holes: Carrier di ffusion: diffusion current, Total current density, relation between the energy diagram and potential, electric field. Einstein relationship between diffusion coeffcient and mobility. Electron- hole recombination, Thermal generation. 12

Unit-II: PN Junction:

Building blocks of the pn junction theory: Energy band diagram and depletion layer of a pn junction, Built-in potential; Depletion layer model: Field and potential in the depletion layer, depletion-layer width; Reverse-biased PN junction; Capacitance-voltage characteristics; Junction breakdown: peak electric field. Tunneling breakdown and avalanche breakdown; Carrier injection under forward bias-Quasi- equilibrium boundary condition; current continuity equation; Excess carriers in forward- biased pn junction; PN diode I-V characteristic, Charge storage. 13

Unit-III: The Bipolar Transistor:

Introduction, Modes of operation, Minority Carrier distribution, Collector current, Base cur-rent, current gain, Base width Modulation by collector current, Breakdown mechanism, EquivalentCircuit Models - Ebers -Moll Model.

Metal-Semiconductor Junction: Schottky Diodes: Built-in potential, Energy-band diagram, I-V characteristics, Comparison of the Schottky barrier diode and the pn-junction diode. Ohmic contacts: tunneling barrier, speci c contact resistance.

MOS Capacitor:

The MOS structure, Energy band diagrams, Flat-band condition and at-band voltage, Sur-face accumulation, surface depletion, Threshold condition and threshold voltage, MOS C-V characteristics, Qinv in MOSFET. 10

MOS Transistor:

Introduction to the MOSFET, Complementary MOS (CMOS) technology, V-I Characteris-tics, Surface mobilities and high-mobility FETs, JFET, MOSFETVt, Body effect and steep retrograde doping, pinch-o voltage, 5

BOOKS:

1. Physics of Semiconductor Devices - Donald A. Neamann
2. Physics of Semiconductor Devices - B. B. Swain
3. Physics of Semiconductor Devices - AnjanaAcharya
4. Physics of Semiconductor Devices - Calvin Hu.
5. Physics of Semiconductor Devices - Dilip K Roy
6. Fundamentals of Semiconductor Devices- M. K. Achthanand K. N. Bhatt
7. Solid state Electronics Devices Bhattacharya , Rajnish Sharma
8. Semiconductor Materials and Devices J. B. Gupta
9. Physics of Semiconductor Devices - JivanJyotiMohanty.