PPH303 SEMICONDUCTOR PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To give knowledge about semiconductor physics and discus working and applications of basic devices, including p-n junctions, BJTs and FETs.

Semiconductors: Energy Band and Charge Carriers: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration, Compensation and charge neutrality. Conductivity and mobility, Effect of temperature, Doping and high electric field.

Optical Excitation in Semiconductor: Optical absorption, carrier generation, Carrier life time, diffusion length and photo conductivity, Direct and indirect recombination and trapping, Photoconductive devices. Diffusion of carriers, Einstein relation, Continuity equation, Carrier injection, Diffusion length. Haynes-Shockley experiment.

Junctions: p-n junction and contact potential, Fermi levels, Space charge, Reverse and Forward bias, Zener and Avalanche breakdown. Capacitance of p-n junction, Schottky barriers; Schottky barrier height, C-V characteristics, current flow across Schottky barrier: thermionic emission, Rectifying contact and Ohmic contact.

Field Effect Transistors: JEFT amplifying and switching, Pinch off and saturation, Gate control, I-V characteristics. MOSFET, Operation, MOS capacitor, Debye screening length, Effect of real surfaces; Work function difference, Interface charge, Threshold voltage and its control, MOS C-V analysis and time dependent capacitance. Output and transfer characteristics of MOSFET.

Bipolar Junction Transistors (BJT): Fundamentals of BJT operation. Minority carrier distribution, Solution of diffusion equation in base region, Terminal current, Current transfer ratio, Ebers-Moll equations, Charge control analysis. BJT switching: Cut off, Saturation, Switching cycle.

Photonics: LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photodetectors: Ideal conversion efficiency, Fill factor, Equivalent circuit, V_{oc}, I_{sc} and Load resistance, Spectral response. Reverse saturation current in photodetector.

Course learning outcomes: Students will have achieved the ability to:

1. explain the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.
2. explain the working, design considerations and applications of various semiconducting devices including p-n junctions, BJTs and FETs.
3. describe the working and design considerations for the various photonic devices like photodetectors, solar-cells and LEDs

Recommended Books

1. *Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006).*
2. *Sze, S.M., Physics of Semiconductor Devices, John Wiley, (1981).*

3. *Tyagi, M.S., Introduction to semiconductor materials and devices, John Wiley, (2000).*
4. *Mishra, Umesh K. and Singh, Jaspreet, Semiconductor Device Physics and Design, Springer, (2008).*
5. *Pierret, R.F., Semiconductor Device Fundamentals, Pearson Education Inc., (2006).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25