PMM211: ELECTRONIC AND OPTO-ELECTRONIC MATERIALS

L	T	P	Cr
3	1	0	3.5

Course Objective(s): To provide theoretical framework of semiconducting materials and an overview of the wide variety of different semiconductors used for various optoelectronic devices. To introduce basics of semiconductor physics (including semiconductor junctions) to understand the functioning of semiconductor devices. To introduce the semiconductor processing techniques including methods of doping. To explain fundamentals of optical processes in semiconductors, which are critical to the optoelectronic applications including Laser, LED, optical communication devices, etc.

Physical basis of Semiconductors: Review of energy bands, Effective mass, Fermi level in intrinsic and extrinsic semiconductors, Effect of temperature, Carrier concentration and mobility on Fermi level and electrical conductivity. Hall effect, Drift and diffusion currents, Einstein relation, Element and compound semiconductor materials: Classification of semiconductors into element, Binary, Ternary and quaternary compounds, Conduction mechanisms, Amorphous semiconductors, Oxide and magnetic semiconductors.

Junctions and Junction Devices: Contact potential explanation based on band structure, M-S contact and its properties, Barrier layer, P-N junction, Potential barrier and barrier width, Forward and reverse saturation current junction capacitance.

Processing of Semiconductor Materials: Purification, Zone refining and zone floating methods, Czochralski and Bridgemann techniques, Epitaxial growth methods, Liquid phase, Vapour phase and molecular beam epitaxy, Thin film techniques.

Optical Processes in Semiconductors: Radiative and non-radiative recombination, Absorption in semiconductors. Luminescence from quantum well, Photo luminescence and phosphorescence, Phototransistors electro luminescence process, LED's; their structures and choice of materials, Polymer LEDS.

Materials for Optical Communication: Optical fibers, Single and multimode electro-optic effect, Kerr and pockels effect liquid crystal displays and display materials, TN and STN effect.

Course Learning Outcomes (CLO):

Students will be able to:

1. Acquire fundamental understanding of optical processes in the semiconductors for optoelectronic devices and application;
2. Develop detailed knowledge about the suitability of materials for a specific optoelectronic application;
3. Know about need-specific processing of semiconductors;
4. Develop basic understanding of devices such as light emitting diodes, Lasers, optical communication devices, etc. Develop an overall understanding of the scope of the optoelectronic industry and its impact on our daily lives.

Recommended Books:

1. *Sze, S.M., Physics of Semiconductor Devices, Wiley (2007).*
2. *Bhattacharya, P., Semiconductor Opto-electronic Devices, PHI (2006).*
3. *Wilson, J. & Hawkes, J.F.B., Optoelectronics- PHI (1988).*