18VL705 **INTEGRATED OPTICS** **3-0-0-3**

Objectives:

- Give an overview of various device building blocks and basic physics behind it.
- Introduce various active optical to electrical (or reverse) conversion devices.
- Give students a view of tuneable device design options.
- Introduce the material and fabrication aspect of integrated optics.

Keywords: Integrated optics, Photonics, waveguides, couplers, modulators.

Contents:

Passive devices: Overview of integrated optic devices and applications. Compound semiconductors, Si, organic semiconductors, 2D materials and low dimensional systems as waveguide media. Slab waveguides, transfer matrix method, rib waveguides, plasmonic waveguides. Coupled mode theory. Overview of common building blocks like AWG, ring resonators, MMI couplers, MZ, gratings, photonic crystals. **Project:** Design geometries of a specified device block for a given wavelength and linewidth.

Active devices: Compound semiconductors, Si, organic semiconductors, 2D materials and low dimensional systems as active media. Transport in semiconductors. Transport in organic semiconductors. Transport in 2D materials. Need for PN junction and heterostructures. Spontaneous and stimulated emission. Lasers and photodetectors. **Projects:** Design the doping, geometry and gain (active region) for a given laser linewidth and modulation speed. Design the doping, dimensions and active region for a given SNR and responsivity curve.

Electro-optic and nonlinear materials: Electro optic coefficients. Different methods to tune refractive index in semiconductors, electro-optic polymers and 2D materials. Franz-Keldysh effect, QCSE, free carrier plasma and MOS capacitor. Modulators, switches, converters and tunable devices. **Project:** Design a modulator with given insertion loss, frequency range and operation voltage.

Processing and characterization: Growth, synthesis and fabrication. Characterization of optoelectronic devices. **Project:** Design a process flow for a given device structure.

Outcome:

Student should have an overview of a photonic integrated circuit design from materials and physics to processing.

TEXT BOOKS / REFERENCES:

1. Katsunari Okamoto – *Fundamentals of Optical Waveguides*, Sec. Ed. , Academic Press, NY
2. Pallab Bhattacharya – *Semiconductor Optoelectronic Devices*, Sec. Ed. PHI, New Delhi
3. Shun Lien Chuang – *Physics of Optoelectronic Devices*, Wiley Series in Pure and Applied Optics, John Wiley and Sons Inc. NY
4. S. O. Kasap – *Optoelectronics and Photonics- Principles and Practices*, Pearson

5. Ammon Yariv- *Optical Electronics*, 4th Ed., John Wiley & Sons
6. John M. Senior - *Optical Fiber Communication: Principles and Practice*, Third. Ed, Pearson
7. Papers for Organic electronics and functional materials.