ECE 770 Special Topics: Integrated Photonics

The course covers design principles, system functionality, and fabrication techniques for photonic integrated circuits for applications in telecommunication, data interconnects and biomedical sensing.

Course Objectives: The course aims to build intuitive understanding for the key principles in design and analysis of photonic integrated circuits. At the end of the course, a student should be able to design and analyze complex photonic integrated circuits and understand the engineering trade-offs needed to fabricate photonic integrated circuits.

Before complex structures can be designed, it is important to understand the components that constitute a photonic integrated circuits. Thus, the course will begin with an introduction to optical waveguides; methods to test and analyze waveguides and then discuss some important components like directional couplers; optical splitters; phase delays; multimode interference devices and Mac-Zehnder interferometers. Using these building blocks we will then discuss advanced integrated structures like optical transceivers; arrayed waveguide gratings; wavelength convertors and optical sensor systems. Depending upon the time, the course will conclude with introduction to silicon photonics.

Course Outline:

1. Introduction: Why Integrated photonics : 1 hour
2. Optical waveguides: 6 hours
   a. Waveguide mode analysis
      Slab waveguides
      2-D waveguides
      Numerical Analysis of 2-D and 3-D waveguides
   b. Waveguide platforms on different materials.
3. Analysis and Modeling Tools: 4 hours
   a. Coupled mode theory
   b. Super mode analysis
   c. Numerical tools.
4. Light coupling to Photonic Integrated Circuits: 2 hours
   a. Optical mode convertors for butt coupling
   b. Prism and grating couplers
5. Advanced Passive Components: 15 hours
   a. Mach-Zehnder and Fabry-Perot Interferometers
   a. WDM multiplexing components: Multiplexers, Demultiplexers;
   b. Multimode interferometers
   c. micro-ring resonators
   d. Arrayed Waveguide gratings
   e. Integrated photonic filters and delay lines
6. Electro-optic Modulators 3 hours
7. III-V Photonic integrated circuits: 3 hours
8. Introduction to silicon photonics: 2 hours.

**Grading Scheme:**
Given the practical nature of the course, the students will be accessed based on their ability to design photonic structures. 50% of grade will be based on design assignments; while 50% will be for a design project. The design project will have an individual viva (rather a report).