Overview

This course provides the fundamentals to understand, analyze, and design micro-scale photonic devices. We will begin with the wave description of light and study optical propagation in homogeneous and stratified media. Then we will study optical waveguides, which are essential to the confinement and routing of light. We will learn how to analyze and design optical reflectors, frequency filters, waveguide couplers, and resonators. We will finish with a brief description of several active devices essential to optical transmitters – the modulator and laser.

Lectures and Tutorials

Monday, 10:00-11:00 am, RS208
Wednesday, 11:00 am - 12:00 pm, BA1200
Tutorial: Friday, 1:00-2:00 pm, BA2195 (starts on Sep. 16, 2011)

Instructor

Prof. Joyce Poon, joyce.poon@utoronto.ca
Office Hours: by appointment, GB444A

Teaching Assistants

Dongpeng Kang, dongpeng.kang@utoronto.ca
Office Hours: by appointment, GB403

The instructor and TA will try to respond to emails within 48 hours, but cannot guarantee a response within the 24 hours before an assignment is due.

Grading

Assignments (5): 25%
Tests (2): 30%
Final exam: 45% (Type: X, Calculator: Type 2)

Assignments

Problem sets will be assigned regularly. Although discussions with other students are permitted, you must complete the assignments independently. Copying, when detected, will result in a zero grade for the assignment. Plagiarism is not tolerated.

Late Policy

Late assignments will be penalized at 20% per day.
Course Outline

Time line is approximate.

1. Introduction (0.5 week)
   • Overview of photonic integrated circuits – materials, devices
2. Basic Electromagnetics (1.5 weeks, Ch. 1)
   • Maxwell’s equations and boundary conditions
   • Wave equation
   • Polarization
3. Wave propagation (2.5 weeks, Ch. 4 & 12)
   • Refraction, reflection, transmission,
   • Fabry-Perot etalons/resonators
   • Anti-reflection coatings
   • Multi-layer periodic media, Bloch waves
4. Waveguides (3.5 weeks, Ch. 3 & 12 & 13)
   • Modes, waveguides, dispersion
   • Coupled-mode theory
   • Directional couplers, grating reflectors
5. Optical modulators (2.5 weeks, Ch. 1 & 9)
   • Light in anisotropic medium and birefringence
   • Electro-optic effect
   • Interferometers
   • Electroabsorption
6. Optical amplifiers and lasers (2 weeks, Ch. 5 & 6)
   • Optical gain in materials
   • Absorption, spontaneous emission, stimulated emission
   • Basic operation of optical amplifiers and lasers
7. Bonus topics (interspersed throughout)
   • High-index contrast (e.g. silicon) photonics
   • Nanoscale optics and surface plasmons
   • Current research and industry trends

Textbooks


Supplementary References:
Yeh. Optical Waves in Layered Media, Wiley.