ECE 672 Optoelectronic Devices (Winter 2024)

Instructor: Dayan Ban, QNC4603, ext. 37467, email:dban@uwaterloo.ca
Lectures: EIT3151,
Office Hour: TBD

Course Outline:

- Basic concepts and overview – optical properties of semiconductors, electromagnetic spectrum, elements of plane wave propagation, elements of solid state physics.
- Basic semiconductor electronics – Maxwell's equations and boundary conditions, semiconductor electronics equations, generation and recombination in semiconductors, semiconductor p-n heterojunctions.
- Basic quantum mechanics – Schrödinger equation, the square well, the harmonic oscillator.
- Electronic band structures in semiconductors – The Bloch Theorem and the k·p method for simple bands, The effective mass theory for a single band and degenerate bands, Kronig-Penney Model for a superlattice, band structures of semiconductor quantum wells.
- Optical waveguide theory – symmetric dielectric slab waveguides, asymmetric dielectric slab waveguides, wave guidance in a lossy or gain medium.
- Optical processes in semiconductors – optical transitions using Fermi's golden rule, spontaneous and stimulated emissions, population inversion, interband absorption and gain, intersubband absorption.
- Semiconductor lasers – carrier and optical confinement in heterostructures, double heterojunction semiconductor lasers, gain-guided and index-guided semiconductor lasers, quantum-well lasers, distributed feedback lasers, surface-emitting lasers.
- Photodetectors – photoconductors, p-n junction photodiodes, p-i-n photodiodes, avalance photodiodes.
- Intersubband transition – intersubband quantum-well photodetectors, selection rule, quantum cascade lasers.

Prerequisites: NE345 or equivalent.

Text: Lecture Notes.

Reference Books:

Shun Lien Chuang, *Physics of Optoelectronic devices,* John Wiley & Sons, Inc., 1995. (QC673 C48)
J. Wilson, J. F. B. Hawkes, *Optoelectronics: An Introduction*, Prentice-Hall International Inc., 1983. (QC673 W54)
Endel Uiga, *Optoelectronics*, Prentice Hall International Inc., 1995. (TA 1750 U35)
G. P. Agrawal, N. K. Dutta, *Semiconductor Lasers, 2nd ed.*, Van Nostrand Reinhold, 1993.
G. H. B. Thompson, *Physics of Semiconductor Laser Devices*, John Wiley & Sons, 1980. (TA 1700, T45)
H. Schneider and H. C. Liu, *Quantum Well Infrared Photodetectors: Physics and Applications*, Sringer, 2006 (ISBN-10:3-540-36323-8)

Grading: Assignments=15%, Project=35% and Final Exam=50%.