

ECE 672 Optoelectronic Devices (Winter 2023)

Instructor: Simarjeet Saini, [REDACTED], sssaini@uwaterloo.ca

Tentative Course Outline:

- Basic concepts and overview – optical properties of semiconductors, electromagnetic spectrum, elements of plane wave propagation, elements of solid state physics.
- Optical waveguide theory – symmetric dielectric slab waveguides, asymmetric dielectric slab waveguides, wave guidance in a lossy or gain medium.
- 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 $k \cdot p$ 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 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, avalanche 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 Photonics devices, John Wiley & Sons, Inc., 2009.

Larry A. Coldren, Scott W. Corzine, and Milan L. Mašanović, Diode Lasers and Photonic Integrated Circuits, Second Edition, Wiley & Sons, Inc., 2012.

G. P. Agrawal, N. K. Dutta, Semiconductor Lasers, 2nd ed., Van Nostrand Reinhold, 1993.

Schneider and H. C. Liu, Quantum Well Infrared Photodetectors: Physics and Applications, Springer, 2006 (ISBN-10:3-540-36323-8)

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