Semiconductor Optoelectronics: Theory and Design

Course Description

The course focuses on the physics of the interaction of photons with semiconductor materials. The band theory of solids is used to calculate the absorption and gain of semiconductor media. The rate equation formalism is used to develop the concepts of laser threshold, population inversion and modulation response. Matrix methods and coupled mode theory are applied to resonator structures such as distributed feedback lasers, tunable lasers and microring devices. The course is also intended to introduce students to noise models for semiconductor devices and to applications of optoelectronic devices to fiber optic communications.

READINGS BY SESSION

CLASS #	TOPICS
1	Background: carrier distributions, pn junctions, carrier injection
2	Photodetectors: absorption in bulk semiconductors, displacement currents, gain-bandwidth limits
3	Modulators: absorption in quantum wells, quantum confined Stark effect
4	Optical amplifiers: population inversion and gain, non-radiative recombination
5	Optical amplifiers: coupled electron-photon rate equations, gain saturation, optical confinement
6	Lasers: Fabry-Perot resonators, lasing threshold
7	Heterostructure materials: optical and electrical properties of alloys, heterostructure band alignment
8	Distributed feedback (DFB) and surface emitting laser resonators T-matrix formalism and coupled mode theory, grating based resonators
	Midterm
9	Tunable optics: chirp in semiconductor media, electro-optic effects
10	Modulation: small-signal and large signal analysis
11	Noise in optoelectronic devices: Langevin theory, shot noise limits, relative intensity noise (RIN) of lasers
12	Systems: WDM system design, noise and power budget for fiber optic systems

Text BOOK

Coldren, and Corzine. Diode Lasers and Photonic Integrated Circuits. 1st ed. New York, NY: Wiley-Interscience, October 16, 1995. ISBN: 0471118753.