SPRING 2024

SEMICONDUCTOR LASERS AND PHOTODETECTORS

ESE519

SUNY at Stony Brook
Department of Electrical and Computer Engineering

Prerequisite: BS in Physical Sciences or Electrical or Computer Engineering.
3 credits

Instructor: Sergey Suchalkin, Light Engineering Building, Rm253

LECTURE

Wednesday, 5:30 p.m. – 8:30 p.m., Melville Library, Rm N4000

OFFICE HOURS

Tuesday, Thursday, 11:00 a.m. – 1:00 p.m., Light Engineering Building, Room 253.

COURSE DESCRIPTION

The course provides an introduction to the design, characterization and fabrication techniques for semiconductor lasers and photodetectors. Topics include the following: fundamentals of the LED, laser and detectors operation, devices band diagram, characteristics and testing technique for lasers as well as avalanche and PIN photodetectors. Special attention is given to the device design and working characteristics.

TOPICS COVERED

- Fundamentals of the lasers operation: population inversion and optical feedback.
- Active media review.
- Semiconductor diode and double heterostructure lasers. Concepts of electron and optical confinement.
- Semiconductor laser band diagram. Concept of the pinning of the carrier concentration at the threshold.
- Parameters of the semiconductor laser: threshold current and device characteristic temperature, external and internal device efficiency, optical gain and losses, laser differential gain.
- Basic balance equations. Carrier lifetime.
- Basic lasers characterization technique. Measurement LI and IV characteristics in pulse and CW regimes. Hakki Paoli technique to measure laser gain.
- Measurements of the differential gain and optical loss.

- Laser emission: far and near field emission patterns. Methods of the lateral optical confinement in edge emitting devices: strong and weak index guided and gain guided semiconductor lasers.
- Quantum well lasers. Design lasers with strain.
- Quantum cascade lasers.
- Design of high-speed telecommunication lasers.
- Single mode lasers: ridge, DFB and DBR devices for telecommunication.
- Multimode high power lasers for pulse and CW operation. Design lasers with broadened waveguide. Pumping laser for fiber optics network. Laser arrays.
- Heterobarrier carrier leakage and laser internal efficiency. Doping profile of the semiconductor lasers. Design of the uncooled lasers for CATV. Interchannel distortion.
- Digital and analog optical transmitters for telecommunications. Lasers for pumping of erbium doped fiber amplifiers (EDFA).
- Vertical cavity surface emitting lasers (VCSEL). Lasers for optical storage. Lasers for spectroscopy. Gas combustion applications.
- High power semiconductor lasers and amplifiers. Lasers arrays. Military applications: countermeasure systems and rangefinders.
- Light absorption in semiconductors. Thermal and quantum detectors.
- Photovoltaic and photoconductive regimes of photodiode. Spectral sensitivity.
- MBE and MOCVD wafer growth methods. Device fabrication and packaging.

RECOMMENDED BOOKS

1. Title: Introductory Semiconductor Device Physics
Author: Greg Parker
Institute of Physics Publishing; New Ed edition (July 2004)
ISBN-10: 0750310219
ISBN-13: 978-0750310215

2. Title: "Semiconductor Laser 1 Fundamentals"
Editor: Eli Kapon
Academic Press
ISBN 0-12-39763

3. Title: “Diode Lasers and Photonic Integrated Circuits”
Authors: L. A. Coldren, S. W. Corzine, M. L. Mashanovitch
John Wiley & Sons
ISBN-13: 978-0470484128
ISBN-10: 0470484128

4. Title: “Photonics”
Authors: Amnon Yariv, Pochi Yeh
Oxford University Press
ISBN-13:978- 0-19-517946-0

EXAMS

1 midterm, 1 final (noncumulative).

Student Accessibility Support Center Statement
If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or via e-mail at: sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Academic Integrity Statement
Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management
Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.