SPRING 2016

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: Gregory Belenky

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.

COURSE TOPICS

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

9. 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.
10. Quantum well lasers. Design lasers with strain.
11. Design of high-speed telecommunication lasers.
12. Single mode lasers: ridge, DFB and DBR devices for telecommunication.
13. Multimode high power lasers for pulse and CW operation. Design lasers with broadened waveguide. Pumping laser for fiber optics network. Laser arrays.
14. Heterobarrier carrier leakage and laser internal efficiency. Doping profile of the semiconductor lasers. Design of the uncooled lasers for CATV. Interchannel distortion.
15. Digital and analog optical transmitters for telecommunications. Lasers for pumping of erbium doped fiber amplifiers (EDFA).
16. Vertical cavity surface emitting lasers (VCSEL). Lasers for optical storage. Lasers for spectroscopy. Gas combustion applications.
17. High power semiconductor lasers and amplifiers. Lasers arrays. Military applications: countermeasure systems and rangefinders.
18. Light absorption in semiconductors. Thermal and quantum detectors.
19. Photovoltaic and photoconductive regimes of photodiode. Spectral sensitivity.
21. MBE and MOCVD wafer growth methods. Device fabrication and packaging.

1. Title: Introductory Semiconductor Device Physics
Author: Greg Parker
Publisher: 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