Optoelectronic Devices (Phy-NITS)

Course Format

COURSE DESCRIPTION: Optoelectronics lies at the intersection of optics and microelectronics. Optoelectronic devices and circuits are quickly becoming core technologies for several key technical areas such as telecommunications, information processing, optical storage, and sensors. The widest deployment of fiber optics has, so far, been in the area of fiber optic technology, which relies on optoelectronic devices to generate (semiconductor light emitting diodes and lasers), modulate, amplify, switch, and detect optical signals. This course will cover these components. Additional topics that will be covered include solar cells, photonic crystals, and plasmonics, which are rapidly emerging optoelectronic technologies.

Optoelectronic Devices

Lecture #1 - Overview

Lectures #2 to #6 - Waveguides
- Theory of Dielectric Waveguides
- Attenuation
- Dispersion
- Fabrication Techniques
- Photonic Crystals
- Plasmonics
- Splices and Connectors (probably assigned reading)

Lectures #7 to #16 - Emitters
- Heterojunctions
  - Current Injection
  - Carrier Confinement
- Light Emitting Diodes
  - Critical Parameters
  - Displays - particularly blue LEDs
- Optical Amplifiers

- Semiconductor Lasers
  - Optical Gain
  - Threshold Condition
  - Device Characteristics
    - Structures
    - LI Characteristic

Field Intensity
Mode Structure
Output Power
Linewidth - DFBs and DBRs
Bandwidth

Lecture #17 – Optical Modulators
Mach-Zehnder modulators
Electroabsorption modulators
Integrated laser/modulators

Lectures #18 to #21 - Photodetectors
Physics of Photodetectors
Solar Cells
PIN Photodiodes
Responsivity
Dark Current
Bandwidth
MSM Photodetectors
Responsivity
Bandwidth
Avalanche Photodiodes
Gain Mechanism
Bandwidth and Gain-Bandwidth Product
Multiplication Noise
Recent advances in Photodetection Techniques

Lectures #22 and 25 – WDM Devices
Wavelength conversion
Optical switching