ECE 546 Optical Electronics- Spring 2021

Course credits: 3

Fall 2020 Delivery: The class will be delivered in person with the option to be taken on-line.

Catalog Description: The course covers the fundamental aspects of lasers and their implementations. It will allow to calculate major laser characteristics such as laser output power from basic principles. The structure and basic engineering aspects of selected lasers will be discussed.

Prerequisites: ECE 341, ECE 342, Electromagnetics; ECE 441 Optical Electronics

Textbook: Class notes provided by the instructor. Recommended reading: J. Verdeyen "Laser Electronics" Prentice Hall; A. Siegman "Lasers" University Science Books; W. Silfvast " Laser Fundamentals" Cambridge University Press

Course Objectives: To become familiar with fundamental concepts of lasers. To be able to compute/estimate key laser parameters such as laser output power, laser pulse energy, from basic principles.

Pre-requisites; It builds on concepts covered In ECE 441 "Optical Electronics". Pertinent ECE 441 lectures are uploaded on Canvas

Topics covered:

Laser fundamentals

- Review of amplification in an inverted medium
- Atomic linewidth and broadening mechanisms: Doppler broadening and collisional broadening, Voigt profile
- Laser amplification in homogenous medium
- Laser amplification in an inhomogeneous medium
- Gain saturation
- Review of optical cavities and optimum mirror transmissivity
- Laser excitation Mechanisms

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Topics covered:

- Rate equations, computation of excitation and de-excitation rates
- Introduction to gas discharge(plasma) lasers
- Collisional electron impact excitation and de-excitation; Principle of detailed balance of microscopy reversibility

- **Laser Devises**
- Helium-Neon laser: computation of the output power from basic principles
- Ion lasers. Example: Argon ion
- Molecular lasers: nitrogen laser, carbon dioxide lasers and excimer lasers
- Solid state lasers and optical pumping
- Nd:YAG and Nd:glass lasers
- Q-switching
- Diode pumping of solid state lasers. Example: Yb:YAG lasers
- Ultrashort pulse lasers, mode-locking ,chirped-pulse-amplification
- Ti:Sapphire laser
- X-ray lasers
- Selected topics

Course Evaluation: Two Mid-term exam (on Canvas) each with 30 % of total grade, and final project with written paper and oral presentation with a combined 40% of total grade.