1. ECE 546: Laser Fundamentals and Devices

2. 3 credits: 2-75 minute lecture sessions/week

3. Jorge Rocca

4. Laser Electronics. Verdeyen, J. T. 1995.
    a. Lasers. Siegman, A. 1986.
    b. Laser Fundamentals. Silfvast, W. T. 2008.

5. Course Information
    a. Amplification of light, laser excitation mechanisms, laser devices, characteristics and design
    b. Prerequisites: ECE 441
    c. Selected Elective: Electrical Engineering; Computer Engineering; Lasers & Optical Engineering

6. Goals for the Course
    a. Course Learning Objectives
        i. Describe basic concepts of light amplification, laser excitation mechanisms, and laser design and implementation
        ii. Identify and discuss the foundations of laser design
        iii. Compute important laser characteristics, such as the output power
    b. Student Outcomes
        1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
        2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline
        3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
        4. An ability to communicate effectively with a range of audiences
        5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
        6. An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge
        7. An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment

7. Topics Covered
    Review of laser amplification, gain coefficient
    Laser linewidth: homogeneous and inhomogeneous broadening
    Gain saturation

Rate equations for computation of population inversion
Laser output power and optimum mirror transmissivity
Gas lasers: principles of gas discharges
Population inversion mechanisms and gain computations in plasmas
The He-Ne laser. Modeling of a He-Ne laser based on basic principles
Ion Lasers: from the visible to the soft x-ray spectral region.
Molecular lasers: The CO2, N2, and Excimer lasers
Solid lasers: Nd:YAG, and Nd: glass lasers, Ti:sapphire laser
Q-switching : principles and techniques
Mode-locking: principle and techniques
Laser oscillator- amplifier designs
Non-linear optics concepts and frequency up-conversion
Diode pumping of solid state lasers
Ultrafast lasers
Amplification of ultra-short pulses, chirped-pulse-amplification
X-ray lasers