1. ECE 574: Optical Materials and Devices

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

3. Carmen Menoni

4. None - Class notes provided by instructor

5. Course Information
    a. Light propagation and interaction with materials; linear and non-linear optical properties
    b. Prerequisites: ECE 441 with a C or higher
    c. Selected Elective: Electrical Engineering; Computer Engineering; Lasers & Optical Engineering

6. Goals for the Course
    a. Course Learning Objectives
        i. Apply the basic physics that governs the interaction of electromagnetic radiation in the optical regime and materials
        ii. Calculate transition rates in different materials from fundament principles
        iii. Use above to explain the behavior of optical devices
    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 welfare, as well as global, cultural, social, environmental, and economic factors
        6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
        7. An ability acquire and apply new knowledge as needed, using appropriate learning strategies

7. Topics Covered

    Elemental properties of photonics materials
    Review Energy bands: Direct and indirect semiconductor materials
    Impurity states; Excitonic states
    Basic Concepts of the optical response: The oscillator model Kramer-Kronig relations
    Plasma resonance Experimental techniques to determine optical constants.
    Linear optical properties of bulk semiconductor material Excitonic absorption
    Linear optical properties of low dimension semiconductor materials.
    Recombination: radiative and non-radiative Band-to-band recombination
    Indirect recombination Band-to-impurity recombination Photoluminescence spectroscopy
    Photoluminescence excitation Electroluminescence.
    Polarization and electric/magnetic-field effects Frank-Keldish effect; DC-Stark effect
    Kerr Effect Faraday Effect Magneto-optics effects

Stimulated emission
Relationship between spontaneous emission and stimulated emission
Condition for lasing
Photonics devices: light emitting and laser diodes; solar cells; detectors.
Processes involving coherent radiation
Photon-Photon interaction: Amplification, Harmonic generation, multi- photon absorption
Frequency Mixing Photon-phonon interactions: Raman and Brillouin scattering, stimulated Raman effect
Oxide materials and devices: Growth and characterization Interference coatings
Photonic crystal structures
Holography