Lasers and Optical Electronics

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Office hours: Tues & Wed.: 4:00 – 5:00 PM

References [optional]:
“Photonics - Optical Electronics in Modern Communications” by Pochi Yeh & A. Yariv  

Grading Policy: 2 mid-term exam.(66 %) and biweekly reports/homework (10%); Final exam. (33%)

Course Contents:
- Reviews of Lasers Principles and Applications
  1. Electromagnetic theory of light/laser [chapter 1]- up to section 1.5
     Basic definitions - intensity, power, energy, refractive index, susceptibility.
  2. Propagation of laser beams [chapter 2] -
     Rays and ray matrix, Gaussian beams descriptions; Fundamental and higher order modes;
     Pulse broadening [modal and chromatic dispersions]
  3. Laser cavity and resonators [chapter 4]- section 4.1, 4.2, 4.7
     Fabry-Perot interferometer, resolution, cavity lifetime, modes.
     -----------------------------------------------------Mid-term I ----------------------------------------
  4. Interaction of laser with atomic medium [chapter 5] - sections 5.1 -5.7
     Spontaneous and induced emissions, gain, amplification and absorption
     Rate equations,
  5. Laser amplification, oscillations, pulsed high power lasers [chapter 6 section 6.1-6.7]
     Oscillation conditions, power and energy considerations, output couplings,
     multimode and singlemode lasers, mode-locking for ultra-short laser pulse, Q-switching for high power laser pulse generation;
     -----------------------------------------------------Mid-term II ----------------------------------------
- Advanced theories of laser interaction with matter; quantum optics and nonlinear optics
  - Quantum theories of light/materials
    - Basic quantum mechanics of atoms, molecules, and semiconductors
    - Electromagnetic theories revisited – photons and harmonic oscillators
    - Time dependent perturbation theory
      - Spontaneous and induced emissions
      - Atomic susceptibilities and refractive index; nonlinear susceptibilities
  - Resonant interaction of laser with materials – Semiclassical theories
    - Density matrix formalism
    - Coherent and incoherent laser-material interaction
     -----------------------------------------------------Final [mid-term III] --------------------------------------
- Laser laboratory demonstration [1 week]
  Nanosecponds and picosecond pulsed laser [1.06 μm and its harmonics at 0.53 μm];
  Near-infrared [750 nm, 1550 nm ] and infrared [10.6 μm] lasers.
  Experimental demonstration of laser generation, mode-locking and q-switching for short intense laser pulse, harmonic generation, gas laser discharge and infrared optics.