

Phys 413/613 - Lasers for Scientists and Engineers - 3 credits

Bulletin Description:

Lecture and laboratory introduction to lasers. Spontaneous and stimulated transitions, line-broadening, gain, gain saturation, optical resonators, Fabry-Perot interferometers, theory of laser oscillation, rate equations, transverse modes, coherence, and Gaussian beams. Prereq: PHYS 252

Course Objectives:

The goal of this course is to provide students with the fundamentals necessary to enable them to successfully apply lasers in their respective disciplines. This will be accomplished through hands-on use of state-of-the-art equipment in conjunction with classroom discussions to experience and understand the basic principles of laser operation and the properties of laser radiation.

Content Listing:

Part 1: Classroom

- **Gaussian beams:** Matrix optics, properties of the Gaussian beam, transmission through a thin lens, Hermite-Gaussian beams.
- **Optical resonators:** Resonator modes, losses and resonance spectra width, spherical-mirror resonators, two- and three-dimensional resonators, microresonators.
- **Interactions of photons with atoms:** Energy levels, spontaneous and stimulated transitions (Einstein coefficients), line-broadening, thermal light.
- **Theory of laser amplification:** Gain of an optical frequency amplifier, gain saturation, amplifier pumping, three-level pumping, four-level pumping, rate equations, common laser amplifiers, amplifier nonlinearity.
- **Theory of laser oscillation:** Optical resonator and optical amplification, laser threshold, laser frequencies, characteristics of the laser output power, characteristics of the laser output spectral distribution, homogeneously broadened medium, inhomogeneously broadened medium, spectral hole burning, common lasers

If time permits, pulsed lasers, Q-switching and mode locking, laser diodes.

Part 2: Seven embedded labs

- Setting up an open cavity HeNe laser (no report)
- Characterization of open cavity HeNe laser
- Gaussian optics with beam profiler
- Laser beam expansion
- Spectral characterization of light sources
- Laser diode/LED characteristics
- Scanning Fabry-Perot interferometer