

ENG EC570 Lasers and Applications

2008-2009 Catalog Data:

Prereq: (ENG EC560) Review of wave optics. Gaussian, Hermite-Gaussian, Laguerre-Gaussian, and Bessel optical beams. Planar- and spherical-mirror resonators; microresonators. Photons and photon streams. Energy levels; absorption, spontaneous emission, and simulated emission. Thermal and scattered light. Laser amplification and gain saturation. Laser oscillation. Common lasers and introduction to pulsed lasers. Photon interactions in semiconductors. LEDs, laser diodes, quantum-confined lasers, and microcavity lasers. Introduction to photon detectors. Laboratory experiments: beam optics; longitudinal laser modes; laser-diode output characteristics.

Status in the Curriculum: Elective

Class/Lab Schedule:

4 lecture hours/wk + 3 labs during term (hours TBA)

Textbooks and other required materials:

B. E. A. Saleh & M. C. Teich, Fundamentals of Photonics, 2nd Ed.

Coordinator:

Malvin C. Teich, Professor, Electrical & Computer Engineering

Prerequisites by topic:

Prereq: CAS PY313, Elementary Modern Physics; COE EC560, Intro to Photonics

Goals: To provide students with:

- A thorough understanding of the theoretical underpinnings of lasers and optical components;
- Experience in the design of optical systems that make use of lasers;
- Knowledge of the applications of lasers in optical systems.

Course Outcomes:

As an outcome of completing this course, students should be able to: solve optics and laser problems and be able to design a laser and laser system to accomplish a specific set of engineering objectives in the form of applications

Course Outcomes mapped to Program Outcomes:

- 1) *Understand* the principles of wave optics and their relationship to ray optics.
- 2) *Understand* the assumptions that lead to the Helmholtz equation.
- 3) *Understand* the importance of the paraxial approximation to the Helmholtz equation.
- 4) *Understand* the notion of a mode and why Gaussian and Gaussian-Hermite beams are modes of spherical-mirror resonators.

- 5) *Understand* how photon optics augments and modifies electromagnetic optics and how photon streams can be characterized.
- 6) *Understand* why different materials have different energy levels and bands.
- 7) *Understand* the concepts of absorption, stimulated emission, and spontaneous emission.
- 8) *Understand* the concepts of optical pumping and population inversion and what is required for a medium to exhibit gain.
- 9) *Understand* the concept of gain saturation and how it comes about.
- 10) *Understand* how resonators can be used to store energy and create laser oscillation in the absence of an external input signal.
- 11) *Understand* the energy levels of semiconductors and how photons interact with them.
- 12) *Understand* how the special properties of semiconductors allow high-efficiency, inexpensive, and small light-emitting diodes and diode lasers to be built.
- 13) *Design* optical beams to achieve specified beam widths, radii of curvature, and Rayleigh ranges.
- 14) *Design* optical resonators to match the modes of various optical beams.
- 15) *Design* lasers to operate at certain wavelengths and to exhibit specified temporal properties at the output.
- 16) *Design* quaternary III-V semiconductor materials to obey lattice matching and bandgap requirements.
- 17) *Implement and test* the divergence and collimation in Gaussian beams and *collaborate* with others in carrying out experiments.
- 18) *Implement and test* the theory of longitudinal laser modes and *collaborate* with others in carrying out experiments.
- 19) *Implement* and test the light-current relation in semiconductor laser diodes and *collaborate* with others in carrying out experiments.
- 20) *Write laboratory reports.*
- 21) *Discover* the range of existing laser equipment via use of the Internet and other resources.
- 22) *Discover* the differences between different types of commercially available LEDs and lasers.
- 23) *Assess the societal impact* of laser and related technologies *and the engineer's responsibilities* in this regard.
- 24) Provide a *retrospective* of the development of laser science in the context of other disciplines including electromagnetics and quantum mechanics.

Program:	a	b	c	d	e	f	g	h	i	j	k
Course:	1-12	17-19	13-16	17-20	1-12	23	20	23	21-22	23	17-19
Emphasis:	5	3	3	2	5	2	3	2	2	2	3

1=not at all; 5=a great deal;

Contribution of Course to Meeting the Professional Component:

Engineering topics: 100%

Prepared by: Malvin C. Teich, Professor

Date: May 20, 2009