EE-4441
Laser Types, Laser Design, Modeling Techniques, and Nonlinear Optics

Curricular Designation: CpE: elective, EE: elective

Catalog Description:
Survey of laser types and analysis of the common physical and engineering principles, including energy states, inversion, gain, and broadening mechanisms. Design issues include resonators, packaging, cooling, pulsed power, and safety. Students will construct a computational model that predicts laser performance. Nonlinear optics and selected applications also covered. Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring Pre-requisites: EE 3140

Textbooks(s) and/or Other Required Materials:

Prerequisites by Topic:
1. Familiarity with Maxwell’s equations, the wave equation, and plane wave solutions.
2. Familiarity with basic physics concepts, including atomic energy levels, photons, waves, and ray optics.
3. Mastery of elementary matrix algebra and elementary complex algebra.

Course Objectives:
1. Introduction to various laser types, designs, and applications.
2. Familiarity with fundamental principles of laser physics including emission, inversion, gain, linewidth, and broadening.
3. Mastery of elementary resonator analysis employing ABCD matrices and calculation of modes.
4. Application of laser physics and engineering concepts by development of a computational laser design and performance model. A formal presentation and report are required.
Topics Covered:
1. Fabry-Perot resonators, longitudinal and transverse modes
2. Gaussian beams, ABCD law
3. Spontaneous and stimulated emission, inversion, gain
4. Linewidth, broadening, broadening mechanisms
5. Initiation schemes, pulsed power, efficiency
6. Rate equation modeling – putting it all together!

Relationship of Course to Program Objectives (See UPAC SOP, Tables 1 and 2):

- **EE:**
  Outcome: a, m via topics: 1-6
  Outcome: o via topics: 1, 2, 6
  Outcome: p via topics: 1, 2

- **CpE:**
  Outcome: a, p, r, s via topics: 1-6

Contribution of Course to Meeting the Professional Component

- **EE:** Engineering Topics
- **CpE:** Engineering Topics

Class/Laboratory Schedule (note: 1 hour = 50 minutes):
Lecture: 45 hours = 3 hours/week for 15 weeks

Prepared by:
Dr. David H. Stone, Associate Professor, February 9, 2004