COLORADOSCHOOLOFMINES

Subject: Physics Number: PHGN480

Course Title: Laser Physics

Section: A

Semester/year: Fall 2017

Instructor or Coordinator: Chip Durfee (Professor)

Contact information: Timberline 1, room 15 x3894 cdurfee@mines.edu

(office will change after move-in)

Office hours: TBD

Class meeting days/times: Lecture MW 11-11:50, Lab Th 9-12

Class meeting location: Lecture Green 211, Lab GRL Annex

Web Page link: http://ticc.mines.edu/csm/wiki/index.php/PHGN-480_Fall-2017

Teaching Assistant: Randy Lemons

Contact information: GRL 1st floor mezz, rlemons@mines.edu

Instructional activity: 2 hours lecture 3 hours lab 3 semester hours

Course designation: Elective

Course description from Bulletin: Theory and application of the following: Gaussian beams, optical cavities and waveguides, atomic radiation, detection of radiation, laser oscillation, nonlinear optics and ultrafast pulses.

Textbook and/or other requirement materials:

Required text: "Principles of Lasers," 5th edition, Orazio Svelto. This book is available online from a campus/VPN connection through the CSM library website.

Other recommended sources:

"Laser Physics," by S. Hooker and C. Webb.

"Lasers," Anthony Seigman. Comprehensive, slightly more advanced than Svelto.

"Solid State Laser Engineering," Walter Koechner (latest edition). This is the bible for laser builders, and included everything from laser theory to power supplies and cooling.

"Lasers and Electro-Optics: fundamentals and engineering," Christopher Davis. Another good comprehensive textbook at the advanced undergraduate/early graduate level. 2nd edition recently published.

"The quantum theory of light," Rodney Loudon. Very good early chapters on the connection between classical and quantum interactions of light with matter.

Student learning outcomes: At the conclusion of the class students will…

1. understand the interaction of light with quantum transitions, including the origin of gain in different media,
2. understand how to derive rate equations to describe the balance of stored energy in the gain medium and in the circulating light field in the resonator,
3. understand how to use matrix methods to calculate the propagation of light as rays and as Gaussian beams and how to use these matrices to design optical resonators,
4. understand how to build and apply a quantitative model of laser oscillation to a real laser system
5. be able to experimentally align and characterize simple lasers

Brief list of topics covered:

1. Atom-EM wave interactions: gain and absorption, line broadening
2. Laser pumping, rate equations and laser oscillation
3. Modeling ray and Gaussian beam propagation
4. Resonator design: transverse and longitudinal modes
5. Pulsed laser systems: Q-switching and modelocking
6. Introduction to ultrafast optics

Policy on academic integrity/misconduct: The Colorado School of Mines affirms the principle that all individuals associated with the Mines academic community have a responsibility for establishing, maintaining an fostering an understanding and appreciation for academic integrity. In broad terms, this implies protecting the environment of mutual trust within which scholarly exchange occurs, supporting the ability of the faculty to fairly and effectively evaluate every student's academic achievements, and giving credence to the university's educational mission, its scholarly objectives and the substance of the degrees it awards. The protection of academic integrity requires there to be clear and consistent standards, as well as confrontation and sanctions when individuals violate those standards. The Colorado School of Mines desires an environment free of any and all forms of academic misconduct and expects students to act with integrity at all times.

Academic misconduct is the intentional act of fraud, in which an individual seeks to claim credit for the work and efforts of another without authorization, or uses unauthorized materials or fabricated information in any academic exercise. Student Academic Misconduct arises when a student violates the principle of academic integrity. Such behavior erodes mutual trust, distorts the fair evaluation of academic achievements, violates the ethical code of behavior upon which education and scholarship rest, and undermines the credibility of the university. Because of the serious institutional and individual ramifications, student misconduct arising from violations of academic integrity is not tolerated at Mines. If a student is found to have engaged in such misconduct sanctions such as change of a grade, loss of institutional privileges, or academic suspension or dismissal may be imposed.

The complete policy is online.

Grading Procedures:

Homework (30%): due approximately once a week.

Lab exercises (20%): lab meets each week, reports approximately every other week.

Midterm (20%)

Final project/presentation (30%): For the final project the students will write a report on a laser system, diagnostic or application of interest to the student, including design calculations. Each student will write a report and make a short presentation to the class.

Extra credit is available for students wishing to do extra experiments using equipment available in the laser lab. Please make arrangements with the instructor.

Coursework Return Policy: Expect to receive your graded homework within two weeks of turning it in. At the time we give homeworks back to you, solutions will be available in printed form in a binder that I'll keep, but you can make a copy.

Absence Policy (e.g., Sports/Activities Policy): Please make arrangements with the instructor in advance of any legitimate planned absences.

Homework:

- Homework will be posted on the course website. Any adjustments, clarifications or hints will be posted there.
- Homework must be turned in when it is due to be graded – plan ahead.
- Exams: If you will be absent during a scheduled exam, you should schedule a make-up time before you leave.

Detailed Course Schedule: See course Wiki for reading schedule, assignments, and Mathematica demos.