AEP1100: LASERS AND PHOTONICS

SPRING 2024

INSTRUCTOR:
Prof. Chris Xu
E-mail: cx10@cornell.edu Office hours: 276 Clark Hall, W: 3:30 p.m.-5 p.m.
F: 4 p.m.-5 p.m.

TEXTBOOKS:

Introduction to Laser Technology, Fourth Edition by Hitz, Ewing, and Hecht [Required]
Available for free online: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118219492
(must be accessed via Cornell network)

Optional readings (ebook or on reserve at Carpenter Hall Engineering Library)

The Laser Guidebook by Jeff Hecht (This book is available as an e-book. Students can find it by typing in the title in the library catalog.)

Optics by E. Hecht

The Laser and Its Applications in Science, Technology, and Medicine by Terrill Cool

COURSE WEB SITE: Log in to https://canvas.cornell.edu/courses/62968

LAB INSTRUCTOR:	Office	E-mail	Office Hours
Dr. Jon Velazquez	131 PSB	jv16@cornell.edu	T/Th: 12:30-1:30 p.m.

TEACHING ASSISTANT:	Office	E-mail	Office Hours
Aman Patel	135 PSB	adp95@cornell.edu	T: 1:30-2:30 p.m.

LAB ASSISTANTS:		Office	E-mail	Office Hours
(M):	David Bertuch	131 PSB	dcb277@cornell.edu	4:30-5:30 p.m.
(T):	Nicole Thean	131 PSB	nct43@cornell.edu	4:30-5:30 p.m.
(W):	Jacob Kiviat	131 PSB	jak482@cornell.edu	4:30-5:30 p.m.
(Th):	Nicole Thean	131 PSB	nct43@cornell.edu	4:30-5:30 p.m.

COURSE SECRETARY/REGISTRAR:
Cynthia Reynolds Office: 261 Clark Hall (8:30 a.m-4:30 p.m.)
E-mail: crr8@cornell.edu Phone: 607/255-0638

Lectures: Tues, Thurs -- 10:10-11:00 a.m., 120 Physical Sciences Building (PSB)

Laboratories: **Start week of 28 January 2024**: M-Th, 2:30-4:25 p.m., 131&135

Physical Sciences Building (PSB)

The criteria upon which your grades will be based:

Examinations: There will be one in-class prelim (dates: 20 February and 28 March; time: 10:10 a.m. - 11 a.m.; venue: 120 PSB) and one final exam (date: TBA; time: TBA; venue: TBA) [see https://registrar.cornell.edu/exams/spring-final-exam-schedule for any updates].

Homework: No credit will be given for late homework, but one assignment may be missed without penalty. Students are encouraged to work together on problem sets; however, each student must hand in an independent write-up.

Homework is to be submitted via Canvas.

Laboratories: Divided into two parts of 6 and 6 weeks each. In one 6-week period you will be involved in a team constructing and testing a molecular nitrogen laser. In the other 6-week period you will participate in a group of six experiments (one-per-week) aimed at demonstrations of various fundamental properties of lasers and optics. You are expected to attend and participate in all labs. Also, there may be short quizzes during the laboratory periods.

Late lab reports will have points deducted per late day. After six late days, reports will no longer be accepted and will be recorded as 0 points.

Lab reports are to be submitted via Canvas.

*Please note that the lecture and lab may not correlate because the lab is divided into two half-semester periods.

Grade Distribution: Prelim (mid-term exam): 20%; Final exam: 25%; Homework: 25%; Laboratory: 30%

Course Topics

- optics and the characteristics of laser light
- states of atoms and molecules
- principles of laser action
- types of lasers
- applications of lasers in science, technology, medicine, …

Each student in this course is expected to abide by the Cornell University Code of Academic Integrity. Any work submitted for academic credit by a student in this class will be the student's own work.

Lasers and Photonics

This is a unique course. It is largely a hands-on laboratory course and a good portion of the final grade (~30%) is based upon performance in the laboratory. The laboratory is divided into two sections, each lasting six weeks: the construction section and the demonstration section.

In the construction section, students will construct, debug, and test a molecular nitrogen laser. This will be a team effort. The section will be divided into three working groups. Each group will be solely responsible for constructing and testing one of the three vital components of the laser. These components are the pulse generator, the pulse amplifier, and the laser cavity itself. In the construction section, students will learn the practical aspects of designing, building, and testing electronic circuits; assembling and testing vacuum systems; and the general fundamentals of laser operation.

At the end of a four-week construction effort, the work of the three separate groups within each section will be combined to form the final product: a working molecular nitrogen laser. This working laser will then be used to perform various experiments. Since there will be a short, written report on the results, students must work closely with one another to insure a properly functioning device. Towards this end, students should learn not only the full details of their component, but also the basics of what other groups in the section are doing so that they know how their component fits into the final project. To aid students in this regard, there will be two short quizzes given during the construction section and student led discussions about each component of the laser. After the nitrogen laser project is finished, students will be introduced to the carbon dioxide laser.

In the demonstration section, students will participate in six laser optics demonstrations. Students will be presented with an experimental set up and obtain data, perform analysis, and answer questions concerning the experiment. A short lab report will be due weekly. The aim of this part of the laboratory is to achieve familiarity with some practical basics of optical physics and with various kinds of lasers and optical devices. The reports will provide practice in presenting experimental data in a format that is understandable to others. The construction and demonstration sections run simultaneously. The two sections are designed so that they can be taken in any order.

CHANNELS OF COMMUNICATION

The lectures for this course are meant to further illustrate principles and applications of lasers. However, because of the nature of the laboratory, they cannot follow the laboratory content as closely as we would like. Some of the lab material will come before we discuss it in lecture and vice versa. And in some cases, we will cover topics in the lecture and not the lab.

*** DO NOT HESITATE TO ASK QUESTIONS ***

One purpose of this course is to have the student learn in an interactive fashion by presenting thoughts to others in the labs and by asking questions of the teaching staff and of fellow students.

We will list office hours for the instructor and the teaching assistants. Please use these hours to clear up any points (lecture or labs) that do not make sense. Do not hesitate to make an appointment at some other time. Attendance at lectures is strongly recommended.

POLICY ON MISSED LABORATORY SECTIONS

If a student cannot attend a demonstration laboratory section, arrangements must be made with the lab instructor to make it up during that week. Since it is impossible to make up the construction lab, the construction lab grade will be reduced proportionally, i.e., if one lab is missed, the grade is reduced by 1/6. If there are any serious problems, please contact the professor.