Optical and Laser Engineering Applications
ENSC 470-4 (Undergraduate) (3-0-2) 894-3 (Graduate) (3-0-0)

Professor

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Schedule for Fall 2017

Tuesday 17:00 - 18:20 Thursday 17:00 - 18:20, AQ5016
Tutorial: Tuesday or Thursday 16:30-17:00, AQ5016

Course Website

http://www.sfu.ca/~gchapman/e470out.html

Description

Optical Engineering is the study of the how optical elements can be applied to the design and construction of optical instruments, and their application to practical engineering problems. Lasers are increasingly moving from the laboratory into commercial products and industrial manufacturing. This course concentrates on the practical applications of optics/laser and less on the physics behind the behaviour. It starts with a basic explanation of the concepts of light then moves on to a concentrated understanding of optics, optical systems and optical design. Lasers operations, and interactions with optical systems (Gaussian optics) are covered, followed by the operational details and characteristics of the major laser types. The course then goes in detail of laser applications in engineering, an understanding of optical design and an introduction to fiber optics. In the lab the students will learn how use basic optical benches, lens setups, measurement tools and basic measurements with lasers and basic optical CAD concepts. Undergraduates (470) will do the three experimental labs while 894 Graduate students two labs and choose to do a minor or major project.

Prerequisites

Students need an introductory optics course (eg Phys 121), Math 310 and must be 3rd year or above. This course replaces 376 for the biophotonics stream.

Course Outline

Week 1: Introduction to light:
Spectrum, electromagnetic nature of light, black body radiation, optical interaction with materials, units of optical measurement, photometry and radiometry
Week 2: Basic Optical elements
Reflection, mirrors, refraction, lenses, human eye
Week 3: Geometric Optics
Geometric optics: reflective systems, refractive systems, matrix and ray tracing. Setting up optics in the lab
Week 4-6: Introduction to lasers & Laser Safety
Basic laser theory of operations, Gaussian optics; characteristics practical operations and care of major laser types:
Gas, Ion, Eximer, Solid State, Dye, Metal Vapour, Semiconductor, X-ray
Dangers in laser uses, potential damages, safety procedures
Week 7: Aberrations in optical systems
Aberrations from mirrors or lenses: beyond the first order approximations of geometric optics
Week 8: Polarization, Interferometry and interferometers
Polarization of light by materials: applications to the LCD display, interference and interferometers
Week 9: Diffraction & Spectrometers
Diffraction of light, Fraunhofer and Fresnel, optical resolution, diffraction gratings, spectrometers, nonlinear optical switches.
Week 9b: How optical elements are fabricated
Fabrication of mirrors and lenses; methods of measuring optical surfaces, lens/mirror quality
Week 10-11: Optical system Design & Zemax CAD
Design of multi-element optical systems; eyeglasses, achromatic optical elements, eyepieces, microscopes, reflecting and refracting telescopes, multi-element photographic lenses, digital cameras, optical CAD (Zemax).
Week 11-12: Laser Applications:
Laser heat treatment, laser heat flow calculations, surface melting, alloying, cladding, cutting, medical applications.
Week 12: Laser Consumer and Holography Applications
Compact disk, DVD operation/mastering, Applications in microelectronics, and holography
Week 13: Photonics, Fiber optics and Integrated Optics
Photodetectors, nonlinear optics, Guided light, integrated optics, Photonics. Laser Fusion, Laser flight, Course summery.

Laboratory

Labs will consist of demonstration labs and experimental project labs. Demonstrations will include the operation and use of laboratory bench optics devices and alignment. 3 Labs are planned for the course:
(1) Lens optics and aberrations measurements
(2) Spectrometer measurement of laser and light sources
(3) CW laser optical setup (beam expander) and beam measurements
(4) Laser dye bleaching
(5) Creation of Holograms lab.
Graduate students will do either a major or minor project in place of lab 4, which will be either from a list of projects or a project connected to their graduate studies.

Lab demos: LA01 Wednesday 17:30-19:20 ASB 10878
LA02 Thursday 14:30-16:20 ASB 10878
These times are for demos of labs. Students book time for their own lab in the same room

Laser Safety

Students must attend the Laser Safety lecture in the class in order to do the labs involving lasers. Students attending that class can take a test to get a Laser Safety certificate for SFU that is required for graduate or undergraduate research lab work with lasers.

Text Book

Full notes will be supplied to students on the web.
Suggested:
Jeff Hecht, "Understanding Lasers, an Entry Level Guide", Wiley/IEEE
Breck Hitz, J.J. Ewing, Jeff Hecht, "Introduction to laser technology, third edition"
Library electronic version available from the SFU library under the IEEE explore ebook section.

Assignments

Assignments will be given every 2-3 weeks after the second week of class. Assignments will be emailed to the students. Each student gets a separate assignment with the same questions but different parameters and solutions. If you used someone else's numbers you get zero on the question. If you do that twice within one assignment you get zero on the assignment. You will be emailed a solution set to your specific questions.

Tutorial/Problem Workshops

Tutorials will be held on an as announced basis (not every week but about every 2nd week) – typically in the hour before class (either day). These will involve workshops where a problem is assigned, worked through in groups, and then solutions given. Typically 2 problems per session. Post workshop problem solutions will be posted to web site.

Marking

Undergrads
Best of: 15% Weekly Assignments, 15% Midterm test, 40% Final Exam, 30% Project/Labs
25% Weekly Assignments, 50% Final Exam, 25% Project/Labs
Graduates
Best of: 15% Weekly Assignments, 15% Midterm test, 40% Final Exam, 30% Project/Labs
20% Weekly Assignments, 20% Midterm test, 20% Labs, 40% major project
Major projects are only for students working on their graduate thesis in the laser/optics fields. Projects are done in cooperation with their supervisor. They must use their own equipment and supplies for such project

Teaching Assistant

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Class Email:

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