Introduction to Optical Engineering and Design
ENSC 376-4 (Undergraduate) (3-0-2)

Professor

Glenn Chapman, Rm 8831; email glennc@cs.sfu.ca

Schedule For 2008-1

Monday: 15:30 - 17:20, Wednesday 15:30 - 16:20: AQ5008

Course Website

http://www.ensc.sfu.ca/~glennc/e376out.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. The course concentrates on the practical application of optics, and less on the physics behind the behaviour. It starts with a basic explanation of the concepts of light, as electromagnetic radiation. Then it looks how light is generated, at both the atomic and black body level. Next optical interaction with materials is discussed beginning with reflection, refraction, and scattering. Then it will look at basic reflection (mirror) optical elements, followed by refractive optics (wedges, lenses). The human eye is considered as an optical system. Then we look optical systems created by multiple optical elements, and the simple geometric, matrix and ray tracing methods of developing systems. Next lens/mirror aberrations are analyzed: what happens in real systems when the simple approximations of geometric optics are exceeded. Polarization of light is studied, and applied to such devices as LCD displays. Optical interference is studied and applied to interferometers. Diffraction is studied next and how this limits the resolution of optical devices, and creates devices such as diffraction gratings. Next we consider how light is measured (radiometry and photometry). Then the course looks at practical engineering optics: first how mirrors, lenses and filters are fabricated. Finally we look at practical optical design and construction of many systems ranging from the simple microscopes, reflecting and refracting telescopes, achromatic optical elements, up to multi element photographic lenses, and digital cameras. In the lab the students will learn how use basic optical benches, lens setups, and measurement tools.

Prerequisites

Also students need an introductory optics course (eg Phys 121) .

Course Outline

Week 1: Introduction to light:
Spectrum, electromagnetic nature of light, optical interaction with mater
Week 2-3: Basic Optical elements
Reflection, mirrors, refraction, lenses, human eye
Week 4-5: Geometric Optics
Geometric optics: reflective systems, refractive systems, matrix and ray tracing. Setting up optics in the lab
Week 6: Aberrations
Aberrations from mirrors or lenses: beyond the first order approximations of geometric optics
Week 7: Polarization
Polarization of light by materials: applications to the LCD display
Midterm test
Week 8: Diffraction
Diffraction of light, Fraunhofer and Fresnel, optical resolution, diffraction gratings, spectrometers
Week 9: Photometry and Radiometry
Unites of optical measurement, how light is measured, photodetectors and power meters.
Week 10: How optical elements are fabricated
Fabrication of mirrors and lenses; methods of measuring optical surfaces, lens/mirror quality
Week 11-13: Optical system Design
Design of multi-element optical systems; eyeglasses, achromatic optical elements, eyepieces, microscopes, reflecting and refracting telescopes, multi-element photographic lenses, digital cameras, optical design software.
Week 13: Course summary
Worked problems covering the course.

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) Simple lens and mirror optics
(2) Lens aberrations measurements
(3) Diffraction and interference
Students will also do a complex optical design project outside of the lab

Text Book

Optics 4th edition, by Eugene Hecht, Addison Wesly, 2002
Strongly recommended reference: Schaum's Outline of Optics, Eugene Hecht, McGraw-Hill 1974

Marking

Best of: 15% Weekly Assignments, 15% Midterm test, 40% Final Exam, 30% Project/Labs
20% Weekly Assignments, 50% Final Exam, 30% Project/Labs