

BME136 ENGINEERING OPTICS FOR MEDICAL APPLICATION

- Catalog Data:** **BME136 Engineering Optics for Medical Application (Credit Units: 4)**
W. Fundamentals of optical systems design, integration, and analysis used in biomedical optics. Design components: light sources, lenses, mirrors, dispersion elements, optical fibers, detectors. Systems integration: microscopy, radiometry, interferometry. Optical system analysis: resolution, modulation transfer function, deconvolution, interference, tissue optics, noise. Prerequisite: BME130, BME135, EECS180, or consent of instructor. Formerly ECE176. (Design units: 3)
- Textbook:** Hecht, E. *Optics*, 3rd edition, Addison-Wesley, 1998.
- References:** Lectures and problem sets are available and downloadable from a website. Handouts from instructor.
- Coordinator:** Bruce Tromberg.
- Course Outcomes:** Students will be able to:
Demonstrate knowledge of the fundamentals of optics and how basic principles are used to design and optimize optical instruments used in medical diagnostics.
Describe geometrical optics and its role in the design of microscopy instruments.
Describe wave optics and its role in the design of instrumentation for optical coherence tomography.
Describe basics of light matter interactions and its role in spectroscopy instruments.
- Prerequisites By Topic:** This course is for upper level (typically senior) undergraduates who have completed core courses in basic sciences and/or engineering, and first or second year graduate students who expect to focus on biophotonics or photonics research.
Electromagnetic fields and solutions of problems in engineering applications.
Maxwell's equations and plane wave propagation.
- Lecture Topics:** Introduction and overview of biomedical optics.
Principles of geometrical optics, lenses, apertures, ray diagrams.
Principles of geometrical optics, fibers and waveguides.
Integration of geometrical optics into Microscopy systems.
Applications of microscopy systems and laser scanning microscopies.
Laser scanning microscopy.
Principles of waves, interference, coherence.
Principles of polarization and Doppler.
Integration of wave concepts into the design of optical coherence tomography (OCT) systems.
Applications of OCT in biology and medicine.
Basic light matter interactions; absorption, emission, scattering.
Photonic devices- sources: lasers, LEDs, SLDs.
Photonic devices- detectors: performance theory; photomultipliers, photodiodes, array detectors.

System integration: Spectroscopy.
Applications of spectroscopy in biology and medicine.
Physiological Optics: eye structure, performance.
Physiological Optics: vision mechanisms, image formation and perception.
Image processing: modulation transfer function, transformation methods.
Imaging: applications of image analysis and processing in biology and medicine.

Class Schedule: Each class meets 3 hours per week for 10 weeks and students are assigned to a 3 hour lab session per week.

Computer Usage: Lectures and problem sets are available and downloadable from a website.

Laboratory Projects: Lab projects will complement lecture topics in microscopy, interferometry, spectroscopy, and diffuse optics.

Professional Component: Contributes toward the Biomedical Engineering Topics and Major Design experience.

Relationship to Program Outcomes: This course relates to Program Outcomes 1, 2, 3, and 4 as stated at: http://www.eng.uci.edu/dept/objective_biomedical.

Design Content Description

Approach: Design an optical instrument that could be used to solve a fundamental problem or provide clinical information regarding one of the following broad areas of biology and medicine: cancer, heart disease, wound healing, or neuroscience. Students will work in small groups or teams. They will analyze relevant published literature and course materials, and present an instrument design in a formal class presentation and written document. The main elements that must be covered include: biological background, competing technologies, novelty of approach, integrated technology problem solving.

Lectures: Lectures are presented on basic optics concepts regarding principles of geometrical optics, wave propagation, optical devices, and photonic technologies. These concepts will be introduced in the framework of biomedical instruments and biomedical problems. (30%)

Laboratory Portion: Three labs in microscopy, six labs in spectroscopy. (70%)

Grading Criteria:

Homework programs:	25%
Midterm exam:	12.5%
Final exam:	12.5%
Group project:	25%
Lab:	<u>25%</u>
	100%

Letter grades are based on a curve about the median score which is assigned B-minus grade.

Estimated ABET Category Content:

Mathematics and Basic Science: 0 credit units or 0%

Engineering Science: 1 credit units or 25%

Engineering Design: 3 credit units or 75%

Prepared by: Bruce Tromberg **Date:** July 2005

CEP Approved: Spring 2004