

BME136 ENGINEERING OPTICS FOR MEDICAL APPLICATIONS
(Elective for BME)

Catalog Data: **BME136 Engineering Optics for Medical Applications (Credit Units: 4)**
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. (Design units: 3)

Textbook: Hecht, E. *Optics*, 4th edition, Addison-Wesley, 2004.

References: Lectures and problem sets are available and downloadable from a website. Handouts from instructor

Coordinator: Bruce Tromberg

Relationship to Program Outcomes: This course relates to the Program Outcomes for **BME: a, b, c, d, e, g, h, i, j, and k** as stated at:
<http://undergraduate.eng.uci.edu/degreeprograms/biomedical/mission>

Course Outcomes / Performance Criteria: Students will:
Demonstrate knowledge of the fundamentals of optics are used to design and optimize optical instruments for current medical diagnostic issues(BME a, c, h, i, j)
Apply fundamental concepts and equations in the optics in order to quantitatively analyze optical technologies in medical diagnostics.(BME a, k)
Design and conduct experiments to quantitatively assess optical signals in the context of biomedical engineering applications.(BME a, b, d, e, k)
Demonstrate written communication skills through written reports describing methods and results used to quantitatively assess optical techniques in biomedical applications.(BME a, g)
Demonstrate oral communication skills in team projects that review and analyze current optical technologies.(BME d, e, g)
Demonstrate knowledge of biomedical applications of optical methods as well as competing approaches and technology development. (BME c, d, e)

Prerequisites By Topic: 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.
Inelastic Scattering signals and applications in Biology and Medicine.
Integration of wave concepts into the design of optical coherence tomography (OCT) systems.
Applications of OCT in Biology and Medicine.
Photon Migration and Imaging of Thick Tissue.
Wide-field Optical Imaging Methods for Vascular Imaging.

Class Schedule: Meets for 3 hours of lecture and 3 hours of lab each week for 10 weeks.

Computer Usage: Students use computers for simulation, data acquisition, data processing, and presentation of lab projects.

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.

Design Content Description

Approach: Design and analyze an optical instrument that is 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 analysis in a formal class presentation and document. The main elements that must be covered include: biological background, competing technologies, novelty of approach, integrated technology problem solving.

Lectures: (50%)

Laboratory Portion: (50%)

Grading Criteria:

Homework:	10%
Midterm	25%
Group projects:	25%
Lab:	15%
Final:	25%
	100%

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

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CEP Approved: Spring 2004