Description:
 Technologies that use light are all around us, both in well-established and rapidly developing areas. Examples abound! Our streaming and cloud services would not function without optical fiber technology. Autofocus in smartphone cameras makes photography easy. LED light sources drastically reduce energy use for illumination. Lasers are crucial in communication, medicine, and metrology. Optical quantum communication and computation is poised to make an impact.

This introductory optics course aims for students to see the potential of optics. Students will learn geometric optic and imaging, including our visual system, wave optics with diffraction and interferometry applications, and use of light sources and detectors. The class includes demonstrations, lab-visits, hands-on exercises, and student presentations. **Optical technologies** (depending on class interest) e.g., precision measurements, holography, bio photonics, lasers and applications, fiber optics and communication.

Prerequisites: Junior or senior standing (MA 221, MA222, PY211, PY212)

Credits: 4

Course objectives
To provide students with hands-on experience with optical components and experimental techniques. To raise awareness of optical solutions for technical problems. Laser safety.

Lecture: MW4:30-6:15 (all students) CAS 227
Labs: R 11-1pm (B1) R 2-4 pm (B2)

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Student hours Tuesday 12-1 pm or by appointment

Lab assistants Parker Landon landonp@bu.edu and Piazza
Hriteshwar Talukder hritesh@bu.edu and Piazza

Reference textbooks “A first Course in Laboratory Optics”, Andri Gretarson
Cambridge University Press
“Introduction to Optics” Pedrotti, Pedrotti, Pedrotti
Cambridge University press

Webpages Blackboard for material Piazza for communication

Requirements Labs 70%, Quiz & HW 10%, Projects 10% presentation 10%
Lecture topics

Introduction
The nature of light (rays, waves, polarization, particle-wave duality, quantum light)
A brief history, photon -particles, Electromagnetic spectrum, Radiometry, Light sources

Geometric Optics (Ray optics)

Geometric optics, ray optics, physical optics (when $\lambda \to 0$) Law of Reflection, Law of Refraction, Snell’s law, Huygens’ Principle, wavefronts Fermat’s principle, Total internal reflection. (and applications)
Geometrical optics and image formation Optical pathlength, Lenses and lens shapes, Thin lenses, cylindrical lenses Gaussian optics (first order expansion $\sin(x) \sim x$, $\cos(x) \sim 1$)
Optical Instrumentation Stops, pupils and windows, Aberrations, Prisms, The camera.
Eye piece Microscope and Kohler illumination Telescope

Wave Optics

Wave-optics 1D wave equation, Harmonic waves, Complex numbers, Harmonic waves and complex functions Plane waves, Spherical waves
Superposition of waves Superposition principle of same frequency, standing waves, random and coherent sources
Interference of light 2 beam interference, double slit, dielectric films and thickness measurements, Newton’s rings.
Optical interferometry Michelson interferometer, Fabry Perot interferometer, Laser cavity, LIGO
Coherence FT of finite wave train, application to OCT
Diffraction grating Free, spectral range, Dispersion, resolution and instrumentation, Spectroscopy

E&M radiation, Polarized light

Matrix Representation of Polarization Jones vectors and Jones matrices
Polarized light from selective absorption, reflection, scattering.
Interaction with matter Bi-refringence, optical activity

Guest lectures/lab visits
Optical Tweezers
Interference bio-detection (Virus)
Birefringence biodetection (Brain)
Deformable mirror for phase-front engineering
Zygo Interferometer for precise height measurements
Optical circuits
Fibers
## PROJECTS

- Pinhole camera, long exposure
- Interference phenomenon
- Polarization phenomenon

## LABS

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