

## EE 320 – Introduction to Electro-Optical Engineering

**Designation:** EE elective course for electrical engineering majors.

University Bulletin Description: EE 320: (3) An introduction covering several fundamental areas of modern optics, optical processes, and devices.

Prerequisite: EE 330.

### Prerequisites by Topics:

1. Three-dimensional analytic geometry
2. Partial differentiation equations
3. Integral vector calculus
4. Basic geometrical optics at level of PHYS 214 or equivalent
5. E&M Fields and their interaction with dielectric materials
6. Understanding of Maxwell's equations

**Textbook/Required Materials:** *Optics*, 4<sup>th</sup> ed, Eugene Hecht, Addison-Wesley, 2002

### Learning Outcomes:

This course provides the foundational education in optical engineering analysis and design. Through the lectures, in-class demonstrations, out-of-class curious observer assignments, and homework problem solutions, the students are provided learning experiences that enable them to:

1. Develop understanding of electromagnetic waves and scattering as light interacts with matter. Expand their knowledge of E&M theory and Maxwell's equations by exploring applications to the optical spectrum.
2. Examine the description of light wave scattering at an interface and calculate results using Fresnel coefficients.
3. Gain capability to design and model simple optical systems by mastering the elements of geometrical optics. Apply that ability to understand several types of optical instruments, including microscopes, telescopes, and fiber optics.
4. Explore the ways of generating and describing polarized light, including the use of wave plates and EO switches, as well as other EO devices.
5. Examine interference phenomena and understand the operation of several types of interferometers. Apply the interference concepts of Fraunhofer diffraction and describe single and multiple-slit diffraction, including gratings.
6. Understand laser operation.
7. Become a curious observer of the world through observer assignments to encourage lifetime learning.

### Topics:

1. Wave description of light (2 classes)
2. Review of Maxwell's Equations with emphasis on physical interpretation and meaning behind the mathematical statements, and use Maxwell's equations to derive the differential wave equation (4 classes)
3. Concepts of wave and corpuscular interaction of photons (2 classes)
4. Electromagnetic wave description of reflection and refraction (2 classes)
5. Fresnel coefficients (2 classes)
6. Geometrical Optics, Ray Tracing Models, Optical Instruments, Aberrations (5 classes)
7. Fiber Optics (1 class)
8. Polarization, E-O devices, Waveplates and Rotators (3 classes)
9. Interference, Interferometers, Coatings and Films, Filters, AR Coatings (3 classes)
10. Fraunhofer Diffraction, Radiation Concepts (2 classes)
11. Introduction to Lasers and Modern Optics (2 classes)

**Class/Laboratory Schedule:** Two 75-minute lectures each week, three evening exams.

**Computer Usage:** Ray trace program provided to each student for solution of multi-element optical system.

**Laboratory Projects/Assignments:** Curious observer assignments are used to encourage thinking and visualization of optical problems. Students are given a polarizer and lenses for out of class investigations of polarized light and simple geometrical systems.

**Contribution to Meeting the Requirements of Criterion 5. Curriculum:**

This course contributes to both the engineering topics and design components.

This course provides the prerequisite foundational knowledge for a wide range of senior courses which focus on Optical Fiber Communications, Laser Applications, Electro-optical Devices, Optical Engineering, and Remote Sensing.

**Relationship to Program Outcomes:**

- O.1.1. Graduates will possess mathematics skills necessary for electrical engineering.
- O.1.2. Graduates will have a theoretical and practical background in both physics and chemistry.
- O.2.4. Graduates will understand fundamental electricity and magnetism concepts and be able to use them in applications.
- O.3.1. Graduates will have in-depth technical knowledge in one or more areas of specialization.
- O.3.2. Graduates will have practical understanding of the major electrical engineering concepts and demonstrate application of their theoretical knowledge of the concepts.
- O.4.2. Graduates will develop an appreciation of continuing educational and professional development.
- O.6. Graduates will appreciate their role as engineers in society.

**Prepared by:** C. Russell Philbrick

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