

455 - Physical Optics

Course Website: <http://www.cis.rit.edu/class/simg455/>

Course description

Physical principles are used to develop a firm fundamental understanding of optics and imaging. Main topics include light as an electromagnetic wave, light at an interface, polarization, interference, and diffraction. Also includes a brief introduction to modern optics and a discussion of the fundamental limitations of an optical system and its effect on images. **Class 3, Lab 3, Credit 4 (S)**

Text: Introduction to Optics, Pedrotti, Pedrotti, Pedrotti, Pearson Prentice-Hall.

Other Resources:

Optics, E. Hecht, Addison-Wesley.

Introduction to Modern Optics G. Fowles, Dover.

Elementary Wave Optics, Robert H. Webb, Dover.

“Signals” (for modeling wave phenomena), Roger Easton and Juliet Bernstein

Topics

1. Mathematics of light as a wave (P³, §4,5)
 - a. Wave equation and traveling wave solutions
 - b. Harmonic waves
 - c. Plane waves, spherical waves
 - d. Principle of superposition
 - e. Addition of waves as phasors
 - f. Coherent vs. incoherent light sources
 - g. Phase velocity and group velocity
 - h. Dispersive media, dispersion curves

2. Electromagnetic waves (P³, §4,5)
 - a. Maxwell's equations in vacuum
 - b. Electromagnetic wave equation
 - c. Poynting vector, energy transport by EM wave
 - d. Superposition and phasors
 - e. Propagation of light in transparent medium; index of refraction

3. Light at an interface (P³, §23)
 - a. Huygens principle
 - b. Reflection and refraction, boundary conditions
 - c. Fresnel equations for TE and TM Polarizations
 - d. Reflectance and transmittance curves, phase change on reflection
 - e. Total internal reflection
 - f. Brewster angle
 - g. Polarization Angle; Brewster Windows
 - h. Reflection from Metals

4. Polarization of light (P³, §14,15)
 - a. Types of polarization
 - b. Linear polarizers and Malus' Law
 - c. Retarding elements, wave plates
 - d. Polarization by scattering
 - e. Jones vectors and matrices

5. Interference (P³, §7,8)
 - a. Division of wavefront: two-slit and multiple-slit interference
 - b. Gratings, resolving power
 - c. Division of amplitude, Michelson interferometer
 - d. Fabry-Perot interferometer
 - e. Thin-film interference

6. Diffraction (P³, §9,11,13)
 - a. Single-slit diffraction
 - b. Fresnel diffraction, impulse response of light propagation
 - i. Straight edge
 - ii. Rectangular aperture
 - iii. Circular aperture, Airy disk
 - iv. Fresnel zone plates
 - c. Fraunhofer diffraction and Fourier transforms

7. Optical Imaging (notes)
 - a. Point spread functions, image formation
 - b. Resolution, Rayleigh criterion.
 - c. Modulation transfer functions
 - d. Fourier-transform holography