

**SIMG-303, Optics for Imaging**  
**SYLLABUS**

Week of 3/8

Preliminaries and introduction

Classes of optical phenomena: quantum optics, geometrical (ray) optics, physical (wave) optics

Nature of Light, Wave Model

1-D Oscillations

longitudinal and transverse oscillations

harmonic and anharmonic oscillations

amplitude, period, frequency, angular frequency, phase

Mathematical representation of harmonic oscillations

sinusoids

complex notation, complex numbers, phasors

Lab 1: 1-D and 2-D harmonic oscillations on computer

3/15     *Last Drop/Add Day*

Week of 3/15

Superposition of oscillations with same frequency

linear and nonlinear media

computing resultants: amplitude and phase

Superposition of oscillations with different frequencies

linear and nonlinear media

average and modulation frequencies

examples: beats, aliasing, Moiré fringes

Coherence

Fourier representation of oscillations, spectra

Traveling waves, derivation of representations

dispersion, phase and group velocities

Mathematics of the Fourier series

two representations of periodic oscillations (space- and frequency-domain)

Homework: Introduction to frequency analysis of waveforms

Week of 3/22

Doppler Effect, transition from acoustic to electromagnetic waves

Electromagnetic waves

Derivation of the wave equation from Maxwell's equations

consequences of Maxwell's equations

transverse nature of EM waves

Huygens-Fresnel secondary spherical wavelets

index of refraction  $n = c/v$

velocity of light  $c$

dispersion,  $n = n(\lambda)$

reflection, phase changes

refraction, Snell's law

plane, cylindrical, spherical waves

Week of 3/29

Polarization: linear, elliptical, circular polarization

Birefringence,  $\lambda/4$  and  $\lambda/2$  plates, circular polarizers

Representation of polarization

Conventions

Jones vectors

Week of 4/5

MIDTERM EXAM I (interference of sinusoidal waves, average and modulation frequency, effect of polarization)

Imaging in the Ray Model

Fermat's principle

Snell's Law for reflection and refraction

Refraction from a single spherical surface, paraxial approximation

Week of 4/12

Thin lens equation

Lens Systems

Multiple thin lenses

Thick lenses

Pupils and stops

Week of 4/19

Optical System Design by Ray Tracing

Week of 4/27

Imaging in the Wave Model

Interference and interferometers

Division-of-wavefront (Young's experiment, Fresnel mirror)

Division-of-amplitude (Michelson)

Multiple-beam interference

Thin films

Optical coatings to enhance and diminish reflectivity

Fabry-Perot interferometer

Week of 5/3

Midterm Exam II

Diffraction

Huygens-Fresnel principle, spherical "wavelets"

Diffraction integrals

Fresnel diffraction, the Fresnel Zone Plate

Diffraction gratings

Fraunhofer diffraction

holography

Week of 5/10

Effects of diffraction on imaging systems

blur circles, OTF, MTF