DETAILED COURSE DESCRIPTION

Course Number PHYS 251

Course Title Fundamentals of Physics: Waves, Optics, and the breakdown of Classical Physics

Target audience Sophomore level physics majors and minors, and majors in some engineering programs. (As of 2021 this is expected to be possibly EECS and/or BME)

Prerequisites PHYS 136, or PHYS 138, or PHYS 231.

Catalog description Explores oscillations, waves, optics, and the breakdown of nineteenth century physics, and special relativity. Topics covered include: simple harmonic motion; mechanical waves; sound; geometric optics; interference; diffraction; and special relativity. This course incorporates both a laboratory component and basic scientific computing.

Expected previous knowledge

> ***Concepts*** Maxwell's equations, Newton's laws, conservation of energy, momentum, oscillations, 1-D waves, sound.
>
> ***Skills*** Able to calculate derivatives and integrals in 1-D, manipulate trigonometric functions, solve equations with logs and exponents.

Course Objectives

After successfully completing this course, students should be able to: 1) Describe mechanical waves and light using terms such as wavelength, frequency, momentum, and energy; 2) write and use wave equations in calculations; 3) Connect the design and outcome of experiments with physical concepts; 4) Estimate uncertainties in experiments; 5) Use simple derivatives in the calculation of wave properties; 6) Write clear and concise laboratory reports and responses to short-answer questions; 7) Describe how 19th Century physics breaks down in specific situations; 8) Calculate special relativistic effects such as length contraction and time dilation; 9) Write computer codes to solve problems relating to waves and optics.

Sample Text

Halliday and Resnick?

Or "University Physics with modern physics", Young and Freedman, Pearson (for engineering students who have already purchased this book for other classes).

Minimum Material Covered

Period Motion – SHM, simple/physical pendulum, resonance. (repeat from 135/7)

Mechanical Waves – waves on a string, interference, boundary conditions, superposition, standing waves, normal modes, wave equations.

Sound – Speed, intensity, resonance, beats, Doppler effect.

Light – EM spectrum, reflection, refraction, total internal reflection, polarization.

Geometric Optics – Ray tracing, plane and spherical surfaces, thin lens, camera.

Interference – Coherent sources, two source interference, intensity in interference patterns, thin films, Michelson interferometer.

Diffraction – Fresnel and Fraunhofer, single slit, multiple slits, gratin, X-ray diffraction.

Failures of Classical Physics – Review of classical physics, simultaneity, UV catastrophe.

Relativity – length contraction, time dilation, relativistic doppler shift, twin paradox, Michaelson-Morley experiment