Physics 212 **Classical and Modern Physics** **Spring 2025**

Objectives for Material to be Learned from Unit 2

By the end of this unit, students should be able to do the following:

2.1 (Continuing objective) Describe applications of the concepts of induction, waves, and light to everyday "real life" situations.

2.2 For a given simple magnetic field and a surface, calculate the magnetic flux.

2.3 Given a situation in which there is a changing magnetic flux, apply Faraday's law to relate the emf, current, or circulation of the $\vec{E}$-field to the properties of the magnetic field and of the coil.

2.4 Distinguish situations for which there is or is not an induced emf.

2.5 Apply Lenz's Law to determine the direction of induced emf, electrical currents, eddy currents, magnetic fields, or forces.

2.6 Relate the directions and magnitudes of the electric and magnetic fields and of the propagation velocity in a harmonic plane electromagnetic wave. Explain polarization of light and how this relates to the direction of the electric field.

2.7 Explain qualitatively how electromagnetic waves are generated by oscillating charge. From the direction and polarization of an incoming wave, determine possible directions and polarization of a re-radiated wave.

2.8 Explain the differences between the different kinds (radio, light, etc.) of EM waves.

2.9 Given a specific expression for a traveling transverse or longitudinal harmonic wave in sinusoidal form, determine amplitude, angular frequency, frequency, wavenumber, wavelength, period, phase shift and wavespeed.

2.10 Correctly sketch phasor diagrams to represent an oscillating system at various times.

2.11 Calculate the beat period and frequency for two signals differing slightly in frequency.

2.12 For standing wave modes on strings or in air columns in pipes: sketch the wave pattern, identify nodes and antinodes, and determine wavelength, wave-number, frequency or wave speed.

2.13 For interference problems, determine the relative phase difference from path length differences, and use the method of phasors to determine the total amplitude and the relative intensity of the combined waves.

2.14 Use the method of phasors to locate maxima and minima in a two-slit interference problem, multi-slit interference pattern, or for diffraction gratings.

2.15 Explain how diffraction gratings can be used to separate colors.

2.16 Using phasors, determine the phase difference corresponding to successive minima in a single slit diffraction pattern. From this, find the angles and screen locations of minima and determine the width of the "bright" central maximum.

2.17 Describe diffraction, and explain how diffraction limits resolution. Use Rayleigh's criterion to solve resolution problems.

2.18 Describe the failures of classical physics in resolving the ultraviolet catastrophe, the stability of atoms, and the atomic spectra.

2.19 Calculate any of these photon properties, given one of the others: energy, momentum, frequency, and wavelength. Solve problems relating light intensity, the number of photons per second, the energy per photon, and the frequency or wavelength of the associated wave.

2.20 Explain how photons resolve the ultraviolet catastrophe, and calculate the number of photons in modes of a cavity in thermal equilibrium at temperature T.

2.21 Describe how light interacts with matter in the form of photons, and how this explains the photoelectric effect, ionizing radiation, and radiation-induced chemical reactions. Relate the photon energy, binding energy, and final kinetic energies of any freed electrons.

2.22 Calculate the de Broglie wavelength for photons and for non-relativistic particles. Conversely, calculate the momentum or kinetic energy of a non-relativistic particle from the de Broglie wavelength.