PHY 250 FUNDAMENTALS OF PHYSICS II / 3 credits/ Study of the basic principles of electromagnetism, light propagation, optics employing differential and integral calculus. Prerequisite: MTH 220 and either PHY 210 or PHY 240 or permission of professor.

General Education Objectives (proposed)

1. Students can apply critical thinking to pose and answer questions.
2. Students can use the processes and methods of science and mathematics to demonstrate how reproducible results give rise to the discovery of fundamental laws and the development of theories.
3. Students can articulate a basic knowledge of current scientific understanding of the universe and the scientific and mathematical laws that govern it.
4l Students can summarize, interpret, analyze, and critically evaluate data and reports relating to the natural sciences and mathematics.

A non-exhaustive list of intended learning outcomes follows

Integration with MTH 220: the math prerequisite is appropriate for this course. Differentiation involves polynomials and trigonometric functions and limited partial integration together with gradient operator. Integration involves normal integration from Mth210 but additionally includes simplified surface integration and line integration. These topics are covered in MTH220 and more extensively in MTH230, and with permission of professor, the two courses (phy250, mth220) can be concurrently taken. Although students extensively use Gauss's law and Ampere's law in integral form, the mathematical treatment of these topics is less full-blown than one would find in a course with students having an extensive background in MTH230. When more advanced techniques are required, the students are provided with the mathematical background necessary.

(a) Ability to understand electrostatic and magnetostatic units and definitions and conservation of charge.
(b) Ability to obtain resultant forces through application of Coulomb’s law for discrete and simple continuous charge distributions.
(c) Ability to perform algebraic analysis to find the net electrostatic force resulting from superposition of distributions of several discrete charges and for simple continuous charge distributions.
(d) Ability to understand the connection between electrostatic force and electrostatic field, and to recognize the physical reality of the electric field.
(e) Ability to obtain electric fields from application of Gauss’s Law[8] in integral form to regionally constant charge distributions and to charge distributions which vary as a function of position.
(f) Ability to understand electrostatic field maps and to be able to sketch such maps for simple charge distributions.
(g) Ability to understand and perform calculations involving electrostatic potential energy and electrostatic work.
(h) Ability to understand the connection between electric potential and electric potential energy.
(i) Ability to understand and mathematically analyze the connection between electric potential and electric field in the case of potentials which vary as some general function of position.
(j) Ability to obtain the capacitance of a system from fundamental considerations and to be able to expand this to linear dielectrics.
(k) Ability to obtain the energy density and total energy of a parallel plate capacitor.
(l) Ability to analyze the effect of electrostatic and magnetostatic fields upon the motion of a charged particle.
(m) Ability to understand motion of a magnetic dipole in an external magnetic field.
(n) Ability to obtain magnetic fields from simple current distributions using Ampere’s Law in integral form. Application of the law of Biot-Savert to simple geometries for magnetostatic field calculation[9].
(o) Ability to perform calculations of induced magnetic field from Faraday’s Law in simple situations and also in situations where the analysis is not possible for non-calculus students (including inductance, self inductance and mutual inductance).
(p) Ability to obtain the magnetostatic energy density and total energy of an ideal solenoid.
(q) Ability to perform calculations involving the following circuits: Series RC, Series RL, Series RLC.

As part of this, students are required to be able to work with circuits where real impedances can be calculated[10]. Ability to apply Kirchoff's circuital laws[11].

(r) Ability to perform calculations involving Snell's law for optics and to subsequently have the ability to understand chromatic aberration in actual lens systems.

(r) Ability to perform thin lens equation calculations to obtain results related to the characterization of resultant image formation.

(s) Ability to perform spherical mirror calculations to obtain results related to the characterization of resultant image formation.

(t) Ability to perform multiple thin lens calculations to analyze simple optical systems.

(u) Exposure to the theoretical basis for the thin lens equation, the spherical mirror equation, Snell's law and ray tracing.

(v) Ability to recognize critical angle and Brewster angle applications and to perform calculations with each and polarization effects.

(w) Ability to understand and perform calculations involving thin film interference.

(x) Ability to understand and perform calculations involving single slit interference, multiple slit interference and diffraction gratings. Ability to understand and perform calculations related to the theoretical basis for limitations of resolution powers of thin lenses and diffraction gratings.

(y) Exposure to the basis for the unification of electrodynamics, magnetism and optics based upon Maxwell's equations. Exposure to the differential forms of Maxwell's equations. Identification of the needed modifications to Ampere's law for electrodynamics and magneto dynamics (the displacement current).

(z) Exposure to the connections and continual reference to the basis for understanding the unification between classical electrodynamics, magnetism and optics (Phy250) and classical mechanics and thermodynamics (Phy240).