

Assessable Learning Outcomes: Phy382Sp12

Phy382

PHY 382¹ SPECIAL TOPICS IN PHYSICS / variable credit

Study of certain topics in physics. Prerequisite: MTH 220, and either PHY 220 or PHY 250 or permission of instructor.

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.**
- 4. Students can summarize, interpret, analyze, and critically evaluate data and reports relating to the natural sciences and mathematics.**

Phy382 has been the most theoretically demanding of all the physics courses offered at Lyon College. In previous history, it was taught once under the topic of quantum mechanics and most recently it has settled to be taught under the topic of Electricity and Magnetism. Regardless of the particular topic which has been taught, the emphasis in this course has been a rigorous mathematical development for the solution of physical systems. The nature of the physics minor is such that a highly theoretical rigorous course such as this is essential to provide students with a taste of what they must expect to work with should they continue with advanced studies in physics. For this reason, the special topics course has settled upon a very rigorous theoretical base using advanced mathematics to provide the depth required by students. The following is a non-exhaustive topical list of expectations from students completing this course.

- (a) Development of the basis for Coulomb's law based upon continuous integration of vector forces arising from continuous and discrete charge distributions based upon integral calculus.
- (b) Relationship of the vector electrostatic field to Coulomb forces and the ability to obtain the electric field arising from continuous and discrete charge distributions based upon integral calculus.
- (c) Development of Gauss's Law as applied to electrostatics as a general requirement from considerations of the properties of charges based upon integral calculus.
- (d) Development of electrostatic potential energy based upon continuous integration of vector forces arising from continuous and discrete charge distributions based upon integral calculus.
- (e) Development of the electrostatic potential from potential energy considerations.
- (f) Development of the connection between electrostatic potential, electric field and charge distributions based upon differential calculus.
- (g) Introduction of Laplace's equation and its connection to regions of space without charges.
- (h) Introduction of the method of images as a solution technique to Laplace's equation where charges and conducting surfaces are involved.

- (i) Understanding the position of the divergence, curl and gradient when applied to electrostatics problems. In particular, the recognition and use of the physical and mathematical significance of conservative potentials.
- (j) Development of multipole expansions as solutions to Laplace's equation, including a development of distinction between ideal dipoles and physical dipoles. Application of dipole radiation terms to quantum harmonic oscillators²².
- (j) Electrostatic problems in the presence of linear and other dielectrics: including the effect of dielectrics upon the capacitance of systems and examination of the time dependence of diodes leading to the Child-Langmuir law.
- (k) Calculation of the magnetostatic field from elementary application of Ampere's law for highly symmetric current distributions.
- (l) Calculation of the magnetostatic field by direct integration of current distributions by direct integration with the law of Biot-Savart.
- (m) Development of the vector potential for magnetostatics. Development of the connection between the vector potential, the magnetic field and current distributions.
- (n) Understanding of Faraday's law and the use of it in development of problems involving electromagnetic induction.
- (o) Understanding the necessity and importance of Maxwell's correction to Ampere's law.
- (p) Integral compilation of Maxwell's equations for charge-free regions of space.
- (q) Conversion between the integral form and the differential form of Maxwell's equations for charged and charge-free regions of space.
- (r) Application of Maxwell's equations to describe propagation of transverse electromagnetic waves in the vacuum.
- (s) Application of Maxwell's equations to waveguides.
- (t) Derivation of modes of oscillation for electromagnetic waves inside resonating cavities.