PHYS 2232 Advanced Introductory Physics II

General Course Description

This course is the second semester of the introductory calculus-based physics sequence primarily intended for Physics majors. The major goals of this class are to learn the basic concepts underlying electromagnetic phenomena and to apply them in quantitative analysis. The topics include Electrostatics, Electric Currents and Circuits, Magnetic Field, and Electromagnetic Induction. The topics covered in this course are similar to those in Principles of Physics II but are treated in more depth in a small-class setting.

Contact Hour Distribution:

3 hours of lecture, 1 hour of studio, and 2 hours of laboratory.

Textbook

Electricity and Magnetism (3rd edition), Edward Purcell and David Morin, ISBN: 978-1-107-01402-2

Pre-requisites

PHYS 2211 or 2231 **(**Intro Physics I**)**. The course assumes that the student is adept at scientific reasoning and has a working knowledge of calculus. Problems requiring understanding of calculus (derivatives and integration) will be included in the course homework and examinations. While elements of multi-variable calculus and differential equations will be used in the course, they will be covered in class. Students are not required to have credits for multi-variable calculus (MATH 2551) and differential equations (MATH 2403).

Tests and grading.

The grade includes several components. The approximate weight of these components is:

- Homework: 5% of the final grade
- 3 Tests 50% of the final grade
- Labs: 20% of the final grade
- Studio: 5% of the final grade
- Final Exam: 20% of the final grade

List of topics covered

Topic
Electric Charge. Coulomb’s Law.
Electric field. Charge distributions.
Flux. Gauss’s law.
Electric Field of various charge distributions.
Energy associated with the electric field.
Potential difference and the potential function. Gradient.

Potential of a charge distribution.
Dipoles.
Divergence. Gauss's theorem. Laplace's equation.
Conductors in the electrostatic field. Image charges.
Capacitors. Energy stored at the capacitor.
Electric current and current density.
Electrical conductivity and Ohm's law.
Circuits.
Networks with voltage sources.
RC circuits.
Definition of the magnetic field. The curl of a vector function. Stoke's theorem.
Ampere's law.
Vector potential.
Magnetic fields of current-carrying objects.
The field of a current loop. Magnetic dipole.
Faraday's law.
Mutual inductance.
Self-inductance. RL Circuits. Energy stored in the magnetic field.
A resonant circuit.
AC current.
Admittance and impedance. Power and energy in AC circuits.
The displacement current.
Maxwell's equations and electromagnetic wave.
Energy transport by electromagnetic waves.

Laboratories

Laboratories are a required part of the course. Students will perform seven labs and present their work in the form of a written report. Most labs will take two weeks to complete.

Students are expected to:

Apply physics in a variety of physical settings.
Build mathematical models.
Document their experimental work, results, and data analysis in lab notes.
Analyze and compare results using uncertainties.
Communicate their work in lab reports.

Each lab description has several sections:

- **Introduction.** A summary of the theory that is relevant to the experiments in the lab.
- **Models.** In this section, a theoretical physical model for the experiment is constructed. Approximations and assumptions made in building the model are outlined. One of the main goals of this course, and in particular the labs, is to make students capable of constructing such models for the studied phenomena.
- **Prelab.** Questions/assignments about the lab and physical models for the lab experiments. This assignment (10% of the lab grade) is due at 3 pm on the lab day.
- **Experiments.** This section contains a description of the measurements. All labs have several experiments. Some labs also offer video tutorials that explain challenging parts of the experiments or the model.
- **Challenge.** This section contains additional (bonus) questions/assignments.

Lab Schedule

Week	**Experiment**
3	**Introduction to the Equipment.**
4	**Electric Fields and Potentials. Gauss's law.**
6	**Capacitors.** Capacitance Measurements. Energy stored on a Capacitor. Capacitor Circuits.
7	**Resistors. Ohm's Law.** Resistor Circuits. RC Circuits. Kirchhoff's rules. Power Dissipated by a Resistor.
9	**Magnetic Field.** The Earth's magnetic field. Magnetic Dipole Moment of a Small Permanent Magnet. The Force Between Magnetic Dipoles. The Force on a Current Carrying Wire in a magnetic Field.
11	**Magnetic Field Flux. Faraday's Law. Inductance.**
12	**Faraday's Law Applications.** Eddy Currents.