Course Information Form (CIF)

Course Code: PHY 142 (IAI PHY 912)

Course Title: Electricity and Magnetism

Department: Natural Sciences
PCS Code: 1.1 - Baccalaureate/Transfer
CIP Code: 40.0801
Repeatability: 0

Effective Date: Summer 2026

Credit Hours

Catalog Notation: 3-3-4
Credit Hour Distribution:

Lecture: 3	Lab: 3	Clinical: 0	**Total: 4**

General Course Information

Catalog Description

Electrical fields, potential, resistance, capacitance, and inductance: RC, RL, RLC circuits, Maxwell's equations, electromagnetic radiation, and geometric optics.

General Course Objectives

The three semester series, of which PHY 142 is the second, is a required part of engineering education and provides a calculus-based physics background for the serious science student.

Minimum Placement Levels

English	Reading	Math
None	Placement out of CCS 098	Credit in MAT 129 with a grade of C or higher, or placement

Prerequisites

Credit in PHY 141 with a grade of C or higher
Recommended before enrolling (not required):
Credit or concurrent enrollment in MAT 228

Methods of Evaluation

2-4 exams, 12-16 homework assignments, 10-13 lab reports, and a final exam.

Instructional Materials and Additional Supplies

Students will need to purchase access to Achieve for University Physics with Prelectures.
Students who are taking the course online will need to purchase lab supplies, typically an iOLab device and E&M kit. They will also need a computer with reliable internet access and a webcam to use for exams.

Course Content

General Learning Outcomes (GLOs)

- Reasoning and Inquiry: Students will demonstrate the ability to solve problems using deductive reasoning and logic, quantitative reasoning, or the scientific method.

Course Segments and Student Learning Outcomes

Course Segment	Learning Outcomes	Lecture Hours	Lab Hours	Clinical Hours
Coulomb's Law and Electric Fields	1. Define electric charge and explain how charges interact via Coulomb's law. 2. Describe the electric field around charges. 3. Explain the relationship between the electric field and electric force. Solve problems based on these concepts. 4. Use online simulations to explore the concepts of electric force and electric fields. 5. Introduce the concept of the electric potential and equipotential lines via diagrams. 6. Explore electric forces and electric fields via simulated challenges.	3	4	0
Gauss' Law	1. Introduce the concept of the electric flux. 2. Explain the principle of Gauss' law and implement it to find the electric fields of various charge configurations.	3	0	0
Resistors and iOLabs	1. Introduce the iOLab and E&M kit. Use a simple two-resistor circuit to explore voltage measurements with the iOLab. Write a lab report explaining these results.	0	4	0
Electric Potential and Electric Potential Energy	1. Define electric potential energy. 2. Describe the electric potential energy of a charge in an electric field. 3. Describe the electric potential energy between pairs of charges. 4. Describe the electric field and electric potential around charges. 5. Define the electric potential. 6. Describe the electric potential around a point charge and a continuous charge. 7. Describe the relationship between electric potential and electric potential energy. Solve problems based on these concepts.	3	0	0
Capacitance	1. Describe the components of a capacitor and the concept of capacitance. 2. Describe how capacitors behave in combination in circuits. 3. Experimentally determine whether charge is conserved for a set of parallel capacitors.	3	4	0
Current, Resistance, and Resistor Circuits	1. Describe the concept of current and resistivity. 2. Introduce Ohm's law. 3. Explain how to find the equivalent resistance of a series/parallel/mixed set of resistors, and use that to solve problems. 4. Assemble a set of resistors in series and parallel (using the limited options available in the iOLab's E&M kit) to create a resistor with a specific effective resistance. Compare the experimentally measured resistance of this combination with the expectation from calculations. Write a lab report explaining these results. 5. Using the iOLab, form a hypothesis regarding whether a diode will behave like a resistor (and follow Ohm's law) across a range of voltages (from 0 - 3V). Design and perform an experiment to test this hypothesis. Write a lab report explaining these results.	3	8	0

Course Segment	Learning Outcomes	Lecture Hours	Lab Hours	Clinical Hours
Kirchoff's Laws and RC Circuits	1. Introduce Kirchoff's laws and apply them to complex circuits. 2. Describe the voltage/current in a series RC circuit over time, and use that to solve problems. 3. Determine the experimental time constant of a variety of resistor and capacitor combinations. Use the time constant to compare the experimental capacitance with the labeled capacitance. Properly propagate error from uncertainty in the resistance and experimental time constant. Write a lab report explaining these results. 4. Set up a circuit where a resistor is in series with a parallel combination of resistor and capacitor. Experimentally measure the different time constant for charging and discharging the capacitor. Use Kirchoff's laws to calculate the expected time constant for the capacitor charging in parallel with a resistor. Compare the experimental time constant with the theoretical expectation. Write a lab report presenting these results.	3	9	0
Magnetic Fields and Electromagnets	1. Describe the concept of magnetic fields. 2. Explain how magnetic fields can be generated by current in wires/coils. 3. Explain the forces and torques that magnetic fields can exert on currents. 4. Explain the Biot-Savart law and Ampere's law. Use these concepts to solve problems.	6	0	0
Motional EMF and Faraday's Law	1. Introduce motional EMF. 2. Describe how to use the concept of motional EMF to calculate the induced voltage and current. 3. Explain the concept of induction via Faraday's law and Lenz's law. Solve problems based on these concepts. 4. Use Faraday's law to determine the largest induced voltage using only the Earth's magnetic field as a source. Write a lab report describing the experimental methods, the physics motivating the experimental methods, and results.	3	4	0
Inductance and Inductors	1. Introduce inductors and define self-inductance. 2. Define the energy in an inductor and the energy density of a magnetic field. 3. Explain the nature of a series LR circuit. Solve problems based on these concepts.	1.5	0	0
LC and RLC Circuits	1. Describe the oscillating nature of a series LC circuit and solve problems with it. 2. Introduce alternating current and RMS values. 3. Compare the behavior of an ideal LC circuit with a damped LC (RLC) circuit. Solve problems based on these concepts.	1.5	0	0
AC Circuits	1. Introduce the reactance. 2. Define the reactance for a capacitor and inductor. 3. Demonstrate how the impedance is found using a phasor diagram. 4. Describe the RLC circuit power dissipation and resonance. Solve problems based on these concepts.	3	0	0

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Displacement Current and Electromagnetic Waves	1. Define the displacement current. 2. Introduce Maxwell's equations. 3. Introduce the plane electromagnetic wave and describe its behavior. 4. Establish equations for the energy and intensity of an electromagnetic wave. 5. Establish equations for the radiation pressure from an electromagnetic wave. Solve problems based on these concepts. 6. Form a hypothesis on how the intensity of a cell phone's flashlight will vary with radius. Use the iOLab's light sensor to measure the intensity of the light as a function of radius. Compare the experimental results to various power law fits to validate or disprove the hypothesis. Write a lab report describing the experimental methods and results.	3	4	0
Reflection, Refraction, and Polarization	1. Define the law of reflection and Snell's law of refraction. 2. Demonstrate total internal reflection (critical angle) and polarization by reflection (Brewster's angle). 3. Demonstrate the effect of linear polarization. 4. Demonstrate how intensity can decrease when light is sent through a polarizer. 5. Explain circular polarization and how birefringent material can be used to produce quarter-wave plates. Solve problems based on these concepts. 6. Use the polarizers in the iOLab's E&M kit to experimentally test Malus' law through intensity measurements. Carefully consider possible sources of experimental error and how to minimize their impact on the experimental results. Write a lab report describing the experimental methods, the physics motivating the experimental methods, and results.	3	4	0
Mirrors and Lenses	1. Introduce real and virtual images. 2. Describe the image formed by flat mirrors. 3. Derive the image distance and height/magnification equations for spherical mirrors. 4. Derive the equation describing a spherical refracting surface. 5. Show how to adapt the image distance and height/magnification equations for thin lenses. 6. Use PhET simulations to explore Snell's law and identify the index of refraction of two mystery materials in the simulation. Use PhET simulations to explore mirrors and lenses. Use the simulation to determine the height and position of images produced by a lens or mirror and compare with theoretically calculated results.	3	4	0
End of Semester Review	1. Refresh recollection of the concepts covered in the class. Work through practice problems that combine concepts that were explored earlier in the semester with concepts that were explored later in the semester to highlight the deeper connections linking the concepts.	3	0	0

Total Contact Hours

Lecture Hours	Lab Hours	Clinical Hours
45	45	0