# Course Information Form (CIF)

**Course Code:** PHY 143 (IAI PHY 915A)
**Course Title:** Modern Physics

**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

Heat, thermodynamics, mechanical waves, electromagnetic radiation, physical optics, kinematics and dynamics of special relativity, introduction to quantum mechanics, Bohr atom, elementary nuclear structure, and band theory.

### General Course Objectives

This course is the last of a three-semester sequence required for engineering education and provides a background for the serious science student.

### Minimum Placement Levels

| English | Reading | Math |
|---|---|---|
| None | Placement out of CCS 098 | None |

### Prerequisites

Credit in PHY 142

### Methods of Evaluation

2-4 one-hour exams, 12-16 homework assignments, 10-13 lab reports, and 1 final exam.

### Instructional Materials and Additional Supplies

Students will need to purchase access to Achieve for University Physics.

## 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 |
|---|---|---|---|---|
| Ideal Gases and Kinetic Theory | 1. Describe the ideal gas law and the kinetic theory of gases. Solve problems based on these concepts.<br>2. Implement linearization on pressure-volume data for a gas. Sketch the linearized plot and interpret the slope. Compare the slope to the ideal gas law prediction. | 3 | 4 | 0 |
| Temperature and Thermal Expansion | 1. Define the various temperature scales.<br>2. Explain the physics of thermal expansion and solve problems with it.<br>3. Implement the concept of thermal expansion to predict the length/volume change of an object. Compare measurements against the prediction. | 1 | 4 | 0 |
| Specific Heat and Phase Change | 1. Explain the concepts of internal energy and the temperature/phase change of materials. Solve problems based on these concepts.<br>2. Use the temperature/phase change equations to measure the specific heat of various materials. Compare the measured values to the accepted ones. | 1 | 4 | 0 |
| Heat Transfer | 1. Recognize the three modes of heat transfer: conduction, convection, and radiation. Solve problems based on these concepts. | 1 | 0 | 0 |
| 1st Law of Thermodynamics | 1. Explain the first law of thermodynamics and describe the work done by a gas. Solve problems based on these concepts.<br>2. Use the concept of adiabatic expansion/compression to calculate the specific heat ratio of a gas based on pressure-volume data. Sketch the P-V data in order to estimate the work done by a gas and compare it to the ideal adiabatic work. | 3 | 4 | 0 |
| 2nd Law of Thermodynamics | 1. Describe the concept of entropy and the second law of thermodynamics.<br>2. Recognize the main components of heat engines/pumps.<br>3. Solve problems based on these concepts. | 3 | 0 | 0 |
| Waves on a String | 1. Derive the classical wave equation for strings and use it to quantify the propagation of waves and energy. | 2 | 0 | 0 |
| Sound Waves | 1. Prove the connection between the mechanical agitation of air molecules and the propagation of sound waves.<br>2. Quantify sound propagation in terms of intensity, wave speed, and mechanical properties of the medium. | 2 | 0 | 0 |
| Standing Waves and String Systems | 1. Use an elastic cord system to set up a variety of standing wave patterns; measure the physical properties of the system to find the spectrum of resonant frequencies. | 0 | 3 | 0 |
| Traveling String Waves | 1. Demonstrate individual proficiency in data analysis techniques in using the time-dependent motion of a string point to determine wave speed, frequency, and maximum speed and acceleration. | 0 | 1 | 0 |
| Interference of Waves and Resonance | 1. Apply principles of wave super-positioning to determine conditions of standing waves in both string and sound systems.<br>2. Explore beat frequency, Doppler effect, and constructive/destructive interference of waves. | 3 | 0 | 0 |

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|---|---|---|---|---|
| Standing Waves and the Speed of Sound | 1. Use a cavity of adjustable level and explore conditions of resonance with a variety of sound sources; use the data to determine the speed of sound in air. | 0 | 3 | 0 |
| Resonance | 1. Demonstrate individual proficiency in data analysis in determining an unknown sound frequency from known cavity sizes that resonate the sound. | 0 | 1 | 0 |
| Acoustic Interference and Phasors | 1. Use a system of three speakers driven in phase with each other to locate and analyze conditions of constructive and destructive interference using phasors.<br>2. Demonstrate individual proficiency in data analysis in using the data from a multiple-source speaker system to analyze a condition of constructive interference. | 0 | 4 | 0 |
| Interference and Diffraction | 1. Use principles of wave super-positioning to determine the optical patterns projected by one-slit, two-slit, and multiple-slit gratings.<br>2. Use a laser system in conjunction with a variety of gratings to explore and measure optical patterns and determine the frequency of the laser light. | 4 | 3 | 0 |
| Interference Pattern | 1. Demonstrate individual proficiency in data analysis techniques in using the visual pattern from a two-slit laser interference experiment and finding the slit width as well as the distance between slits. | 0 | 1 | 0 |
| Relativistic Kinematics and Dynamics | 1. Prove the principles of relativistic kinematics from the fundamental postulates of Einstein and apply them to the physical behavior of high-speed particles. | 3 | 0 | 0 |
| Relativity | 1. Demonstrate individual proficiency in applying the principles of relativity to a review problem on relativistic kinematics. | 0 | 1 | 0 |
| Protons and Matter Waves | 1. Describe the experimental evidence for the wave aspects of matter and the particle aspects of light absorption.<br>2. Describe the photoelectric effect and its connection with the quantization of energy. | 4 | 0 | 0 |
| Wave Nature of Matter | 1. Use the Schroedinger Equation and Heisenberg's Uncertainty Principle to quantify the probability distribution of systems of electrons propagating through space and trapped in various wells.<br>2. Demonstrate individual proficiency in applying the principles of quantum mechanics to a review problem. | 3 | 0 | 0 |
| Atoms | 1. Explore both the early Bohr attempts at describing atomic properties as well as the Schroedinger wavefunction picture. | 3 | 0 | 0 |
| Spectra | 1. Use a discharge tube system to measure emission spectra and compare the emission lines to the theoretical model for single-electron atoms.<br>2. Demonstrate individual proficiency in data analysis technique in using an emission spectrum to determine the corresponding atomic transitions. | 0 | 4 | 0 |
| Conduction of Electricity in Solids | 1. Explain the electrical properties of solids and the conductivity of semiconductor materials.<br>2. Identify key applications of solid-state theory to junctions, rectifiers, and diodes. | 3 | 0 | 0 |
| Nuclear Structure and Radioactive Decay | 1. Use principles of nuclear binding to determine energies released in nuclear reactions and binding energies of isotopes.<br>2. Prove the exponential decay of radioactive isotopes. | 4 | 0 | 0 |

| Course Segment | Learning Outcomes | Lecture Hours | Lab Hours | Clinical Hours |
|---|---|---|---|---|
| Radioactivity | 1. Use data from nuclear radiation experiments to determine half-life of radioactive decay.<br>2. Demonstrate individual proficiency in data analysis techniques in determining the radioactive decay constant using linear regression analysis. | 0 | 4 | 0 |
| Elementary Principles | 1. Explore evidence for the existence of elementary particles and the quark model.<br>2. Describe the fundamental structure of elementary particles. | 2 | 0 | 0 |
| Doppler Effect | 1. Record a spinning wireless speaker to determine the period of motion and the frequency range of the sound produced.<br>2. Compare the source's speed using the Doppler Effect to the speed found using circular motion equations. | 0 | 4 | 0 |

**Total Contact Hours**

| Lecture Hours | Lab Hours | Clinical Hours |
|---|---|---|
| 45 | 45 | 0 |