OP051/OP053: AP Physics C

Course Description

AP Physics C is a year-long calculus-based physics course designed to be equivalent to an introductory calculus-based university-level physics course. By the end of the year, students will be prepared to take the AP Physics C Mechanics and E&M exams, though the scope of the course is not limited exclusively to the AP curriculum. Prior completion of AP Physics B and/or AP Calculus BC is advantageous but not required. If a student has previously successfully completed AP Physics C Mechanics, they may take AP Physics C Electricity and Magnetism in the spring semester with instructor approval. The fall semester covers mechanics, including study of kinematics, force, circular motion, momentum, energy, rotation, gravitation, and simple harmonic oscillation. During the spring semester, the main focus will be on electricity and magnetism, including exploration of electrostatic force, electric fields, electric potential, simple circuits, magnetic fields, induction, and EM Waves. By completing lab work (a mixture of at-home labs, on site labs as part of a summer session, and virtual labs), students will reinforce their understanding of concepts, gain hands-on experimentation experience, and develop their written communication skills.

Learning Objectives

Upon successful completion of OP051/OP053, students will demonstrate proficiency in:

- Modeling of physical systems:
  - Translating worded descriptions into mathematical statements
  - Intuiting the physical nature of a system from mathematical statements
  - Visualization of physical systems in one, two, and three dimensions
  - Abstracting motions into static representations parameterized by time

- Ability to interpret graphs and extrapolate meaning from them
  - Representing relations between components of systems quantitatively
  - Representing systems of three-dimensional space in lower dimensions

- Interpreting lower dimensional representations of higher dimensional dynamics

- Applying methods of problem solving learned in this course to unfamiliar scenarios

- Using additional criteria (symmetry, dimensional analysis, etc.) to solve problems not necessarily amenable to the previously stated methods

- Distinguishing between rates of change and absolute values of quantities

- Solving some classes ordinary differential equation

Required Textbook

Physics for Scientists & Engineers with Modern Physics with Knight Workbook
Plus MasteringPhysics with eText—Access Card Package, 3/E
Addison-Wesley, Published 02/03/2012
Topics Covered

- **Kinematics and dynamics in one and two dimensions**
  - Kinematics and Vectors including non-constant acceleration
  - Projectile motion
  - Circular motion (kinematics)
  - Newton's Laws
  - Problem solving with Newton's Laws
  - Retarding forces and pseudoforces

- **Work, Energy, and Momentum**
  - Work and energy in one to three dimensions
  - Work for varying forces and non-conservative forces
  - Momentum and collisions in one to three dimensions
  - Center of Mass and the center of mass reference frame
  - Impulse

- **Rotational Kinematics and Dynamics**
  - Rotational Kinematics
  - Torque
  - Moment of Inertia requiring integration
  - Kinetic energy of rotating objects
  - Conservation of Angular momentum
  - Gyroscopes
  - Statics, Solving problems with Newton's Second Law in its rotational form

- **Gravitation, Simple Harmonic Motion**
  - Newton's Law of Universal Gravitation
  - Finding the gravitational force via integration
  - Oscillations and Simple Harmonic Motion

- **Electrostatics**
  - Electric Charges and Forces
  - Coulomb's laws
  - The Electric Field
  - Gauss's Law
  - Electric Potential
  - Problem solving in Electrostatics, requiring integration to find fields and forces

- **Current and Electronic Circuits**
  - Capacitors and Dielectrics
  - Electric Current and Conductivity
  - Ohm's Law
  - Resistance and Resistors
  - Electric Circuits
  - Kirchoff's Laws and solving circuit problems
• **Magnetism**
  ▪ The Magnetic Field
  ▪ Force on currents and charged particles moving through a magnetic field
  ▪ Sources of Magnetic field, requiring integration to find fields and forces
  ▪ Ampere’s Law

• **Induction, Maxwell’s Equations and AC circuits**
  ▪ Magnetic induction and EMF
  ▪ Lenz’s Law
  ▪ Inductance and Mutual Inductance
  ▪ Introduction to Maxwell’s Equations
  ▪ Alternating Current circuits (RC, LR, LRC)
  ▪ Generators

**Key Assignments**

Each semester, the final letter grade will be determined through the following types of assignments:

• **Homework**: Each week, students will turn in solutions to assigned homework problems. These homework assignments are challenging and useful as preparation for the AP Exam.

• **Lab Reports**: Formal lab reports will be required for all virtual and at-home lab work.

• **In class participation**: Students are expected to be active participants in weekly discussion sections.

• **Final Exams**: At the end of each semester, students will take a proctored final exam covering the entire semester’s content, including a mixture of multiple choice, short answer, and long answer problems. Students will take 3-4 exams each semester, some of which will be proctored. There will be a comprehensive, written, proctored midterm and final exam that will include multiple-choice questions regarding material covered in lecture, discussions, and lab work and free-response questions as described above.

• **Part Exams**: Students will take 3-4 smaller tests per semester, usually covering 3-4 week sections of course content. These tests are similar to the final in form, but smaller in scope, and half will be proctored.