Lecture Contact Hours: 64-72; Outside-of-Class: 128-144;
Laboratory Contact Hours: 48-54; Outside-of-Class Hours: 0;
Total Student Learning Hours: 240-270

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

Physics 202 – Electricity, Magnetism, and Heat

4 hours lecture, 4 units
3 hours laboratory, 1 unit
Total units: 5

Catalog Description
This is the second course of a three-semester, calculus level sequence of physics courses designed for engineering, physics, mathematics, and science students. The topics of heat, electricity, and magnetism are introduced at the beginning level with reliance upon students' ability to apply topics introduced in Physics 201 The laboratory provides emphasis on measurements using gas laws and of electric and magnetic fields, DC and AC circuits, and oscilloscope techniques.

Prerequisite
"C" grade or higher or "Pass" in PHYSICS 201 or equivalent; and "C" grade or higher or "Pass" or concurrent enrollment in MATH 280 or equivalent

Entrance Skills
Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:
1) Solve algebraic word problems by using substitution or simultaneous equations.
2) Knowledge of trigonometric functions and their identities.
3) Solve linear, quadratic and trigonometric equations.
4) Knowledge of related rates and derivatives.
5) Integrate polynomial, exponential and trigonometric functions.
6) Apply Taylor and Fourier series as approximations of functions using simpler functions.
7) Convert between polar and rectangular coordinates.
8) Use the relationship between force, mass and acceleration to solve dynamics problems.
9) Use conservation of energy and conservation of momentum concepts.
10) Understand simple harmonic motion and apply its concepts to analyze oscillating systems.
11) Understand definition of vectors and how to use them.

Course Content
1) Heat and Temperature.
2) Kinetic Theory.
3) The first and second laws of thermodynamics: entropy.
4) Heat engines.
5) Electrostatics and Coulomb's Law.
6) Electric fields and potentials.
7) Gauss's Law.
8) DC circuits, including capacitors and resistors.
9) Magnetic fields.
10) Ampere's law.
11) Motion of charged particles in uniform electric and magnetic fields.
12) Magnetic properties of matter.
13) AC circuits.
14) Faraday's and Lenz's Laws.

15) Maxwell's equations.
16) Properties of electromagnetic waves.
17) Historical development of physics.
18) Techniques of problem solving using dynamical equations or conservation principles.
19) Use of basic and advanced equipment to perform experiments illustrative of the topics covered in lecture.
20) Analysis of experimental data, including use of
    a. calculus-based error propagation
    b. statistical error analysis,
    c. chi-squared tests,
    d. Gaussian Distributions and histograms
    e. data reduction
    f. least squares fitting,
    g. weighted averages,
    h. and correlation,

Course Objectives

Students will be able to:

1) Describe basic concepts in electricity, magnetism, and heat and apply laws and principles of physics to events related to these topics.
2) Analyze thermodynamic systems in terms of the gas laws and the first and second laws of thermodynamics.
3) Analyze systems of charges and current distributions to determine electric fields and potentials and magnetic fields.
4) Predict the trajectory of charged particle in electric and magnetic fields.
5) Analyze circuits in terms of current, potential difference, and power dissipation.
6) Evaluate written problems on all topics to determine which physical laws and concepts are required for the solutions.
7) Calculate solutions to physics problems using the fundamental principles of physics and algebraic, trigonometric, and calculus principles.
8) Employ basic measurement equipment and laboratory techniques to study the laws and principles used in the course.
9) Evaluation of data via advanced error analysis techniques

Method of Evaluation

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in the subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.

1) Quizzes, exams that measure students' ability to recognize physical situations and the concepts associated with them, and use mathematical expressions to formulate solutions while under a time pressure.
2) Homework that measures students' ability to use the fundamental principles of physics and symbolic logic skills to calculate solutions to physics problems.
3) Lab techniques as demonstrated by students' ability to design an experiment, set up the equipment, make the appropriate measurements, and maintain a safe work environment.
4) Lab reports will demonstrate students' ability to use the English language; record, interpret and analyze data; and draw conclusions from the results.
5) Physics research paper(s) in which students are required to analyze, interpret and draw conclusions from scientific sources.
6) Participation based on in-class responses to questions, contribution to discussions, and attendance.

Special Materials Required of Student
Scientific calculator

Minimum Instructional Facilities
1) Laboratory with blackboard, Smart Cart, appropriate lab/demonstration equipment
2) Computers with data acquisition probes

Method of Instruction
1) Integrated lecture, demonstration, discussion
2) Small/large group discussion
3) In-class activities and independent homework, research projects
4) Group work in a laboratory situation
5) Auxiliary use of study groups, peer tutoring and/or instructional office hours

Out-of-Class Assignments
1) Reading assignments
2) Homework assignments solving practice problems
3) Completion of lab reports

Texts and References
1) Required (representative examples):
   a. Halliday, David, Resnick, Robert, and Walker, Jearl, Fundamentals of Physics, 12th edition, Hoboken, NJ, John Wiley & Sons, Inc., 2022
   b. Knight, Randall, Physics for Scientists and Engineers - a Strategic Approach, 5th edition, Upper Saddle River, NJ, Pearson Education, 2022.
   c. Young, Hugh D., Freedman, Roger A., and Ford, A. Lewis, University Physics, 15th edition, Upper Saddle River, NJ, Pearson Education, 2020.
   d. Taylor, John R., *Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements*, 2nd edition, Sausalito, CA, University Science Books, 1997.
   e. *OpenStax University Physics*, OpenStax, Rice University, Houston, TX, 2016.
2) Supplemental: none

Exit Skills
Students having successfully completed this course exit with the following skills, competencies and/or knowledge:
1) Understand the concepts of heat, thermodynamics, and ideal gases and be able to use them in solving problems involving thermal equilibrium, heat transfer or heat engines.
2) Calculate electric and magnetic forces and fields.
3) Understand the basic concepts of voltage, current and power.
4) Understand the basic concepts of resistance, capacitance and inductance.
5) Solve for current, voltage, power and time constants in DC circuits consisting of resistors, capacitors, inductors and batteries.
6) Solve for current, voltage, phase angle and power in AC circuits consisting of resistors, capacitors, inductors and generators.
7) Use Maxwell's Equations to solve problems in electricity and magnetism.

Student Learning Outcomes
Upon successful completion of this course, students will be able to:
1) Use the laws of thermodynamics and/or Maxwell’s Equations to organize and solve multi-concept physics problems.
2) Organize and communicate concepts or applications of electromagnetism or thermodynamics using words, mathematical equations, and other visualization tools (ex: tables, graphs, pictures, animations, diagrams).

3) LAB - Use the scientific method to design controlled experiments and analyze data including statistical and uncertainty analysis; distinguishing between models; and presenting those results with appropriate tables and charts.