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 203 – Light, Optics, and Modern Physics

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

Catalog Description
This is the third course of a three-semester, calculus level sequence of physics courses designed for engineering, physics, mathematics, and science students. The topics of optics, quantum mechanics, special relativity, and atomic and nuclear physics are introduced at the beginning level with reliance upon ability to apply topics introduced in Physics 201 and Physics 202. The laboratory provides experiments in optics, interference and diffraction, and nuclear physics.

Prerequisite
"C" grade or higher or "Pass" in PHYSICS 202 or equivalent; and "C" grade or higher or "Pass" or concurrent enrollment in MATH 281 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) Application of trigonometric functions and their identities.
3) Solve linear, quadratic and trigonometric equations.
4) Application of related rates and derivatives.
5) Integrate polynomial, exponential and trigonometric functions.
6) Use the relationship between force, mass and acceleration to solve dynamics problems.
7) Use conservation of energy and conservation of momentum concepts.
8) Understand simple harmonic motion and apply its concepts to analyze oscillating systems including traveling and standing waves.
9) Use integration techniques such as integration by parts, trig substitution and "u" substitution.
10) Understand use of vectors, differentiation, and integration.

Course Content
1) Interference.
2) Diffraction.
3) Polarization.
4) Geometrical optics, lenses, mirrors, and optical instruments.
5) Wave optics/physical optics.
6) Special relativity.
7) Light as a particle.
8) Matter as a wave.
9) Heisenberg uncertainty principle.
10) Schrödinger's equation.
11) 1D and 2D potential wells.
12) Bohr Model of hydrogen.
13) Multi-electron atom.

14) Nuclear physics.
15) Statistical physics.
16) Molecular structure.
17) Solid-state physics.
18) Use of basic and advanced equipment to perform experiments to be chosen from:
    a. refraction, diffraction, and interference
    b. optical spectra
    c. photoelectric effect,
    d. e/m ratio of particles
    e. radioactive decays
    f. Hall effect
19) Analysis of real-world experimental data, including
    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. covariance and correlation,

Course Objectives

Students will be able to:

1) Describe basic concepts in optics, quantum mechanics, special relativity, atomic and nuclear physics and apply laws and principles of physics to these topics.
2) Analyze basic physical situations involving reflection and refraction, and use this analysis to predict the paths of light rays.
3) Analyze interference and diffraction effects of light waves, and devices that use these effects.
4) Apply concepts from special relativity to analyze physical situations, including time dilation, length contraction, and the Lorentz transformation, relativistic momentum and energy.
5) Apply basic concepts of quantum mechanics to analyze situations including quantization of energy levels, and Heisenberg's uncertainty principle.
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 technique 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) Solve thin lens problems using geometric optics techniques.
2) Use concepts of waves to solve diffraction and interference problems in optics.
3) Use the basic concepts of modern physics: special relativity, photon behavior, matter waves, the uncertainty principle, quantum mechanics in one and three dimensions, statistical physics and nuclear physics.

Student Learning Outcomes
Upon successful completion of this course, students will be able to:
1) Use optics, relativistic, or quantum models to organize and solve multi-concept physics problems.
2) Teach a modern physics optics concept or application to others 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.