Curriculum Committee Approval: 05/05/2020
Lecture Contact Hours: 64-72; Homework Hours: 128-144; Total Student Learning Hours: 192-216
Laboratory Contact Hours: 48-54; Homework Hours: 0; Total Student Learning Hours: 48-54

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

PHYSICS 210 – WAVE MOTION AND MODERN PHYSICS

4 hours lecture, 3 hours laboratory, 5 units

Catalog Description

Course focuses on hydrostatics, hydrodynamics, wave behavior, geometric and physical optics, relativity, light as a particle, matter as a wave, the hydrogen atom and the Schrodinger Equation, electrical conductivity of solids, lasers, and nuclear physics. This course is part of a three semester sequence intended for students majoring in physical sciences and engineering.

Prerequisite

"C" grade or higher or "Pass" in PHYC 190 or equivalent; "C" grade or higher or "Pass" in MATH 281 or equivalent or concurrent enrollment

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) Lecture:
    a. Elasticity
    b. Fluid mechanics
    c. Transverse waves
    d. Longitudinal waves
    e. Optics including geometric optics, wave optics, physical optics; lenses, mirrors and optical instruments
    f. Interference
    g. Diffraction
    h. Polarization
    i. Relativity
    j. Light as a particle
    k. Electron as a wave
    l. Schrodinger Equation and two dimensional potential wells
    m. Schrodinger Equation and the hydrogen atom
    n. Many-electron atoms
    o. Nuclear structure and radioactivity
    p. Nuclear reactions

q. Elementary particles (optional)
r. Statistical physics
s. Molecular structure (optional)
t. Solid-state physics (optional)
u. Historical development of physics
v. Application of physics principles to engineering, chemistry, etc.

2) Laboratory Content:
   a. Standing wave on a string
   b. Speed of sound
   c. Image formation with spherical lenses
   d. Single slit diffraction patterns
   e. Double slit diffraction patterns
   f. Diffraction Grating
   g. Interferometer and the index of refraction for air
   h. Bragg Diffraction
   i. Prism spectrophotometer
   j. Radioactive half-life

Course Objectives

Students will be able to:

1) Recognize the basic concepts concerning hydrostatics and hydrodynamics, transverse and longitudinal waves, geometric optics, diffraction and interference, special relativity, photon behavior, matter waves, the uncertainty principle, quantum mechanics in one and three dimensions, statistical physics and nuclear physics, and use algebraic, trigonometric and advanced calculus expressions to represent physical situations involving these subjects.
2) Investigate and delineate the relationship between the theoretical principles of physics and their practical applications, and explain how this relationship affects real world problem solving.
3) Investigate, interpret and analyze the fundamental principles of physics based on reading assignments and in-class discussions.
4) Calculate solutions to physics problems using the fundamental principles of physics and symbolic logic skills:
   a. Analyze basic physical situations involving reflection and refraction, and use this analysis to predict the path of a light ray.
   b. Analyze situations involving interference and diffraction of light ways, and apply these to situations including double slits, diffraction gratings, and wide slits.
   c. Apply concepts from special relativity to analyze physical situations, including time dilation, length contraction and the Lorentz transformation. Solve basic problems involving relativistic momentum and energy.
   d. Apply basic concepts of quantum mechanics to analyze basic physical setups, including a particle in a box and simple atomic models.

During the lab students will:

1) Design experiments using the scientific method.
2) Collect and analyze data using both traditional and computer data acquisition methods; interpret and analyze numerical data, including appropriate use of error propagation, units and significant figures, and generate a visual representation of the data.
3) Using concepts covered in class, evaluate and interpret the experimental results.

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 and 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; 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) Smart laboratory with blackboard, appropriate lab/demonstration equipment
2) Computers with data acquisition probes

Method of Instruction
1) Integrated lecture, demonstration, discussion
2) Small/large group discussions
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. Serway and Jewett, *Physics for Scientists and Engineers with Modern Physics*. 9th edition. Cengage, 2014.
    b. Young and Freedman. *University Physics*. 14th edition. Pearson, 2015.
    c. Serway, Moses and Meyer. *Modern Physics*. 3rd Edition. Brooks Cole, 2004.
    d. Laboratory Manual for Physics 210, Cuyamaca College.
2) Supplemental: None

Exit Skills
Students having successfully completed this course exit with the following skills, competencies and/or knowledge:
1) Analyze transverse and longitudinal waves.
2) Solve hydrostatic and hydrodynamic problems.
3) Solve thin lens problems using geometric optics techniques.
4) Use concepts of waves to solve diffraction and interference problems in optics.
5) 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) Analyze basic physical situations involving reflection and refraction, and use this analysis to predict the path of a light ray.
2) Analyze situations involving interference and diffraction of light waves, and apply these to situations including double slits, diffraction gratings, and wide slits.
3) Apply concepts from special relativity to analyze physical situations.
4) Apply basic concepts of quantum mechanics to analyze basic physical setups.
5) LAB: Collect and analyze experimental data using graphical representation, including appropriate use of units and significant figures.
6) LAB: Relate the results of experimental data to the physical concepts discussed in the lecture portion of the class.