PHYS 2C: GENERAL PHYSICS

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2025
Units:	5
Hours:	4 lecture, 3 laboratory per week (84 total per quarter)
Prerequisite:	PHYS 2B.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Labs experiments should teach the students the background science, error analysis and how to perform experiments.
- Students should demonstrate competence in Modern Physics, including Special Relativity, Wave Nature of Quantum Physics.
- Students should demonstrate competence in optics, including Relection, Refraction, Lenses, Mirrors.
- Students should demonstrate competence in waves, including Sound, E&M Waves, Interference.

Description

Lectures, demonstrations, and problems in waves; optics; introductory quantum mechanics; atomic physics; and nuclear physics.

Course Objectives

The student will be able to:

1. Analyze the properties of waves and apply mathematical formulas to physical problems.
2. Analyze and solve problems in optics.
3. Compute special relativity problems and interpret related paradoxes and special cases.
4. Explain wave-particle duality and its implications through both historical and thought experiments.
5. Discuss the concepts of quantum mechanics and solve simple problems.
6. Explain models of nuclear physics and how they relate to observed results, and solve problems concerning radioactive decay.
7. Explain current theories in particle physics.
8. Assess the limitations of physical laws and make mathematical approximations in appropriate situations.
9. Discuss how physical laws are established and the role of scientific evidence as support.
10. Discuss historical and current barriers to access in physics.

Course Content

1. Analyze the properties of waves and apply mathematical formulas to physical problems
    a. The wave function and the propagation speed of a wave
        i. Traveling waves
        ii. Speed of a wave on a string
        iii. Transverse vs. longitudinal waves
        iv. Energy transfer
    b. Reflection, transmission, and superposition of waves
    c. Sound waves, intensity, and the Doppler effect
        i. Sounds as a pressure wave
        ii. Speed of sound
        iii. Periodic sound waves
            1. Definition
            2. Intensity
                a. Decibels
                b. Loudness and frequency
        iv. Doppler effect
            1. Source moving
            2. Detector moving
            3. Both moving
            4. Sonic booms
    d. Standing waves, interference, and resonance
        i. Superposition and interference
            1. Destructive interference
            2. Constructive interference
            3. Superposition of sinusoidal waves
        ii. Standing waves
            1. Nodes and antinodes
            2. Standing waves as a function of time
            3. Standing waves on a string
            4. Standing waves in air columns
                a. Open both ends
                b. Closed one end
            5. Standing waves on a membrane
        iii. Resonance
        iv. Beats
    e. Electromagnetic waves and their propagation speed
2. Analyze and solve problems in optics
    a. Reflection and refraction of light
        i. Ray approximation
        ii. Reflection
        iii. Refraction
            1. Index of refraction
            2. Ibn-Sahl's Law (Snell's law)
                a. Huygen's principle
                b. Total internal reflection
    b. Geometrical optics, mirrors, lenses, and optical instruments
        i. Images formed by mirrors
            1. Image distance
            2. Object distance
            3. Magnification
            4. Real vs. virtual
            5. Upright vs. inverted
            6. Concave vs. convex
            7. Ray diagrams for mirrors
        ii. Images formed by lenses

            1. Image distance
            2. Object distance
            3. Magnification
            4. Real vs. virtual
            5. Upright vs. inverted
            6. Concave vs. convex
            7. Ray diagrams for lenses
        iii. Optical instruments
            1. The eye
            2. Microscopes
            3. Telescopes
    c. Optical interference, diffraction, and polarization
        i. Young's double slit
            1. Constructive and destructive interference
            2. Intensity distribution
        ii. Thin film interference
            1. Change of phase on reflection
            2. Coatings
            3. Newton's rings
        iii. Michlson interferometer
3. Compute special relativity problems and interpret related paradoxes and special cases
    a. Frames of reference
        i. Inertial vs. noninertial frames
        ii. Galilean tranforms
    b. Einstein's postulates
        i. Laws of physics same in inertial frames
        ii. Speed of light constant in inertial frames
    c. Lorentz transformations
        i. Length contraction
        ii. Time dilation
        iii. Simultaneity
        iv. Experimental evidence
            1. Muon decay
            2. Airborne atomic clocks
    d. Paradoxes
    e. Addition of velocities
    f. Momentum
    g. Energy
4. Explain wave-particle duality and its implications through both historical and thought experiments
    a. Light acting like a particle
        i. Blackbody radiation
            1. Definition of a black body
            2. Classical attempts at solution
            3. Planck's solution
        ii. The photoelectric effect
            1. Experimental evidence
            2. Einstein's solution
        iii. The Compton effect
    b. Wave properties of particles
        i. The de Broglie hypothesis
        ii. Electron diffraction
    c. Wave-particle duality
        i. Two slit experiments
            1. Predictions for waves
            2. Predictions for particles
            3. Experimental results
        ii. The concept of probabilistic results
5. Discuss the concepts of quantum mechanics and solve simple problems
    a. Probabilistic nature of quantum mechanics
    b. Heisenberg uncertainty principle
    c. Correspondence principle
6. Discuss models and solve problems pertaining to the hydrogen atom, the periodic table, and condensed matter physics
    a. Bohr's model of the hydrogen atom and the hydrogen spectrum
        i. Restriction of angular momentum to integer multiples of Planck's constant
        ii. Bohr radius
        iii. Energy levels and the hydrogen spectrum
        iv. Shortcomings of the Bohr model
    b. Quantum mechanical approach
        i. Schrodinger's equation
        ii. The need for four quantum numbers
        iii. Wave functions for the hydrogen atom
            1. Shapes
            2. Probabilities
        iv. Pauli exclusion principle
        v. The periodic table
7. Explain models of nuclear physics and how they relate to observed results, and solve problems concerning radioactive decay
    a. Models of the nucleus
        i. Stability
        ii. Ratio of protons to neutrons
    b. Radioactivity
        i. Decay and half-lives
        ii. Biological effects of radiation
    c. Fission
    d. Fusion
8. Explain current theories in particle physics
    a. Inventory of particles
        i. Leptons
        ii. Hadrons
            1. Baryons
            2. Mesons
    b. Conservation laws
    c. Quarks
9. Assess the limitations of physical laws and make mathematical approximations in appropriate situations
    a. Physical laws as ideal models
    b. Methods of approximation
10. Discuss how physical laws are established and the role of scientific evidence as support
    a. Historical development of a sampling of physical laws
    b. Use of student-collected data in labs to confirm physical laws
11. Discuss historical and current barriers to access in physics
    a. Discuss that historically our field has had barriers to entry and advancement due to race, gender, sexuality, class, and other factors

b. Discuss "hidden figures" in our field
c. Discuss that many of these issues persist to the current day and detail efforts to address them

Lab Content

Suggested laboratory experiments:

1. Speed of sound in air
2. Standing waves (in a string or air column)
3. Index of refraction
4. Focal length
5. Lenses
6. Interference and diffraction
7. Photoelectric effect
8. The hydrogen spectra
9. Measurements of radioactivity

Special Facilities and/or Equipment

1. Physics laboratory with equipment for teaching introductory thermal physics, electricity, and magnetism.
2. When taught via Foothill Global Access, on-going access to computer with email software and hardware; email address.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Weekly assignments
Weekly quizzes
Mid-term test(s)
Laboratory
Projects/presentations
Final examination
Students are evaluated using a variety of measures that can include written exams, project presentations, and discussions, in order to allow them to demonstrate their knowledge and skills by the end of the quarter

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture (may be live/interactive or in the form of pre-recorded videos)
Discussion
Cooperative learning exercises
Electronic discussions/chat
Laboratory
Demonstration
Students gain an understanding of physics through connecting new terms, concepts, and procedures to what they already know through small group and large group discussions, making predictions and correcting each other's assumptions on ranking tasks, and practicing problem solving methods with the support and guidance of peers and the instructor

Representative Text(s) and Other Materials

Urone and Hinrichs. OpenStax College Physics. 2012.

OpenStax is the main OER text in the field. The text itself has undergone regular updates since 2012, but the copyright/edition date remains 2012. Note that the bulk of the material in this course was developed in the 19th and 20th centuries, and has been consistent since then.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

1. Homework problems: Homework problems covering subject matter from text and related material ranging from 10-40 problems per week. Students will need to employ critical thinking in order to complete assignments.
2. Lecture: Four hours per week of lecture covering subject matter from text and related material. Reading and study of the textbook, related materials, and notes.
3. Labs: Students will perform experiments and discuss their results either in the form of a written lab report or via oral examination. Reading and understanding the lab manual prior to class is essential to success.

Discipline(s)

Physics/Astronomy