

College of San Mateo
Official Course Outline

1. **COURSE ID:** PHYS 250 **TITLE:** Physics with Calculus I **C-ID:** PHYS 205, PHYS 200S (PHYS 250 & 260 & 270)

Units: 4.0 units **Hours/Semester:** 48.0-54.0 Lecture hours; 48.0-54.0 Lab hours; and 96.0-108.0 Homework hours

Method of Grading: Letter Grade Only

Prerequisite: Completion of or concurrent enrollment in MATH 252

Recommended Preparation:
PHYS 150 or equivalent

2. **COURSE DESIGNATION:**

Degree Credit

Transfer credit: CSU; UC

AA/AS Degree Requirements:

CSM - GENERAL EDUCATION REQUIREMENTS: E5a. Natural Science

CSU GE:

CSU GE Area B: SCIENTIFIC INQUIRY AND QUANTITATIVE REASONING: B1 - Physical Science

CSU GE Area B: SCIENTIFIC INQUIRY AND QUANTITATIVE REASONING: B3 - Laboratory Activity

IGETC:

IGETC Area 5: PHYSICAL AND BIOLOGICAL SCIENCES: A: Physical Science

IGETC Area 5: PHYSICAL AND BIOLOGICAL SCIENCES: C: Science Laboratory

3. **COURSE DESCRIPTIONS:**

Catalog Description:

First semester in a three semester calculus-based physics sequence covering mechanics, wave motion, and special relativity. Intended primarily for students majoring in the physical sciences or engineering.

4. **STUDENT LEARNING OUTCOME(S) (SLO'S):**

Upon successful completion of this course, a student will meet the following outcomes:

1. Identify problems that should be solved using Newton's Laws of Motion and correctly solve them.
2. Identify problems that should be solved using the Work-Energy Theorem and correctly solve them.
3. Identify problems that should be solved using Conservation of Momentum (Linear and Angular) and correctly solve them.
4. Collect and analyze data to verify physics principles.

5. **SPECIFIC INSTRUCTIONAL OBJECTIVES:**

Upon successful completion of this course, a student will be able to:

Content-specific objectives: Upon completion of this course, students will have a working knowledge of the skills and concepts listed in the course outline. For example, they will be able to:

1. Recognize situations in which velocity or acceleration is constant and be able to apply the relationships between kinematics variables to solve for unknown quantities.
2. Distinguish between physical quantities that are scalar and those that are vectors and perform algebraic operations on both types of quantities.
3. Recognize the basic principles of dynamics as embodied in Newton's Laws, and apply these laws to solve problems in mechanics involving systems containing one or more objects.
4. Apply the two conditions of equilibrium to determine unknown forces and/or torques. Know the laws of friction and apply them to a given situations.
5. Understand the law of conservation of momentum and apply it in problem solving involving collisions.
6. Understand concepts of potential and kinetic energy and the work energy theorem. Recognize the conditions under which the total mechanical energy of the system remains constant and use this knowledge in solving problems.
7. Understand the principal concepts involved in rotary motion about a fixed axis and apply these concepts in problem solving.
8. Understand the concepts of elasticity and apply this knowledge to solving problems having to do with simple harmonic motion.
9. Recognize the two types of mechanical wave motion and phenomena associated with waves. Solve

problems having to do with wave phenomena.

10. Understand the principals of fluid mechanics and be able to solve the problems having to do with fluids at rest and in motion.

General objectives: Upon completion of this course, the student will be better able to:

1. Follow scientific arguments, including derivations of formulas, presented either orally or in writing.
2. Determine whether a physical law or principle applies in a given situation, and use it appropriately if it applies.
3. Use the language and notation of differential and integral calculus and other mathematics correctly in the solution of physics problems, and use appropriate style and format in written work.
4. Demonstrate good problem-solving habits, including: 1) estimating solutions and recognizing unreasonable results. 2) considering a variety of approaches to a given problem, and selecting one that is appropriate. 3) rejecting the temptation to rely on mechanical techniques (either pencil-and-paper or electronic) that they do not understand. 4) interpreting results of problems and experiments correctly, and answering the questions that were actually asked.
5. Read and follow laboratory procedures. Use a variety of instruments to take physical measurements and record them with correct precision and units.

6. COURSE CONTENT:

Lecture Content:

Units, Physical Quantities, and Vectors

Typically 2 to 4 days

International System (SI) of units; unit conversions and consistency; uncertainty and significant figures; vectors and vector operations

Motion along a Straight Line

Typically 2 to 4 days

Definitions: displacement, average and instantaneous velocity, average and instantaneous acceleration; motion with constant acceleration; freely falling bodies; velocity and position by integration.

Motion in Two or Three Dimensions

Typically 2 to 4 days

Position, velocity, and acceleration vectors; projectile motion; motion in a circle; relative velocity.

Newton's Laws of Motion

Typically 4 to 6 days

Forces; Newton's First, Second, and Third Laws; mass and weight; free-body diagrams; applications: particles in equilibrium, dynamics of particles; frictional forces; dynamics of circular motion; the fundamental forces of nature.

Work and Energy

Typically 5 to 7 days

Work; kinetic energy; work-energy theorem; gravitational and elastic potential energy; power; conservative and non-conservative forces; force and potential energy; energy diagrams.

Momentum, Impulse, and Collisions

Typically 3 to 5 days

Momentum and impulse; conservation of momentum; elastic and inelastic collisions; center of mass; rocket propulsion.

Rotation of Rigid Bodies

Typically 2 to 4 days

Angular velocity and acceleration; rotation with constant angular acceleration; relating linear and angular kinematics; energy in rotational motion; parallel-axis theorem; moment of inertia calculations.

Dynamics of Rotational Motion

Typically 3 to 5 days

Torque; torque and angular acceleration for a rigid body; rigid-body rotation about a moving axis; work and power in rotational motion; angular momentum and conservation of angular momentum; gyroscopes and precession.

Equilibrium and Elasticity

Typically 2 to 3 days

Conditions for equilibrium; center of gravity; solving rigid-body equilibrium problems; stress, strain, and elastic moduli; elasticity and plasticity.

Gravitation

Typically 1 to 3 days

Newton's Law of Gravitation; weight; gravitational potential energy; Kepler's Laws and the motion of planets; spherical mass distributions; apparent weight and the earth's rotation.

Periodic Motion

Typically 2 to 3 days

Describing oscillations; simple harmonic motion; energy in simple harmonic motion; applications of simple harmonic motion; simple pendulum; physical pendulum; damped oscillations; forced oscillations and resonance.

Fluid Mechanics

Typically 2 to 3 days

Density; pressure in a fluid; buoyancy; fluid flow; Bernoulli's equation; viscosity and turbulence.

Mechanical Waves

Typically 2 to 4 days

Types of mechanical waves; periodic waves; mathematical description of a wave; speed of a transverse wave; energy in wave motion; wave interference, boundary conditions, and superposition; standing waves on a string; normal modes of a string.

Sound and Hearing

Typically 1 to 3 days

Sound waves; speed of sound waves; sound intensity; standing sound waves and normal modes; resonance; interference of waves; beats; the Doppler effect.

Special Relativity

Typically 1 to 3 days

Invariance of physical laws; relativity of simultaneity; relativity of time intervals; relativity of length; the Lorentz transformation; the relativistic Doppler effect; relativistic momentum; relativistic work and energy; Newtonian mechanics and relativity.

Lab Content:

Students complete laboratory experiments with hands-on data acquisition and analysis. Students also practice problem solving skills and complete other projects as assigned.

The following is a list of the experiments in the current Physics 250 Laboratory Manual, College of San Mateo Physics Department. Students typically complete between 10 and 15 experiments per semester.

1. Basic Measurements, Basic Calculations and Conversion of Units
2. The Acceleration Due to Gravity
3. Projectile Motion
4. Equilibrium of Concurrent Forces
5. Newton's Second Law
- 5A. Newton's Second Law with Computers
- 5B. The Work-Energy Theorem
6. Centripetal Force
7. The Ballistic Pendulum
8. Conservation of Momentum
9. Moment of Inertia
10. Rotational Dynamics
11. Equilibrium of a Rigid Body
12. Moments—Center of Gravity
13. Linear Simple Harmonic Motion
14. Torsion Constant of a Rod
15. The Physical Pendulum
16. Standing Waves on a String
17. Archimedes's Principle

7. REPRESENTATIVE METHODS OF INSTRUCTION:

Typical methods of instruction may include:

- A. Lecture
- B. Lab
- C. Discussion
- D. Experiments
- E. Other (Specify):
 1. Lecture: Introduce and explain the concepts, define the appropriate terms, provide examples and solve problems to illustrate the application of the concepts.
 2. Demonstrations: Use physical demonstrations to reinforce understanding of the physical concepts
 3. Collaborative learning: Guided discussions and in-class exercises, which lead to clarification of concepts and development of problem solving skills.
 4. Laboratory work: Group and individual work to investigate physical principles; observe, record, and analyze the results of experiments, which deepens the understanding of concepts introduced in lecture.

8. REPRESENTATIVE ASSIGNMENTS

Representative assignments in this course may include, but are not limited to the following:

Writing Assignments:

Students complete written laboratory reports in which they analyze the results of experiments performed in the lab. This analysis requires critical thinking and requires students to connect lecture topics to the experiments performed. These assignments also require students to effectively communicate their ideas in writing.

Reading Assignments:

Reading the textbook prior to lectures to become familiar with the topics to be presented. Reading the textbook after lectures to review the key points and concepts.

Other Outside Assignments:

Solving textbook (or similar) problems after each lecture. Problems are of varying difficulty and are completed by students to help further their understanding of the concepts and to learn how physics formulas and mathematics are used to apply the concepts to specific situations.

9. REPRESENTATIVE METHODS OF EVALUATION

Representative methods of evaluation may include:

- A. Class Participation
- B. Exams/Tests
- C. Homework
- D. Lab Activities
- E. Projects
- F. Quizzes
- G. 1. Lab activities require students to participate in performing measurements and observations during the lab period. Lab reports assess students' careful recording of observations and measurements, correctness of calculations, and critical thinking ability. Furthermore, these reports evaluate students' ability to communicate their results in clear writing. Department policy is that students must pass the lab portion of the course to receive a grade of "C" higher. 2. Homework assignments allow students to receive feedback from instructors on their understanding of the material before they are required to demonstrate their understanding on the exams. Homework problems require and develop critical thinking and other problem solving skills. 3. Exams are designed to assess both students' conceptual understanding of the material and their problem solving skills, logical reasoning, and analytic thinking. Department policy is for a comprehensive final exam to be required which accounts for at least 20% of a student's grade.

10. REPRESENTATIVE TEXT(S):

Possible textbooks include:

- A. Young & Freedman. *University Physics with Modern Physics*, 14th ed. Pearson, 2016

Other:

- A. CSM Physics Department, Physics 250 Lab Manual, CSM, available on Physics Department website.

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Course Originator: David Locke