PHYS 4A: GENERAL PHYSICS (CALCULUS)

Foothill College Course Outline of Record

Heading	Value
Units:	6
Hours:	5 lecture, 3 laboratory per week (96 total per quarter)
Corequisite:	Completion of or concurrent enrollment in MATH 1B or 1BH.
Advisory:	Students who have not taken physics in high school are strongly encouraged to take either PHYS 2A or 6 prior.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Area III: Natural Sciences
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students should be able to solve problems involving Kinematics, Newton's Laws, Energy, and Momentum, and know when to use which concept.
- Via lab experiments, students will have an understanding of the background science, error analysis, and how to perform experiments.

Description

Mathematics-physics interrelationships, classical Newtonian mechanics.

Course Objectives

The student will be able to:
A. Explain basic kinematics and solve related problems.
B. Apply Newtonian dynamics and the three laws of motion.
C. Explain work, energy and power and solve related problems.
D. Derive momentum and impulse and apply these concepts to problems.

E. Apply their understanding of mechanics to rotational cases.
F. Apply their understanding of mechanics to the standard introductory topics of oscillators and universal gravity.
G. Assess the limitations of physical laws and make mathematical approximations in appropriate situations.
H. Discuss how physical laws are established and the role of scientific evidence as support.

Course Content

A. Explain basic kinematics and solve related problems.
1. Concept of position
2. Concept of velocity
a. Average velocity
b. Instantaneous velocity
c. Velocity as the derivative of position
3. Concept of acceleration
a. Average acceleration
b. Instantaneous acceleration
c. Acceleration as the derivative of velocity and second derivative of position
4. Problems featuring constant acceleration
5. Falling body problems
6. Motion in two or three dimensions
a. Position, velocity and acceleration as vectors
b. Projectile motion
c. Motion in a circle
B. Apply Newtonian dynamics and the three laws of motion.
1. Concept of a force
2. Newton's first law
3. Newton's second law
a. The difference between mass and weight
b. Free body diagrams
4. Newton's third law
5. Special forces
a. The spring force
b. Friction
c. The centripetal force
C. Explain work, energy and power and solve related problems.
1. The definition of work
a. Work in one dimension as a result of a constant force
b. Work in one dimension as a result of a non-constant force
c. Work when the displacement and force are not in one dimension
2. Kinetic energy
a. Derivation from Newton's second law
b. The work-energy theorem
3. Power
4. Potential energy
a. Derivation from work
b. Gravitational potential energy
c. Spring potential energy
d. Conservation of energy
1) Conservative and nonconservative forces
2) Conservation of energy-type problems with friction
e. Energy diagrams and the relationship between forces and potential energies
D. Derive momentum and impulse and apply these concepts to problems.

1. Conservation of momentum from Newton's third law
2. Definition of impulse
3. Elastic and inelastic collisions
4. The center of mass
E. Apply their understanding of mechanics to rotational cases.
1. Definitions of angular position, velocity and acceleration
a. Cases with constant angular acceleration
b. Relationship between linear and angular motion
2. Energy considerations in rotational motion
3. The moment of inertia
a. Moment of inertia for collections of point particles
b. Calculation of moment of inertia for extended bodies
c. The parallel axis theorem
4. Torque
5. Angular momentum
6. Gyroscopes
F. Apply their understanding of mechanics to the standard introductory topics of oscillators and universal gravity.
1. Statics
a. Equilibrium
b. Center of gravity
c. Stress, strain and elastic moduli

2. Oscillators
a. Simple harmonic motion
1) Spring and a mass
2) Second order differential equations
3) Pendula
b. Advanced cases
1) Damped oscillators
2) Forced oscillators
3) Resonance
3. Universal gravitation
a. Newton's law of gravitation
b. Gravitational potential energy
c. Kepler's laws
1) Historical development
2) Motion of satellites
G. Assess the limitations of physical laws and make mathematical approximations in appropriate situations.
1. Physical laws as ideal models
2. Methods of approximation
H. Discuss how physical laws are established and the role of scientific evidence as support.
1. Historical development of a sampling of physical laws
2. Use of student-collected data in labs to confirm physical laws

Lab Content

A. Suggested laboratory experiments (most experiments should by student driven - they should design how they will test the week's material):
1. Introduction to uncertainty
2. Period of a pendulum (2 week lab)
3. Atwood's machines (2 week lab)
4. Drag (2 week lab)
5. Measurements of g
6. Energy in the bouncing ball system
7. Ballisitc pendula
8. Numerical simulations

Special Facilities and/or Equipment

A. Physics laboratory with equipment for teaching introductory mechanics.

Method(s) of Evaluation

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

A. Weekly problem sets
B. Periodic midterm tests
C. Laboratory performance
D. Final examination

Method(s) of Instruction

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

A. Lecture
B. Discussion
C. Cooperative learning exercises
D. Electronic discussions/chat
E. Laboratory
F. Demonstration

Representative Text(s) and Other Materials

Moebs, Ling, and Sanny. University Physics. OpenStax, 2017.

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

A. 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.
B. Lecture: Five hours per week of lecture covering subject matter from text and related material. Reading and study of the textbook, related materials and notes.
C. Labs: Students will perform experiments and discuss their results in either 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