EL CAMINO COLLEGE
COURSE OUTLINE OF RECORD – Approved

I. Course Information

Subject:	**PHYS**
Course Number:	**1A**
Descriptive Title:	**Mechanics of Solids**
Division:	**Natural Sciences**
Department:	**Physics**
Course Disciplines:	**Physics**

Catalog Description:
This is the first course in a four-semester calculus-based physics sequence designed for students with majors in engineering and the physical sciences. The course focuses on the mechanics of solids, with topics including statics, kinematics, Newton's Laws, energy, power, linear and angular momentum, rotational dynamics, elasticity, simple harmonic motion, and gravitation.

Conditions of Enrollment:
Prerequisite: One year of high school physics or Physics 2A AND Mathematics 190 with a minimum grade of C

Course Length: Full Term

Hours Lecture (per week):	3
Hours Laboratory (per week):	3
Outside Study Hours:	7
Total Hours:	108
Course Units:	4

Grading Method:	Letter Grade only	
Credit Status:	Credit, degree applicable	
Transfer CSU:	Yes	Effective Date: July 1992
Transfer UC:	Yes	Effective Date:

General Education:
ECC: Area 1 - Natural Sciences
Term: Other:

CSU GE: Area B1 - Physical Universe and its Life Forms: Physical Science, Area B3 - Physical Universe and its Life Forms: Laboratory Activity
Term: Other:

IGETC: Area 5A - Physical Science
Term: Other:

II. Outcomes and Objectives

A. Student Learning Outcomes (SLOs) (The course student learning outcomes are listed below.)

SLO #1 Applying Relevant Principles
Students can recognize the basic physical principles which are relevant in a given physical situation involving mechanics in order to correctly answer conceptual questions.

SLO #2 Solving Physics Problems
Students can identify and apply the relevant laws of physics along with the necessary mathematics to successfully solve a mechanics problem.

SLO #3 Data Collection & Analysis
Students can read and record, with appropriate units and uncertainties, measurements taken from a Vernier caliper and a micrometer caliper. Students can interpret and analyze the collected data, including error analysis.

B. Course Objectives (The major learning objective for in this course are listed below)

1. Draw a free-body diagram which depicts forces acting on a rigid object, and use this diagram to quantitatively analyze these forces.
2. Analyze the motion of objects moving in one- or two-dimensions with constant or variable acceleration, including free-falling objects.
3. Analyze the motion of a rigid object using a free-body diagram analysis together with Newton's laws of motion.
4. Use the concepts of work, energy, impulse and momentum to analyze the motion of rigid objects.
5. Analyze the motion of a rotating object using appropriate physical principles, including Newton's second law for rotation, and conservation of angular momentum.
6. Identify the possibility of simple harmonic motion in a given physical scenario, and describe the motion of the system in question.
7. Use Kepler's laws, Newton's law of gravitation, and the concepts of gravitational potential energy and gravitational fields, to describe the motion of objects in gravitational orbits.
8. Demonstrate the ability to explain physical phenomena conceptually and qualitatively.
9. Use different measuring devices, such as the micrometer or Vernier caliper and determine the errors that are introduced with each measurement.
10. Define and use the basic concepts and equations in error theory. Recognize when to use the different equations.
11. Analyze data graphically using linear, semi-log, and log-log scales.
12. Solve mechanics problems utilizing differential calculus for a variety of physical situations.

III. Outline of Subject Matter

(Topics should be detailed enough to enable an instructor to determine the major areas that should be covered to ensure consistency from instructor to instructor and semester to semester.)

Major Topics

I. EQUILIBRIUM (6 hours, lecture)

A. Systems of units
B. Mathematics of vectors and scalars.
C. Forces, including friction and weight.
D. Newton's 1st and 3rd Laws of motion.
E. Conditions of Equilibrium for point objects.
F. Torque and center of gravity.
G. Conditions of equilibrium for point extended objects.

II. TRANSLATIONAL KINEMATICS (6 hours, lecture)

A. Displacement, velocity, and acceleration.
B. Graphical representation of motion.
C. Motion with constant acceleration.
D. Motion with variable acceleration.

III. TWO-DIMENSIONAL KINEMATICS (6 hours, lecture)

A. Displacement, velocity, and acceleration vectors, and resolution of these vectors into components.
B. Constant acceleration and free-fall motion in two dimensions.
C. Projectile motion and trajectories.
D. Relative velocity.

IV. LINEAR DYNAMICS (6 hours, lecture)

A. Mass and force.
B. Newton's 2nd law, and applications thereof.

V. WORK AND ENERGY (6 hours, lecture)

A. Work, kinetic energy, and the work-kinetic energy theorem.
B. Power.
C. Potential energy.
D. Conservation of mechanical energy.
E. Conservative vs. non-conservative forces, and the effect of non-conservative forces on conservation of mechanical energy.

VI. IMPULSE AND MOMENTUM (6 hours, lecture)

A. Impulse and momentum.
B. Conservation of momentum.
C. Elastic and inelastic collisions.
D. Coefficient of restitution.
E. Motion of the center of mass.

VII. CIRCULAR MOTION (6 hours, lecture)

A. Rotational kinematics.
B. Centripetal and tangential acceleration.
C. Newton's laws applied to objects moving in circles.

VIII. ROTATIONAL DYNAMICS (6 hours, lecture)

A. Moment of inertia and parallel axis theorem.
B. Newton's second law for rotation applied to pivoted and nonpivoted objects.
C. Rotational vs. translation motion.

D. Rolling motion.
E. Angular impulse and angular momentum.
F. Vector representation of angular quantities.
G. Work and power in rotational motion.

IX. ELASTICITY (6 hours, lecture)

A. Longitudinal stress and strain.
B. Shear stress and strain.
C. Torsion in a rod.
D. Poisson's ratio.
E. Relationship between elastic constants.

X. OSCILLATION (6 hours, lecture)

A. Hooke's law.
B. Differential equation for simple harmonic motion.
C. Kinematic equations for objects undergoing simple harmonic motion.
D. Energy in simple harmonic motion.
E. Centers of oscillation and percussion.
F. Forced oscillation and resonance.
G. Damped harmonic motion.

XI. GRAVITATION (6 hours, lecture)

A. Newton's law of gravitation.
B. Orbital motion.
C. Gravitational fields and potential.

XII. LABORATORY EXERCISES (54 hours, lab)

Measurements and Their Errors
Propagation of Errors
Graphical Analysis on Linear Graph Paper/Friction Lab
Variable Accelerating Motion
Ballistic Pendulum and Projectile Motion
Functional Relations from Log-Log and Semi-Log graphs; Pendulum Period
Moment of Inertia by Angular Acceleration and by Angular Collision
Gyroscopic Motion
Propagation of Determinate and Random Errors

Total Lecture Hours: 54
Total Laboratory Hours: 54

Total Hours: 108

<u>IV. Primary Method of Evaluation and Sample Assignments</u>

A. Primary Method of Evaluation (choose one):

2) Problem solving demonstrations (computational or non-computational)

B. Typical Assignment Using Primary Method of Evaluation

A particle of mass, m = 1.00 kg, traveling at a speed of vo=10.0 m/s, strikes a stationary particle of mass, M=4.00 kg, and rebounds in the direction from which it came, with a speed of vf. If the amount of heat produced in this

collision is 20.0 J, find vf. (Draw a neat sketch, and show and label all the physical quantities used in your equations. Also state which physical law is responsible for each equation.)

C. College-level Critical Thinking Assignments

Critical Thinking Assignment 1:
Answer the question below. Use complete sentences and show calculations where appropriate. A plumb bob does not hang exactly along a line directed to the center of the Earth's rotation. How much does the plumb bob deviate from a radial line at 35 degrees north latitude? Assume that the Earth is spherical.

Critical Thinking Assignment 2:
Answer the question below. Use complete sentences and show calculations where appropriate. Water flows over a section of Niagara Falls at a rate of 1.2 x 10^6 kg/s and falls 50.0 m. How many 60-W bulbs can be lit with this power?

D. Other Typical Assessment and Evaluation Methods
Essay Exams, Homework Problems, Laboratory Reports, Multiple Choice, Objective Exam, Other Exams, Quizzes, Written Homework

V. Instructional Methods
Demonstration, Discussion, Lab, Lecture

If other:

Note: In compliance with Board Policies 1600 and 3410, Title 5 California Code of Regulations, the Rehabilitation Act of 1973, and Sections 504 and 508 of the Americans with Disabilities Act, instruction delivery shall provide access, full inclusion, and effective communication for students with disabilities.

VI. Work Outside of Class
Answer questions, Problem solving activity, Required reading, Study

If Other:

VII. Texts and Materials
A. Up-to-date Representative Textbooks: (Please use the following format: Author, Title, Edition, Publisher, Year. If you wish to list a text that is more than 5 years old, please annotate it as a "discipline standard".)

Wilson. Laboratory Manual for Mechanics of Solids. El Camino College Bookstore, 2013.

Young, Freedman, Ford. University Physics with Modern Physics. 15th Edition ed. Addison-Wesley, 2020.

B. Alternative Textbooks: (Please use the following format: Author, Title, Edition, Publisher, Year. If you wish to list a text that is more than 5 years old, please annotate it as a "discipline standard".)

C. Required Supplementary Readings

D. Other Required Materials

VIII. Conditions of Enrollment

A. Requisites (Course Prerequisites and Corequisites) Skills needed without which a student would be highly unlikely to succeed.

Requisite: Prerequisite

Category: communication or computation skill

Requisite course(s): Mathematics prerequisite: Mathematics-190 with a grade of C or higher

Physics prerequisite: Physics-2A with a grade of C or higher OR one year of high school physics

Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s). Students will need to have a basic knowledge of methods for solving physics problems such as force diagrams, kinematics equations, and conservation laws.

PHYS 2A - Demonstrate the ability to solve problems using Newton's Laws of Motion, momentum and impulse, work-energy theorem, conservation of energy, torque, the laws of thermodynamics, hydrostatics, hydrodynamics, Newton's Law of Universal Gravitation, and simple harmonic motion.

Identify what is and is not important in a problem, draw meaningful diagrams to aid in problem solving, and construct mathematical models of physics problems.

PHYS 2A -Analyze physical problems in order to recognize the physical principles required to solve the problem, isolate and model the physical principles underlying each part of the problem, formulate the equations for each part, combine and solve the system of equations for the problem, and analyze and explain the results of the computations.

Ability to perform elementary differentiation and integration.

MATH 190 - Calculate derivatives of algebraic and transcendental functions symbolically using rules and using the definition of the derivative, as well as estimating derivatives graphically and numerically.

Calculate single-variable integrals.

B. Requisite Skills: (Non-Course Prerequisite and Corequisites) Skills needed without which a student would be highly unlikely to succeed.

Requisite:

Requisite and Matching Skill(s): Bold the requisite skill(s). If applicable

C. Recommended Preparations (Course) (Skills with which a student's ability to succeed will be strongly enhanced.)

Requisite course:

Requisite and Matching skill(s):Bold the requisite skill. List the corresponding course objective under each skill(s). Students will need to have a basic knowledge of methods for solving physics problems such as force diagrams, kinematics equations, and conservation laws.

D. Recommended Preparation (Non-Course) (Skills with which a student's ability to succeed will be strongly enhanced.)

Requisite:

Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). If applicable

E. Enrollment Limitations

Enrollment Limitations and Category:

Enrollment Limitations Impact:

Course Created by: T. Wilson, G. Karpel, M. Feero, and J. Platts
Date:02/01/1965

Original Board Approval Date:

Last Reviewed and/or Revised by: Susan Stolovy Date: 05/13/2021

Last Board Approval Date: 06/21/2021