El Camino College

COURSE OUTLINE OF RECORD - Official

I. GENERAL COURSE INFORMATION

Subject and Number: **Physics 1A**
Descriptive Title: **Mechanics of Solids**

Course Disciplines: **Physics/Astronomy**

Division: **Natural Sciences**

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 in prerequisite or

Concurrent Enrollment

Course Length: [X] **Full Term** [ ] **Other (Specify number of weeks):**
Hours Lecture: **4.00 hours per week** [ ] **TBA**
Hours Laboratory: **2.00 hours per week** [ ] **TBA**
Course Units: **4.00**

Grading Method: **Letter**
Credit Status **Associate Degree Credit**

Transfer CSU: [X] **Effective Date: Prior to July 1992**
Transfer UC: [X] **Effective Date: Prior to July 1992**

General Education:

El Camino College: **1 – Natural Sciences**
Term: Other: Approved

CSU GE: **B1 - Physical Science**
Term: Other:

B3 - Laboratory Sciences

Term: Other: Approved

IGETC:

5A - Physical Science with Lab

Term: Fall 1991 Other:

II. OUTCOMES AND OBJECTIVES

A. COURSE STUDENT LEARNING OUTCOMES (The course student learning outcomes are listed below, along with a representative assessment method for each. Student learning outcomes are not subject to review, revision or approval by the College Curriculum Committee)

1. Students can recognize the basic physical principles which are relevant in a given physical situation involving mechanics in order to correctly answer conceptual questions.
2. Students can identify and apply the relevant laws of physics along with the necessary mathematics to successfully solve a mechanics problem.
3. Students can read and record, with appropriate units and uncertainties, measurements taken from a Vernier caliper and a micrometer. Students can interpret and analyze the collected data, including error analysis.

The above SLOs were the most recent available SLOs at the time of course review. For the most current SLO statements, visit the El Camino College SLO webpage at http://www.elcamino.edu/academics/slo/.

B. Course Student Learning Objectives (The major learning objective for students enrolled in this course are listed below, along with a representative assessment method for each)

1. Draw a free-body diagram which depicts forces acting on a rigid object, and use this diagram to quantitatively analyze these forces.

   Other exams
2. Analyze the motion of objects moving in one- or two-dimensions with constant or variable acceleration, including free-falling objects.

   Other exams
3. Analyze the motion of a rigid object using a free-body diagram analysis together with Newton's laws of motion.

   Other exams
4. Use the concepts of work, energy, impulse and momentum to analyze the motion of rigid objects.

   Other exams
5. Analyze the motion of a rotating object using appropriate physical principles, including Newton's second law for rotation, and conservation of angular momentum.

   Other exams
6. Identify the possibility of simple harmonic motion in a given physical scenario, and describe the motion of the system in question.

   Other exams
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.

Other exams

8. Demonstrate the ability to explain physical phenomena conceptually and qualitatively.

   Essay exams

9. Use different measuring devices, such as the micrometer or vernier caliper and determine the errors that are introduced with each measurement.

   Laboratory reports

10. Define and use the basic concepts and equations in error theory. Recognize when to use the different equations.

    Laboratory reports

11. Analyze data graphically using linear, semi-log, and log-log scales.

    Laboratory reports

12. Solve mechanics problems utilizing differential calculus for a variety of physical situations.

    Other exams

III. OUTLINE OF SUBJECT MATTER (Topics are detailed enough to enable a qualified instructor to determine the major areas that should be covered as well as ensure consistency from instructor to instructor and semester to semester.)

Lecture or Lab	Approximate Hours	Topic Number	Major Topic
Lecture	16	I	I. EQUILIBRIUM 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.
Lecture	3	II	II. TRANSLATIONAL KINEMATICS A. Displacement, velocity, and acceleration. B. Graphical representation of motion. C. Motion with constant acceleration. D. Motion with variable acceleration.
Lecture	3	III	III. TWO-DIMENSIONAL KINEMATICS 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.
Lecture	3	IV	IV. LINEAR DYNAMICS A. Mass and force. B. Newton's 2nd law, and applications thereof.
Lecture	10	V	V. WORK AND ENERGY A. Work, kinetic energy, and the work-kinetic energy theorem. B. Power. C. Potential energy. D. Conservation of mechanical energy. E. Conservative vs. nonconservative forces, and the effect of nonconservative forces on conservation of mechanical energy.
Lecture	9	VI	

			VI. IMPULSE AND MOMENTUM A. Impulse and momentum. B. Conservation of momentum. C. Elastic and inelastic collisions. D. Coefficient of restitution. E. Motion of the center of mass.
Lecture	9	VII	VII. CIRCULAR MOTION A. Rotational kinematics. B. Centripetal and tangential acceleration. C. Newton's laws applied to objects moving in circles.
Lecture	7	VIII	VIII. ROTATIONAL DYNAMICS 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.
Lecture	2	IX	IX. ELASTICITY A. Longitudinal stress and strain, B. Shear stress and strain. C. Torsion in a rod. D. Poisson’s ratio. E. Relationship between elastic constants.
Lecture	7	X	X. OSCILLATION 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.
Lecture	3	XI	XI. GRAVITATION A. Newton’s law of gravitation. B. Orbital motion. C. Gravitational fields and potential.
Lab	36	XII	XII. LABORATORY EXERCISES A. - Measurements and Their Errors B. - Propagation of Errors C. - Graphical Analysis on Linear Graph Paper D. - Variable Accelerating Motion E. - Ballistic Pendulum and Projectile Motion F. - Moment of Inertia by Angular Acceleration and by Angular Collision G. - Gyroscopic Motion H. - Standard deviation; general formulas for propagation of error.
Total Lecture Hours		72	
Total Laboratory Hours		36	
Total Hours		108	

IV. PRIMARY METHOD OF EVALUATION AND SAMPLE ASSIGNMENTS

A. **PRIMARY METHOD OF EVALUATION:**

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:**

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.
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
Objective Exams
Other exams
Quizzes
Written homework
Laboratory reports
Homework Problems
Multiple Choice

V. INSTRUCTIONAL METHODS

Demonstration
Discussion
Laboratory
Lecture

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

Study
Answer questions
Required reading
Problem solving activities
Other (specify)
Reduced the study hours from 8 to 7 with the understanding that the 2 hours of lab was instrumental in supporting the lecture material.

Estimated Independent Study Hours per Week: 7

VII. TEXTS AND MATERIALS

A. **UP-TO-DATE REPRESENTATIVE TEXTBOOKS**
Wilson. Laboratory Manual for Mechanics of Solids . El Camino College Bookstore, 2013.
Young, Freedman, Ford. University Physics with Modern Physics. 13th Edition ed. Addison-Wesley, 2011.

B. **ALTERNATIVE TEXTBOOKS**

C. **REQUIRED SUPPLEMENTARY READINGS**

D. **OTHER REQUIRED MATERIALS**
Scientific calculator
Ruler and protractor
Graph paper (linear, semi log, log-log)

VIII. CONDITIONS OF ENROLLMENT

A. Requisites (Course and Non-Course Prerequisites and Corequisites)

Requisites	Category and Justification
Non-Course Prerequisite or	Students will need to have a basic knowledge of methods for solving physics problems such as force diagrams, kinematics equations, and conservation laws.
Course Prerequisite Physics-2A AND	Sequential
Course Prerequisite Mathematics-190	Computational/Communication Skills

B. Requisite Skills

Requisite Skills

Basic knowledge of Newton's Laws, kinematics, work, and energy. 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.

C. Recommended Preparations (Course and Non-Course)

Recommended Preparation	Category and Justification

D. Recommended Skills

Recommended Skills

E. Enrollment Limitations

Enrollment Limitations and Category	Enrollment Limitations Impact

Course created by T. Wilson, G. Karpel, M. Feero, and J. Platts on 02/01/1965.

BOARD APPROVAL DATE:

LAST BOARD APPROVAL DATE: 02/17/2015

Last Reviewed and/or Revised by Eyal Goldmann on 10/08/2013

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