El Camino College

COURSE OUTLINE OF RECORD - Official

I. GENERAL COURSE INFORMATION

Subject and Number: Physics 1B
Descriptive Title: Fluids, Heat and Sound

Course Disciplines: Physics/Astronomy

Division: Natural Sciences

Catalog Description: This is the second course in a four-semester calculus-based physics sequence designed for students with majors in engineering and the physical sciences. This course focuses on fluids, thermodynamics, and wave phenomena, with topics including fluids, statics and dynamics, gas laws, heat transfer, engines, the first and second laws of thermodynamics, and sound.
Note: The maximum UC credit allowed for students completing Physics 1A, 1B, 1C, 1D and Physics 2A, 2B and/or Physics 3A, 3B is one series.

Conditions of Enrollment: **Prerequisite**

Physics 1A
with a minimum grade of C

AND

Mathematics 191
with a minimum grade of C or concurrent enrollment

Course Length: [X] **Full Term** [ ] **Other (Specify number of weeks):**
Hours Lecture: **3.00 hours per week** [ ] **TBA**
Hours Laboratory: **2.00 hours per week** [ ] **TBA**
Course Units: **3.00**

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: Fall 1991 | Other:

B3 - Laboratory Sciences

Term: Fall 1991 | Other:

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 heat, fluids or sound in order to correctly answer conceptual questions.
2. Students can identify and apply the laws of physics along with the necessary mathematics to successfully solve a problem dealing with heat, fluids, or sound.
3. Students can read and record, with appropriate units and uncertainties, measurements taken from an instrument used to measure temperatures, densities, or pressures. Students can interpret and analyze that 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. Explain the concepts of fluid pressure and density, and compute the force exerted by fluid pressure on an object in contact with a fluid.

   Other exams

2. Use Archimedes' principle to solve problems in which solid objects are in contact with a fluid.

   Other exams

3. Analyze capillarity phenomena associated with the effects of surface tension.

   Other exams

4. Compute properties of fluid flows in the presence of viscous forces.

   Other exams

5. Use the concept of specific heat to analyze processes in which materials undergo temperature changes.

   Other exams

6. Use the concept of latent heat to analyze process in which materials undergo phase transitions (such as solid ice melting into liquid water).

   Other exams

7. Analyze the behavior of gases using the ideal gas law, the first law of thermodynamics and the formulas for constant-volume and constant pressure molar

specific heats.

Other exams

8. Analyze and relate the changes in pressure, temperature and volume for a gas undergoing an adiabatic process.

   Other exams

9. Compute the work done on or by a gas undergoing a reversible process, including standard processes such as isobaric, isochoric, isothermal, and adiabatic.

   Other exams

10. Describe an engine cycle or refrigerator cycle as a closed path in the pressure-volume plane, and use this graph to compute the efficiency of the engine or coefficient of performance of the refrigerator.

    Other exams

11. Explain the Kelvin and Carnot statements of the second law of thermodynamics, and the relation between them.

    Other exams

12. Analyze the Carnot engine and refrigerator cycles, and the consequent limits on the performances of real engines and refrigerators.

    Other exams

13. Compute entropy changes for various physical processes, including temperature changes and phase transitions. Use the second law of thermodynamics to determine whether a particular physical processes is reversible or irreversible.

    Other exams

14. Recognize the general form of the one-dimensional wave equation, and determine whether a particular function f(x,t) is a solution thereof.

    Other exams

15. Use the ideas underlying the wave equation to show that a stretched string supports traveling waves, and extract the speed of these waves from this analysis. Solve problems related to traveling waves on strings.

    Other exams

16. Use the concepts underlying the wave equation to explain the existence of sound waves, and extract from this analysis a formula relating the speed of sound in a material to the material properties.

    Other exams

17. Describe the various quantities describing of a sound wave in air, such as variations in pressure, density, and particle position. For a given sound wave, use the amplitude of one of these quantities to compute the amplitudes of the others.

    Other exams

18. Compute the energy transported by a wave on a string or a sound wave.

    Other exams

19. Analyze standing waves on vibrating strings and in air columns. For given boundary conditions, determine the frequencies at which standing waves appear, and describe the pattern of nodes and antinodes.

    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	6	I	I. FLUID STATICS A. Pressure and Density B. Forces Exerted by Fluid Pressure C. Archimedes' Principle D. Surface Tension
Lecture	6	II	II. FLUID DYNAMICS A. Mass Flow Rate and Continuity Equation B. Bernoulli's Equation C. Viscosity
Lecture	6	III	III. THERMAL PROPERTIES OF MATTER A. Microscopic Origin of Temperature B. Specific Heat C. Thermal Expansion
Lecture	6	IV	V. THERMODYNAMICS OF GASES A. Ideal Gas Law B. Constant-Volume and Constant-Pressure Molar Specific Heat C. Processes in the P-V Plane D. Work Done On or By a Gas E. First Law of Thermodynamics F. Adiabatic Processes
Lecture	6	V	IV. HEAT TRANSPORT A. Conduction B. Convection C. Radiation
Lecture	6	VI	VI. ENGINES AND REFRIGERATORS A. Definitions of Efficiency and Coefficient of Performance B. Engine and Refrigeration Cycles Represented in the P-V Plane C. Kelvin and Carnot statements of the Second Law of Thermodynamics D. Carnot Cycle E. Theoretical Limits on Engine Efficiency and Coefficient of Performance
Lecture	3	VII	VII. SECOND LAW OF THERMODYNAMICS A. Quasistatic, Reversible, and Irreversible Processes B. Computation of Entropy C. Second Law of Thermodynamics
Lecture	3	VIII	VIII. KINETIC THEORY A. Derivation of Ideal Gas Law B. Microscopic Degrees of Freedom C. Postulates of Statistical Mechanics D. Maxwell-Boltzmann Distribution
Lecture	6	IX	IX. WAVES - GENERAL TREATMENT A. Traveling Waves; Longitudinal vs. Transverse Waves B. General Form of the Wave Equation in One Dimension C. Traveling Waves on Strings D. Energy Transport by Waves on Strings
Lecture	6	X	X. SOUND WAVES A. Description of a Sound Wave: Particle Displacement, Pressure Deviations and Connections Between These B. Derivation of the Wave Equation for Sound; Speed of Sound

			C. Energy Transport by Sound Waves
Lab	36	XI	XI. LABORATORY EXERCISES A. Standard Deviation and Gaussian Distributions B. Random Walks C. Archimedes' Principle D. Terminal Velocity E. Properties of Gases F. Specific Heat; Heat Transfer G. Mean Free Path H. Speed of Sound
Total Lecture Hours		54	
Total Laboratory Hours		36	
Total Hours		90	

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 straw with a 1.20-mm diameter is inserted into a tub of water. The wetting angle between water and the surface of the straw is 130°. Consequently, the liquid surface inside the straw is **lower** than the liquid surface outside the straw. Starting with a free-body diagram, determine the vertical distance *h* between the meniscus in the straw and the bulk surface level of the water. The surface tension of water is 72 dyne/cm. (Hint: Draw the free-body diagram for the column of water in the straw.)

C. **COLLEGE-LEVEL CRITICAL THINKING ASSIGNMENTS:**

1. Write a short paragraph explaining how the phenomenon of musical beats may be used to tune a piano.
2. In the space provided, explain what happens and why, when a glass thermometer at room temperature with the same coefficient of expansion as that of the liquid within the thermometer is placed in a pot of boiling water.

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
Multimedia presentations

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
Skill practice
Required reading
Problem solving activities
Written work
Other (specify)
Reduced the study hours from 6 to 5 with the understanding that the 2 hours of lab was instrumental in supporting the lecture material.

Estimated Independent Study Hours per Week: 5

VII. TEXTS AND MATERIALS

A. **UP-TO-DATE REPRESENTATIVE TEXTBOOKS**
Young and Freedman. University Physics with Modern Physics. 13th Edition ed. Addison-Wesley, 2011.
Wilson/Leonardo,. Fluids, Heat, and Sound. 7th ed. ed. El Camino College Bookstore, 2015.

B. **ALTERNATIVE TEXTBOOKS**

C. **REQUIRED SUPPLEMENTARY READINGS**

D. **OTHER REQUIRED MATERIALS**
Ruler and protractor

Graph paper (linear, semilog, log-log)
Scientific calculator

VIII. CONDITIONS OF ENROLLMENT

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

Requisites	Category and Justification
Course Prerequisite Physics-1A AND	Sequential
Course Prerequisite Mathematics-191	Computational/Communication Skills

B. Requisite Skills

Requisite Skills
Ability to draw and use free-body diagrams. PHYS 1A - Draw a free-body diagram which depicts forces acting on a rigid object, and use this diagram to quantitatively analyze these forces.
Solve problems using Newton's Laws of motion. PHYS 1A - Analyze the motion of a rigid object using a free-body diagram analysis together with Newton's laws of motion.
Solve problems using the Work-Energy theorem. PHYS 1A - Use the concepts of work, energy, impulse and momentum to analyze the motion of rigid objects.
Solve problems using momentum, impulse, angular momentum, angular impulse. PHYS 1A - Use the concepts of work, energy, impulse and momentum to analyze the motion of rigid objects. PHYS 1A - Analyze the motion of a rotating object using appropriate physical principles, including Newton's second law for rotation, and conservation of angular momentum.
Ability to solve involving using Simple Harmonic Motion. PHYS 1A - Identify the possibility of simple harmonic motion in a given physical scenario, and describe the motion of the system in question.
Ability to use simple measuring devices. PHYS 1A - Use different measuring devices, such as the micrometer or vernier caliper and determine the errors that are introduced with each measurement.
Have knowledge of error analysis at the Physics 1A level. PHYS 1A - Define and use the basic concepts and equations in error theory. Recognize when to use the different equations.
Analyze data graphically using linear, semi log, and log-log paper. PHYS 1A - Analyze data graphically using linear, semi-log, and log-log scales.
Compute integrals with integrands including polynomials, exponentials, and trigonometric functions. MATH 191 - Use integration to solve application problems involving: areas between curves; volumes of solids of known cross section; volumes of solids of revolution; work; arc length and areas of surfaces of revolution. MATH 191 - Evaluate integrals using integration techniques including: integration by parts; trigonometric substitutions; partial fraction decomposition and tables of integrals.

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, C. Karpel, M. Lehman, J. Platts on 02/01/1965.

BOARD APPROVAL DATE:

LAST BOARD APPROVAL DATE: 04/13/2015

Last Reviewed and/or Revised by Eyal Goldmann on 01/16/2015

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