EL CAMINO COLLEGE
COURSE OUTLINE OF RECORD – Approved

I. Course Information

Subject:	**PHYS**
Course Number:	**1B**
Descriptive Title:	**Fluids, Heat and Sound**
Division:	**Natural Sciences**
Department:	**Physics**
Course Disciplines:	**Astronomy, Physics**

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: Full Term

Hours Lecture (per week):	2
Hours Laboratory (per week):	3
Outside Study Hours:	4
Total Hours:	90

Course Units: 3

Grading Method:	Letter Grade only
Credit Status:	Credit, degree applicable

Transfer CSU:	Yes	Effective Date: Prior to 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 heat, fluids or sound in order to correctly answer conceptual questions.

SLO #2 Solving Physics Problems
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.

SLO #3 Data Collection & Analysis
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.

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

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.
2. Use Archimedes' principle to solve problems in which solid objects are in contact with a fluid.
3. Analyze capillarity phenomena associated with the effects of surface tension.
4. Compute properties of fluid flows in the presence of viscous forces.
5. Use the concept of specific heat to analyze processes in which materials undergo temperature changes.
6. Use the concept of latent heat to analyze process in which materials undergo phase transitions (such as solid ice melting into liquid water).
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.
8. Analyze and relate the changes in pressure, temperature and volume for a gas undergoing an adiabatic process.
9. Compute the work done on or by a gas undergoing a reversible process, including standard processes such as isobaric, isochoric, isothermal, and adiabatic.
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.
11. Explain the Kelvin and Carnot statements of the second law of thermodynamics, and the relation between them.
12. Analyze the Carnot engine and refrigerator cycles, and the consequent limits on the performances of real engines and refrigerators.
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.
14. Recognize the general form of the one-dimensional wave equation, and determine whether a particular function f(x,t) is a solution thereof.
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.
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.

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

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. FLUID STATICS (4 hours, lecture)

A. Pressure and Density
B. Forces Exerted by Fluid Pressure
C. Archimedes' Principle
D. Surface Tension

II. FLUID DYNAMICS (4 hours, lecture)

A. Mass Flow Rate and Continuity Equation
B. Bernoulli's Equation
C. Viscosity

III. THERMAL PROPERTIES OF MATTER (4 hours, lecture)

A. Microscopic Origin of Temperature
B. Specific Heat
C. Thermal Expansion

IV. THERMODYNAMICS OF GASES (4 hours, lecture)

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

V. HEAT TRANSPORT (3 hours, lecture)

A. Conduction
B. Convection
C. Radiation

VI. ENGINES AND REFRIGERATORS (3 hours, lecture)

A. Definitions of Efficiency and Coefficient of Performance
B. Engine and Refrigeration Cycles Represented in the P-V Plane|
C. Carnot Cycle
D. Theoretical Limits on Engine Efficiency and Coefficient of Performance

VII. SECOND LAW OF THERMODYNAMICS (3 hours, lecture)

A. Quasistatic, Reversible, and Irreversible Processes
B. Computation of Entropy
C. Second Law of Thermodynamics

VIII. KINETIC THEORY (3 hours, lecture)

A. Derivation of Ideal Gas Law
B. Microscopic Degrees of Freedom
C. Postulates of Statistical Mechanics
D. Maxwell-Boltzmann Distribution

IX. WAVES - GENERAL TREATMENT (4 hours, lecture)

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

X. SOUND WAVES (4 hours, lecture)

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

XI. LABORATORY EXERCISES (54 hours, lab)

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:	36
Total Laboratory Hours:	54
Total Hours:	90

IV. Primary Method of Evaluation and Sample Assignments

A. Primary Method of Evaluation (choose one):

2) 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

Critical Thinking Assignment 1:

Write a short paragraph explaining how the phenomenon of musical beats may be used to tune a piano.

Critical Thinking Assignment 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, Homework Problems, Laboratory Reports, Multiple Choice, Objective Exam, Other Exams, Quizzes, Written Homework

V. Instructional Methods

Demonstration, Discussion, Lab, Lecture, Multimedia presentations

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, Skill practice, Study, Written work (such as essay/composition/report/analysis/research)

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".)

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

Wilson/Leonardo,. Fluids, Heat, and Sound. 7th ed. ed. El Camino College Bookstore, 2015.

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):
Physics Prerequisite: Physics-1A

Math Corequisite: Mathematics-191

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

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).

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

Original Board Approval Date:

Last Reviewed and/or Revised by: Susan Stolovy Date: 05/12/2021

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