ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences & Business

COURSE: PHY 2003 General Physics I: Mechanics, Thermodynamics, Waves and Sound

Date: Spring 2023

Credit Hours: 5

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): None

Enrollment by assessment or other measure? ☐ Yes ☒ No
If yes, please describe:

Corequisite(s): None

Pre- or Corequisite(s): MTH 1005 or equivalent (MTH 1003 *and* MTH 1004)

Consent of Instructor: ☐ Yes ☒ No

Delivery Method:		
☒ **Lecture**	**3 Contact Hours**	**(1 contact = 1 credit hour)**
☒ **Seminar**	**1 Contact Hours**	**(1 contact = 1 credit hour)**
☒ **Lab**	**2 Contact Hours**	**(2-3 contact = 1 credit hour)**
☐ **Clinical**	**0 Contact Hours**	**(3 contact = 1 credit hour)**

Offered: ☒ **Fall** ☐ **Spring** ☐ **Summer**

CATALOG DESCRIPTION and IAI NUMBER (if applicable):
This is the first in sequence of general physics course using a non-calculus-based approach for students majoring in (some engineering and technology programs), the life sciences, preprofessional health programs, agriculture, veterinary medicine and the arts. This course includes, Newton's Laws, work and energy, momentum, rotational motion, properties of matter, fluids, thermodynamics, waves and sound. **IAI equivalent: P1900L**

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

1. **Representing Motion**
   - 1.1 Motion: A First Look
   - 1.2 Models and Modeling
   - 1.3 Position and Time: Putting Numbers on Nature
   - 1.4 Velocity
   - 1.5 A Sense of Scale: Significant Figures, Scientific Notation, and Units
   - 1.6 Vectors and Motion: A First Look
   - 1.7 Where Do We Go from Here?
2. **Motion in One Dimension**
   - 2.1 Describing Motion
   - 2.2 Uniform Motion
   - 2.3 Instantaneous Velocity
   - 2.4 Acceleration
   - 2.5 Motion with Constant Acceleration
   - 2.6 Solving One-Dimensional Motion Problems
   - 2.7 Free Fall
3. **Vectors and Motion in Two Dimensions**
   - 3.1 Using Vectors
   - 3.2 Coordinate Systems and Vector Components
   - 3.3 Motion on a Ramp
   - 3.4 Motion in Two Dimensions
   - 3.5 Projectile Motion
   - 3.6 Projectile Motion: Solving Problems
   - 3.7 Circular Motion
   - 3.8 Relative Motion
4. **Forces and Newton's Laws of Motion**
   - 4.1 Motion and Forces
   - 4.2 A Short Catalog of Forces
   - 4.3 Identifying Forces
   - 4.4 What Do Forces Do?
   - 4.5 Newton's Second Law
   - 4.6 Free-Body Diagrams
   - 4.7 Newton's Third Law
5. **Applying Newton's Laws**
   - 5.1 Equilibrium
   - 5.2 Dynamics and Newton's Second Law
   - 5.3 Mass and Weight
   - 5.4 Normal Forces
   - 5.5 Friction
   - 5.6 Drag
   - 5.7 Interacting Objects
   - 5.8 Ropes and Pulleys

6. **Circular Motion, Orbits, and Gravity**
   - 6.1 Uniform Circular Motion
   - 6.2 Dynamics of Uniform Circular Motion
   - 6.3 Apparent Forces in Circular Motion
   - 6.4 Circular Orbits and Weightlessness
   - 6.5 Newton's Law of Gravity
   - 6.6 Gravity and Orbits
7. **Rotational Motion**
   - 7.1 Describing Circular and Rotational Motion
   - 7.2 The Rotation of a Rigid Body
   - 7.3 Torque
   - 7.4 Gravitational Torque and the Center of Gravity
   - 7.5 Rotational Dynamics and Moment of Inertia
   - 7.6 Using Newton's Second Law for Rotation
   - 7.7 Rolling Motion
8. **Equilibrium and Elasticity**
   - 8.1 Torque and Static Equilibrium
   - 8.2 Stability and Balance
   - 8.3 Springs and Hooke's Law
   - 8.4 Stretching and Compressing Materials
   - 8.5 Forces and Torques in the Body
9. **Momentum**
   - 9.1 Impulse
   - 9.2 Momentum and the Impulse-Momentum Theorem
   - 9.3 Solving Impulse and Momentum Problems
   - 9.4 Conservation of Momentum
   - 9.5 Inelastic Collisions
   - 9.6 Momentum and Collisions in Two Dimensions
   - 9.7 Angular Momentum
10. **Energy and Work**
    - 10.1 The Basic Energy Model
    - 10.2 Work
    - 10.3 Kinetic Energy
    - 10.4 Potential Energy
    - 10.5 Thermal Energy
    - 10.6 Conservation of Energy
    - 10.7 Energy Diagrams
    - 10.8 Molecular Bonds and Chemical Energy
    - 10.9 Energy in Collisions
    - 10.10 Power
11. **Using Energy**
    - 11.1 Transforming Energy
    - 11.2 Energy in the Body
    - 11.3 Temperature, Thermal Energy, and Heat
    - 11.4 The First Law of Thermodynamics
    - 11.5 Heat Engines

11.6 Heat Pumps
11.7 Entropy and the Second Law of Thermodynamics
11.8 Systems, Energy, and Entropy

12. Thermal Properties of Matter

12.1 The Atomic Model of Matter
12.2 The Atomic Model of an Ideal Gas
12.3 Ideal-Gas Processes
12.4 Thermal Expansion
12.5 Specific Heat and Heat of Transformation
12.6 Calorimetry
12.7 Specific Heats of Gases
12.8 Heat Transfer
12.9 Diffusion

13. Fluids

13.1 Fluids and Density
13.2 Pressure
13.3 Buoyancy
13.4 Fluids in Motion
13.5 Fluid Dynamics
13.6 Viscosity and Poiseuille's Equation
13.7 The Circulatory System

14. Oscillations

14.1 Equilibrium and Oscillation
14.2 Linear Restoring Forces and SHM
14.3 Describing Simple Harmonic Motion
14.4 Energy in Simple Harmonic Motion
14.5 Pendulum Motion
14.6 Damped Oscillations
14.7 Driven Oscillations and Resonance

15. Traveling Waves and Sound

15.1 The Wave Model
15.2 Traveling Waves
15.3 Graphical and Mathematical Descriptions of Waves
15.4 Sound and Light Wav
15.5 Energy and Intensity
15.6 Loudness of Sound
15.7 The Doppler Effect and Shock Waves

16. Superposition and Standing Waves

16.1 The Principle of Superposition
16.2 Standing Waves
16.3 Standing Waves on a String
16.4 Standing Sound Waves
16.5 Speech and Hearing
16.6 The Interference of Waves from Two Sources
16.7 Beats

INSTRUCTIONAL METHODS:

1. Lectures and interactive lecture demonstration (ILDs), Activity-based physics and other audio-visual aids and technologies.
2. Homework assignments and related class discussion sessions.
3. Micro – computer-based laboratory exercises.
4. Modeling and guided practice of a variety of physics problems.

EVALUATION OF STUDENT ACHIEVEMENT:

Reading of textbook, note taking, and participation in classroom discussions as well as performing laboratory experiments are required of the students. Students are assigned approximately 15 homework problems per Chapter. Solutions of graded problems are discussed after grading if and when necessary. Evaluation of the students will include written problem class tests and one problem-orientated comprehensive final exam, written reports of laboratory experiments, quizzes and homework assignments

A = 90 -100
B = 80 – 89
C = 70 – 79
D = 60 – 69
F = 59 and below

INSTRUCTIONAL MATERIALS:

Textbooks

College Physics, a strategic approach 4th ed (with mastering physics and student work book), Knight, Jones and Field

Physics Laboratory Experiments, 6thedition, Jerry D Wilson and Cecilia A. Hernandez

Real Time Physics (Active Learning Laboratories), 3rd ed, David R. Sokoloff, Ronald K. Thornton, Priscilla W. Laws

Advance physics laboratory exercises and physics with video analysis by Vernier Science Education

Resources

University Physics with Modern Physics with Mastering Physics, 13/E, Hugh D. Young, Roger A. Freedman

Classical Dynamics of particles and systems, Thornton and Marion, Brooks/Cole

The Mechanical Universe and Beyond the Mechanical Universe Physics Demonstration series, by Physics Curriculum and Instruction,

LEARNING OUTCOMES AND GOALS:

Institutional Learning Outcomes

☐ 1) Communication – to communicate effectively;

☒ 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;

☐ 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;

☐ 4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies

Upon completion of the course, the student will be able to:

Outcome 1 – Students will be able to demonstrate an understanding of unit analysis, vector and scalar addition and describe linear motion

Competency 1.1 Students will be able to know the basic units of length, mass and time used in the SI, CGS, and English system of units, as well as the derived units based on these which are commonly used in the description of mechanics.

Competency 1.2 Students will be able to know and apply all of the common prefixes used in the SI system and their appropriate symbols.

Competency 1.3 Students will be able to define displacement, velocity and acceleration and solve problems involving uniformly accelerated motion, including problems involving free fall motion and motion in a plane.

Competency 1.4 Students will be able to define the terms vector and scalar and resolve vectors into components as well as add, subtract, and multiply vector quantities.

Outcome 2 – Students will be able to demonstrate and apply their knowledge of force and Newton's laws of motion.

Competency 2.1 Students will be able to explain Newton's three laws of motion and solve problems utilizing these laws.

Competency 2.2 Students will be able to distinguish between mass and weight of an object. They will be able to apply Newton's laws of motion to linear motion, projectile motion and circular motion problems.

Competency 2.3 Students will be able to describe and determine frictional forces and solve problems involving frictional forces.

Competency 2.4 Students will be able to define Newton's Law of Universal Gravitation and solve problems utilizing it.

Outcome 3 – Students will be able to demonstrate an understanding of work, energy, momentum and center of mass.

Competency 3.1 Students will be able to explain or define the following terms: work, power, kinetic energy, potential energy, simple machine, linear momentum and Impulse. Also, be able to solve problems applying these concepts.

Competency 3.2 Students will be able to explain the laws of conservation of energy and linear momentum and apply these laws to the solve problems, including elastic and inelastic collision problems.

Competency 3.3 Students will be able to calculate center of mass.

Outcome 4 – Students will be able to demonstrate an understanding of rotational kinematics, rotational dynamics and elasticity

Competency 4.1 Students will be able to define angular displacement, angular velocity, and angular acceleration and solve angular motion problems.

Competency 4.2 Students will be able to explain or define the following terms moment of inertia, torque, rotational kinetic energy, angular momentum, center of gravity of a body or a system of bodies, and solve problems involving these concepts.

Competency 4.3 Students will be able to apply the concept of torque (moment) to solve problems involving static equilibrium and accelerated motion.

Competency 4.4 Define the following terms and solve problems based on them: density, specific gravity, stress, strain, and modulus.

Outcome 5 – Students will be able to demonstrate a basic understanding of the properties and dynamics associated with Fluids.

Competency 5.1 Be able to solve problems involving fluid statics and fluid dynamics, including problems using the following concepts or laws: pressure, Archimedes's Principle, Viscosity, Poiseuille's Law, Bernoulli's Equation, Torricelli's Theorem.

Outcome 6 – Students will be able to demonstrate a basic understanding of the Vibrations, waves and sound

Competency 6.1 Students will be able to describe simple harmonic motion, including the defining and/or describing, in words, of terms such as period, frequency, amplitude, and equilibrium position. Student would be able to solve periodic motion problems including problems involving a mass on the end of a vibrating spring and the simple pendulum.

Competency 6.2 Students will be able to describe in words, the motion of waves especially the phenomena of transverse waves, longitudinal waves, waves on a string or spring, and resonance. Student would be able to solve problems involving these concepts.

Competency 6.3 Students will be able to define or describe, in words, and equations, the following terms: intensity and loudness of sound, frequency and pitch of sounds, wave forms associated with sound and tone quality, beats, resonance of sound waves, especially with regard to air columns, and the Doppler effect. Be able to solve problems based on these concepts and phenomena.

Outcome 7--Students will be able to demonstrate a basic understanding of the Temperature, kinetic theory, heat, and laws of thermodynamics.

Competency 7.1 Students will be able to use the Fahrenheit, Celsius, and Kelvinscales, and convert temperatures from one scale to another, and define the linear and volume coefficients of the thermal expansion and to solve thermal expansion problems.

Competency 7.2 Students will be able to use the ideal gas law to solve problems involving pressures, volumes, and temperatures.

Competency 7.3 Students will be able to define the calorie, BTU, specific heat capacity, heat of fusion, heat of vaporization, and solve calorimetry problems.

Competency 7.4 Students will be able to explain and describe the transfer of heat by conduction, convection, and radiation and solve heat transfer problems.

Competency 7.5 Students will be able to define relative and absolute humidity and solve problems based on these concepts.

Competency 7.6 Students will be able to explain and/or describe the first and second laws of thermodynamics and solve problems based on these, including thermal efficiency problems