ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences & Business

COURSE: PHY 2011 Engineering Physics I: Mechanics

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 2001

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 engineering physics course using a calculus-based approach for students majoring in physics, chemistry, engineering, mathematics and related fields of study. The course provides a clear and precise introduction to the theory, experiment, and applications of Newtonian mechanics. Topics includes motion, Newton's laws, work and energy, systems of particles, momentum and rotations, fluids and oscillations. **IAI equivalent: P2900L/PHY911**

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

1. Concepts of Motion
1.1 Motion Diagrams
1.2 Models and Modeling
1.3 Position, Time, and Displacement
1.4 Velocity
1.5 Linear Acceleration
1.6 Motion in One Dimension
1.7 Solving Problems in Physics
1.8 Unit and Significant Figures

2. Kinematics in One Dimension
2.1 Uniform Motion
2.2 Instantaneous Velocity
2.3 Finding Position from Velocity
2.4 Motion with Constant Acceleration
2.5 Free Fall
2.6 Motion on an Inclined Plane
2.7 ADVANCED TOPIC Instantaneous Acceleration

3 Vectors and Coordinate Systems
3.1 Scalars and Vectors
3.2 Using Vectors
3.3 Coordinate Systems and Vector Components
3.4 Unit Vectors and Vector Algebra

4. Kinematics in Two Dimensions
4.1 Motion in Two Dimensions
4.2 Projectile Motion
4.3 Relative Motion
4.4 Uniform Circular Motion
4.5 Centripetal Acceleration
4.6 Nonuniform Circular Motion

5 Force and Motion
5.1 Force
5.2 A Short Catalog of Forces
5.3 Identifying Forces
5.4 What Do Forces Do?
5.5 Newton's Second Law
5.6 Newton's First Law
5.7 Free-Body Diagrams

6. Dynamics I: Motion Along a Line
6.1 The Equilibrium Model
6.2 Using Newton's Second Law

6.3 Mass, Weight, and Gravity
6.4 Friction
6.5 Drag
6.6 More Examples of Newton's Second Law

7. Newton's Third Law
7.1 Interacting Objects
7.2 Analyzing Interacting Objects
7.3 Newton's Third Law
7.4 Ropes and Pulleys
7.5 Examples of Interacting-Objects Problems

8. Dynamics II: Motion in a Plane
8.1 Dynamics in Two Dimensions
8.2 Uniform Circular Motion
8.3 Circular Orbits
8.4 Reasoning About Circular Motion
8.5 Nonuniform Circular Motion

9. Work and Kinetic Energy
9.1 Energy Overview
9.2 Work and Kinetic Energy for a Single Particle
9.3 Calculating the Work Done
9.4 Restoring Forces and the Work Done by a Spring
9.5 Dissipative Forces and Thermal Energy
9.6 Power

10. Interactions and Potential Energy
10.1 Potential Energy
10.2 Gravitational Potential Energy
10.3 Elastic Potential Energy
10.4 Conservation of Energy
10.5 Energy Diagrams
10.6 Force and Potential Energy
10.7 Conservative and Nonconservative Forces
10.8 The Energy Principle Revisited

11 Impulse and Momentum
11.1 Momentum and Impulse
11.2 Conservation of Momentum
11.3 Collisions
11.4 Explosions
11.5 Momentum in Two Dimensions
11.6 ADVANCED TOPIC Rocket Propulsion

12. Rotation of a Rigid Body
12.1 Rotational Motion
12.2 Rotation About the Center of Mass
12.3 Rotational Energy

12.4 Calculating Moment of Inertia
12.5 Torque
12.6 Rotational Dynamics
12.7 Rotation About a Fixed Axis
12.8 Static Equilibrium
12.9 Rolling Motion
12.10 The Vector Description of Rotational Motion
12.11 Angular Momentum
12.12 ADVANCED TOPIC Precession of a Gyroscope

13 Newton's Theory of Gravity
13.1 A Little History
13.2 Isaac Newton
13.3 Newton's Law of Gravity
13.4 Little g and Big G
13.5 Gravitational Potential Energy
13.6 Satellite Orbits and Energies

14 Fluids and Elasticity
14.1 Fluids
14.2 Pressure
14.3 Measuring and Using Pressure
14.4 Buoyancy
14.5 Fluid Dynamics
14.6 Elasticity

15 Oscillations
15.1 Simple Harmonic Motion
15.2 SHM and Circular Motion
15.3 Energy in SHM
15.4 The Dynamics of SHM
15.5 Vertical Oscillations
15.6 The Pendulum
15.7 Damped Oscillations
15.8 Driven Oscillations and Resonance

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

1. Physics for Scientist and Engineers, a strategic approach, with modern physics (including student work book, with masteringphysics), 4th edition. Randall D. Knight
2. Modern Physics, 3rd ed, Raymond A. Serway; Clement J. Moses; Curt A. Moyer
3. Physics Laboratory Experiments, 6thedition, Jerry D Wilson and Cecilia A. Hernandez
4. Real Time Physics (Active Learning Laboratories), 3rd ed, David R. Sokoloff, Ronald K. Thornton, Priscilla W. Laws
5. Advance physics laboratory exercises and physics with video analysis by Vernier Science Education

Resources

University Physics with Modern Physics with Mastering Physics, 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

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

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 derive kinematic equations using calculus and solve problems using
Competency 1.5 Students will be able to define the terms vector and scalar and give examples of each.
Competency 1.6 Students will be able to 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 Newton's laws of motion.
Competency 2.1 Students will know Newton's laws of motion and apply them to problems involving the equilibrium of particles and rigid bodies.
Competency 2.2 Students will be able to apply Newton's laws of motion to problems including the motion of particles and rigid bodies.
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 distinguish between mass and weight, and correctly use each while solving static and dynamic problems.

Outcome 3 – Students will be able to demonstrate a basic understanding of the conservation laws related to mechanics and dynamics.
Competency 3.1 Students will be able to define the concepts of work, kinetic energy, potential energy, mechanical energy, and power to solve problems involving these concepts
Competency 3.2 Students will be able to define the concepts of linear and angular momentum and impulse and solve problems based on these concepts especially collision problems.
Competency 3.3 Students will be able to know and apply the conservation laws of momentum and energy to solve problems related to these topics.

Outcome 4 – Students will be able to demonstrate a basic understanding of rotational dynamics, periodic motion and the universal law of gravitation.
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 define and determine the center of gravity of a body or a system of bodies.
Competency 4.3 Students will be able to define torque and apply the concept of torques to the solution of problems involving equilibrium and accelerated motion.
Competency 4.4 Students will be able to describe Newton's universal law of gravitation and solve problems based on energy, force, torque and momentum related to gravitation

Outcome 5 – Students will be able to demonstrate a basic understanding of the properties and dynamics associated with liquid and solid materials.
Competency 5.1 Students will be able to define the concepts of stresses, strains, and modulus and solve problems based on these concepts, especially problems involving Young's modulus.
Competency 5.2 Students will be able to solve problems involving fluid statics, including problems using the following concepts: pressure, density, buoyancy, and displacement.
Competency 5.3 Students will be able to describe and solve problems involving fluid dynamics using Bernoulli's principles.