COURSE OUTLINE

Physics-I: Mechanics and Properties of Matter

Course Code: 0533-14-114

Credit Hours: 3.0

Department: Department of Chemistry

Institution: Comilla University, Cumilla, Bangladesh

Course Duration: 14 Teaching Weeks

1. Rationale/Course Summary

This course provides a comprehensive foundation in classical and modern physics, encompassing mechanics, oscillations, gravitation, and fluid dynamics. It is designed to develop students' conceptual understanding, analytical thinking, and problem-solving skills necessary for scientific inquiry and engineering applications. By integrating theoretical knowledge with practical examples, the course prepares students to apply fundamental principles to real-world situations, analyze complex systems, and develop appropriate physical models. The inclusion of introductory concepts of relativistic and quantum mechanics, as well as fluid and surface phenomena, provides a foundation for advanced studies, research, and interdisciplinary applications.

2. Course Objectives

The objectives of this course are:

1. To impart knowledge of the motion of particles and systems of particles and their associated physical properties.
2. To develop an understanding of the laws, theories, and mathematical equations governing mechanics and their applications.
3. To investigate the macroscopic properties of matter through the principles of classical mechanics and introductory quantum mechanics.

3. Course Learning Outcomes (CLOs)

After successful completion of the course, students will be able to:

- **CLO-1:** Recall and define the fundamental concepts of mechanics, gravitation, oscillations, and fluid properties.
- **CLO-2:** Explain the principles of motion, forces, energy, momentum, rotation, oscillations, gravitation, and fluid behavior using appropriate physical reasoning.

- **CLO-3:** Solve numerical and conceptual problems using Newton's laws, kinematic equations, conservation laws, Bernoulli's equation, and other mechanical principles.
- **CLO-4:** Analyze physical systems by identifying forces, resolving motion into components, examining energy and momentum transfer, and interpreting fluid-flow characteristics.
- **CLO-5:** Evaluate and justify solutions, assumptions, and physical models in mechanics, oscillations, gravitation, and fluid dynamics under various conditions.
- **CLO-6:** Develop and construct mathematical or conceptual models of mechanical, gravitational, oscillatory, or fluid systems to predict physical behavior in real-world scenarios.

4. Weekly Course Outline (14 Weeks)

Week	Topics and Contents	CLO's
1	**Kinematics and Dynamics of Particles I:** Motion in one dimension and in a plane; displacement, velocity, and acceleration; freely falling bodies; equations of motion; projectile motion.	CLO-1, CLO-2, CLO-3
2	**Kinematics and Dynamics of Particles II:** Relative velocity and acceleration; classical mechanics; Newton's laws of motion; mass and force; applications of Newton's laws; frictional forces; uniform circular motion; introductory concepts of relativistic and quantum mechanics.	CLO-1, CLO-2, CLO-3, CLO-4
3	**Work, Energy, and Momentum:** Work done by constant and variable forces; kinetic energy and the work–energy theorem; significance of the work–energy theorem; conservative forces and potential energy; conservative systems in one, two, and three dimensions; conservation of energy.	CLO-2, CLO-3, CLO-4
4	**Center of Mass and Linear Momentum:** Center of mass; linear momentum of a particle and a system of particles; conservation of linear momentum; impulse and momentum; applications of momentum principles.	CLO-2, CLO-3, CLO-4, CLO-5
5	**Collisions and Interaction Processes:** Conservation of momentum during collisions; collisions in one, two, and three dimensions; elastic and inelastic collisions; cross section; reactions and decay processes.	CLO-2, CLO-3, CLO-4, CLO-5
6	**Rotational Motion and Dynamics of Rigid Bodies I:** Rotational motion; rotational quantities as vectors; rotation with constant angular acceleration;	CLO-1, CLO-2, CLO-3, CLO-4

	relationships between linear and angular quantities; torque acting on a particle; angular momentum of a particle.	
7	**Rotational Motion and Dynamics of Rigid Bodies II:** Kinetic energy of rotation; rotational inertia; rotational dynamics of rigid bodies; combined translational and rotational motion; angular momentum and angular velocity; conservation of angular momentum and its applications.	CLO-2, CLO-3, CLO-4, CLO-5, CLO-6
8	**Oscillations:** Simple harmonic oscillator; energy considerations in simple harmonic motion; relationship between simple harmonic motion and uniform circular motion; two-body oscillations; forced oscillations and resonance.	CLO-1, CLO-2, CLO-3, CLO-4, CLO-6
9	**Gravitation I:** Newton's law of universal gravitation; inertial and gravitational mass; variations in acceleration due to gravity; gravitational effects of a spherical mass distribution.	CLO-1, CLO-2, CLO-3, CLO-4
10	**Gravitation II:** Gravitational potential energy; potential energy of many-particle systems; Earth as an inertial reference frame; principle of equivalence; applications of gravitational principles and physical modeling.	CLO-2, CLO-3, CLO-4, CLO-5, CLO-6
11	**Hydrostatics and Surface Tension I:** Hydrostatic pressure; variation of pressure with elevation; Pascal's law; hydrostatic paradox; center of pressure; equilibrium of floating bodies.	CLO-1, CLO-2, CLO-3, CLO-4
12	**Hydrostatics and Surface Tension II:** Surface tension and surface energy; adhesive and cohesive forces; molecular theory of surface tension; capillarity; variation of surface tension with temperature.	CLO-1, CLO-2, CLO-3, CLO-4, CLO-5
13	**Hydrodynamics and Viscosity:** General concepts of fluid flow; streamline flow; equation of continuity; Bernoulli's equation and applications; viscosity; critical velocity and Reynolds number; Poiseuille's formula and its correction; Stokes' law; variation of viscosity with temperature.	CLO-2, CLO-3, CLO-4, CLO-5, CLO-6
14	**Integrated Problem-Solving and Course Review:** Review of kinematics, Newton's laws, work and energy, momentum and collisions, rotational dynamics, oscillations, gravitation, hydrostatics, surface tension, hydrodynamics, and viscosity. Practice problems and clarification of difficult concepts.	CLO-1, CLO-2, CLO-3, CLO-4, CLO-5, CLO-6

5. Teaching-Learning Strategies

CLO	Teaching-Learning Strategy
CLO-1	Lectures and student activities
CLO-2	Lectures with guided discussion
CLO-3	Problem-solving sessions and worked examples
CLO-4	Interactive lectures and analytical discussions
CLO-5	Student activities and group discussions
CLO-6	Group projects and collaborative tasks

6. Assessment Strategies

CLO	Assessment Strategy
CLO-1	Quiz
CLO-2	Quiz and mid-semester examination
CLO-3	Quiz and assignment
CLO-4	Assignment and summative examination
CLO-5	Mid-semester examination
CLO-6	Presentation and summative examination

7. Assessment Components and Weight Distribution

Assessment Component	Weight (%)	Purpose
Class tests/ Quizzes/Assignment / Problem-solving Exercises	5	Assess students' conceptual understanding, fundamental knowledge, and ability to solve basic problems.
Presentation	10	Develop students' communication, analytical reasoning, and ability to explain physics concepts and applications.
Midterm Examination	20	Evaluate students' understanding and application of the concepts and principles covered in the first half of the course.

Class Attendance	5	Encourage regular class participation, engagement, and continuity in learning.
Final Examination	60	Assess comprehensive knowledge, conceptual understanding, analytical reasoning, and problem-solving skills across the entire course syllabus.
Total	**100**	

8. CLO–Assessment Mapping

CLO	Class Tests / Quizzes/ Assignment	Presentation	Midterm	Final Examination
CLO-1	✓	✓	✓	✓
CLO-2	✓	—	✓	✓
CLO-3	✓	—	✓	✓
CLO-4	✓	✓	—	✓
CLO-5	—	✓	—	✓
CLO-6	—	✓	—	✓

9. Recommended Learning Materials

9.1 Recommended Readings

1. Halliday, D., and Resnick, R., *Physics, Part I*, Wiley Eastern Private Limited.
2. Mathur, D. S., *Properties of Matter*, S. Chand & Company Ltd.

9.2 Supplementary Readings

1. Sears, F. W., *Mechanics, Wave Motion and Heat*, Addison-Wesley Publishing Company.

10. Expected Learning Outcomes

Upon completion of this course, students are expected to demonstrate a sound understanding of fundamental mechanical principles and the properties of matter. They should be able to solve quantitative problems, analyze the motion and interactions of physical systems, apply conservation laws, interpret oscillatory and gravitational phenomena, and explain the behavior of fluids and

surface phenomena. Students will also develop the ability to construct mathematical and conceptual models for predicting the behavior of physical systems in practical situations.

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