暨南大學
JINAN UNIVERSITY

Summer 2022

0702P101
Fundamentals of Physics I (With Lab)

Instructor: TBA
Time: Monday through Friday (June 20, 2022-July 22, 2022)
Office Hours: 2 hours (according to the teaching schedule)
Contact Hours: 60 (50 minutes each)
Credits: 4
Location: Huiquan Building
Office: Huiquan Building 518
E-mail: TBA

Course Description

Fundamentals of Physics I is a general education course designed as an introduction to college physics for students majoring in the biological, environmental, earth, and social sciences, as well as disciplines such as architecture, business, and the humanities. The mathematical techniques used in this course include algebra and trigonometry. The main emphasis of the course is on the fundamentals of Newtonian mechanics and the physics of fluids. The goal of this course is to provide the student with a clear and logical presentation of the basic concepts and principles of physics, and to strengthen concept understanding through a range of interesting applications to the real world, including practical examples that demonstrate the role of physics in other disciplines.

Required Textbook

The Physics of Everyday Phenomena: A Conceptual Introduction to Physics, 8th edition (2014), by W. Thomas Griffith and Juliet Brosing. Publisher: McGraw-Hill, ISBN 978-0073513904.

Course Hours

The course has 20 lecture sessions and 5 lab sessions in total. Each class session is 120 minutes in length. The course meets from Monday to Friday.

Course Structure

The course content is divided into 8 modules:
Module I (Introduction and Vectors) discusses mathematical concepts and techniques used throughout the course, such as dimensional analysis, significant figures, unit conversion, mathematical notation, and coordinate systems. This module will also define the basic quantities of measurement in mechanics (length, time, mass), and discuss the difference between scalar and vector quantities, as well as the properties and components of vectors.

Module II (Motion in One and Two Dimensions) investigates kinematics, the part of mechanics that describe motion without regard to the causes of motion. We will start by describing motion along a straight line and define the concepts of velocity and acceleration. We will then investigate the motion of free-falling bodies influenced by gravity, and conclude this module by exploring projectile motion.

Module III (The Laws of Motion) is an introduction to the classical (Newtonian) mechanics. Here we shall use the concepts of force and mass to describe the change in the motion of an object, relate mass and acceleration, and explore the laws of motion proposed by Newton. We will conclude this module by investigating some of the applications of Newton's laws and discuss the forces of friction.

Module IV (Circular Motion and the Law of Gravity) deals with circular motion, a specific type of two-dimensional motion. We explore the concepts of angular velocity, angular acceleration, and centripetal force, and introduce Newton's universal law of gravity. We discuss how this law, together with the laws of motion, enables us to understand many familiar phenomena, including the motion of satellites. We will also explore Kepler's laws of planetary motion.

Module V (Work and Energy) will focus on the mechanical forms of energy. We will introduce the concepts of work, power, and kinetic and potential energy, and explore how the ideas of work and energy can be used in place of Newton's laws to solve certain problems. We will conclude this module by discussing the law of conservation of energy and applying it to various problems.

Module VI (Momentum and Collisions) will discuss momentum and impulse, and investigate how they relate to the law of conservation of momentum. We will apply this understanding to a number of elastic/inelastic collisions.

Module VII (Equilibrium and Rotational Motion) will examine the relationship between angular velocity, angular acceleration, and the forces that produce rotational motion. We will also explore the conditions for equilibrium, and the relationship between torque, rotational inertia, and conservation of momentum.

Module VIII (Solids, Fluids, and Fluid Dynamics) will explore the states of matter and some properties of solids and fluids (liquids and gases). We will investigate concepts of density and pressure, explore buoyant forces and the Archimedes ' principle, then understand how these properties and concepts explain the behavior of fluids, both the fluids at rest and the fluids in motion.

Course Schedule

Please note that the schedule is meant to give an overview of the major concepts in this course. Changes may occur in this calendar as needed to aid in the student`s development.

Week 1
Lecture 1: Introduction to Mechanic Measurements and Vectors (Chapter 1)
Lecture 2: Describing Motion in One and Two Dimensions (Chapter 2)
Lecture 3: Falling Objects and Projectile Motion (Chapter 3)
Lecture 4: Introduction to Classical Mechanics (Chapter 4)
Lab 1: Measurements, Velocity, and Acceleration

Week 2
Lecture 5: Applications of Newton's Laws (Chapter 4)
Lecture 6: Circular Motion, Angular Velocity and Acceleration (Chapter 5)
Lecture 7: Planetary Motion and Newton's Law of Universal Gravitation (Chapter 5)
Lecture 8: Work and Energy – Kinetic and Potential Energy (Chapter 6)
Lab 2: Kepler's and Newton's Laws

Week 3
Lecture 9: Conservative and Non-Conservative Forces (Chapter 6)
Lecture 10: Review session for the Mid-Term Exam (Chapters 1-6)
Mid-Term Exam (Chapters 1 to 6)
Lecture 11: Momentum and Impulse (Chapter 7)
Lab 3: Conservation of Mechanical Energy (Mass and Spring Apparatus)

Week 4
Lecture 12: Elastic and Inelastic Collisions (Chapter 7)
Lecture 13: Rotational Motion (Chapter 8)
Lecture 14: Objects in Equilibriu-Torque, Balance, and Center of Gravity (Chapter 8)
Lecture 15: Rotational Inertia and Conservation of Momentum (Chapter 8)
Lab 4: Conservation of Energy and Momentum

Week 5
Lecture 16: Solids and Fluids – States of Matter, Density, and Pressure (Chapter 9)
Lecture 17: Fluids Dynamics and the Bernoulli's Equation (Chapter 9)

Lecture 18: Concepts of Temperature and Heat
Lab 5: Archimedes' Principle + Buoyancy
Final Exam

Course Requirements

Quizzes/Homework

Multiple self-assessment quizzes and homework assignments will be offered for students to practice their concept understanding and to prepare for the lectures. These quizzes and homework assignments will be distributed in class a weekly basis. Many of these assignments will be discussed during class and/or recitation. Late homework will NOT be accepted, except in the case of a documented medical reason (documentation is required).

Practical Exercises (Lab Activities)

At the end of each week (on Fridays) students will have the chance to practice their understanding of the concepts discussed in class. The students will form groups of four team members at the beginning of the first lab. The groups will perform the experiments together, but each individual student turns in a lab report.

Materials:

Four toy cars (e.g., Lego, matchbox)
Scale
Meter stick or measuring tape
Ruler
Rubber bands for the toy cars
Straight drinking glasses or cans

Lab 1: Measurements, Velocity, and Acceleration: Experiment vs Theory

Students learn how to perform scientific measurements of displacement and time, and how to determine the statistics of the measurements (mean, standard error and deviation, percentage difference and error). The students will be also introduced to concepts of velocity and constant acceleration and how to compare measurements from experiments to theoretical predictions:

A) A toy can will roll for 10 meters and the time will be measured by the students. Each group will perform five measurements of the time using the stopwatches on their cell phones. They will then calculate the average velocity of the toy car and its statistics.
B) The track from A) will be divided into four equal segments, and the velocity of the toy car will be measured in each segment as shown in A). This will be used to calculate the acceleration of the car. Then the initial velocity of the toy car will be calculated using the equation for constant acceleration and

compared to the measured velocity in the first segment, and the percentage difference will be derived.

Lab 2: Newton's and Kepler's Laws

This lab is a workshop with the aim of applying the concept of gravitational force to predict the orbital motions of planetary bodies in space. Students will also learn how to read data tables and to derive physical laws using the provided data.

A) This part of the lab consists of a worksheet in order to discover Kepler's Laws and how they can be translated into Newton's laws of inertial and gravitational force. Students will draw different orbits with different eccentricities and compare the orbital speeds of the objects at different sections of the orbit.

B) Students will use a table containing the orbital distance, orbital period, and planet mass of the planets in the Solar system. These data will be used to derive Kepler's third law and the concept of gravitation.

Lab 3: Conservation of Energy and Momentum

The classroom will be used to set up the same ten meter track from the first experiment. Two toy cars will be engaged in elastic and inelastic collision in order to measure the conservation of energy and momentum.

A) The cars will be set up with a rubber band bumper. One car is accelerated towards the collision with the other car (originally at rest). The student teams will measure the velocity (as in Lab 1) for both cars before and after the collisions.

B) The same measurements will be performed for the toy cars without the rubber bumpers. The conservation of energy and momentum in case A) and B) will be calculated and compared.

Lab 4: Rotational Motion

The lab teams engage in a workshop to use the concepts of circular and rotational motion and gravitation to measure the mass of Jupiter.

A) Lab teams find the measurements of the periods and semi-major axes of the Galilea moons of Jupiter. The collection of those data is the responsibility of each lab group. The data can be found using various online sources, such as planetarium software (e.g., World Wide Telescope, Stellarium)

B) The equation of radial (also known as centripetal) force and the universal law of gravitation will be combined and used to derive the satellite equation. Then this formula will be used to derive Jupiter's mass from the collected moon orbit data and the compared to the textbook value of Jupiter. The percentage difference of the masses will be derived.

Lab 5: Buoyancy

This lab will engage the student teams in the concepts of fluids, pressure, and buoyance. This will be done by measuring the relation between depth and pressure in a liquid. Students will also learn how to plot data, draw a linear regression line, and derive a physical relation law from the slope of this line.

A) The mass of a couple of graduated cylinders, cans, or glasses will be measured on a scale with and without water. The difference is the mass of the water columns. Then the mass of the water columns is measured for three more column heights. The cross-section area of the column is derived from the radius of the glass.
B) The pressure on the bottom of each column height is derived. Additionally, students draw a mass (kg) vs. area (m2) graph, fit a linear regression line on the data, and calculate the slope of the graph.

Attendance Participation

Attendance at lectures and recitations. Continued absences will detract from your final grade. If you have missed/will be missing a class or recitation session for an acceptable reason, such as illness or religious observance, please let me know in person with a written document. Ideally, you should let me know of your absence prior to missing the class. In addition, **missing a class for an acceptable reason will not excuse you from completing the class exercises and the out of class assignments** so, if you miss a class, it is your responsibility to obtain notes from a classmate and contact the instructor in order to complete all the assignments by their original or extended deadlines.

Grading Policy

Your final grade is based on the following components:

Quizzes/Homework	20%
Laboratory Experiments	20%
Midterm Exam	20%
Final Exam	30%
Participation	10%
Total	100%

Grading Scale

The instructor will use the grading system as applied by JNU:

Definition	Letter Grade	Score
Excellent	A	90~100
Good	B	80~89
Satisfactory	C	70~79
Poor	D	60~69
Failed	E	Below 60

Attendance

Attendance is mandatory in the class. It would be recorded each class and forms part of students' participation record. Students should inform the instructor at the earliest opportunity if they need to ask for a leave. All absences may have negative effect on students` final grades. Any students with more than three unexcused absences will automatically fail the course.

Academic Integrity

As members of the Jinan University academic community, students are expected to be honest in all of their academic coursework and activities. Academic dishonesty, includes (but is not limited to) cheating on assignments or examinations; plagiarizing, i.e., misrepresenting as one's own work any work done by another; submitting the same paper, or a substantially similar paper, to meet the requirements of more than one course without the approval and consent of the instructors concerned; or sabotaging other students` work within these general definitions. Instructors, however, determine what constitutes academic misconduct in the courses they teach. Students found guilty of academic misconduct in any portion of the academic work face penalties that range from the lowering of their course grade to awarding a grade of E for the entire course.