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JINAN UNIVERSITY
Fundamentals of Physics I (With Lab)

Lecturer: Ozeas S. Costa Jr.
Time: Monday through Friday (June 18, 2018-July 20, 2018)
Office hours: 2 hours (according to the teaching schedule)
Contact Hours: 60 (50 minutes each)
Credits: 4
Location: Huiquan Building
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E-mail: costa.47@osu.edu

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**, but not calculus. 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. Because physics is a science based upon experimental observations, concept lectures will be supplemented by practical exercises and hands on experimentation.

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.

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 session is 120 minutes in length. Lecture session meets from Monday to Thursday. Lab session meets on each Friday.

Assessment

Your final grade is based on the following components:

Quizzes/Homework	20%
Practical Exercises	25%
Midterm Exam	25%
Final Exam	30%
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

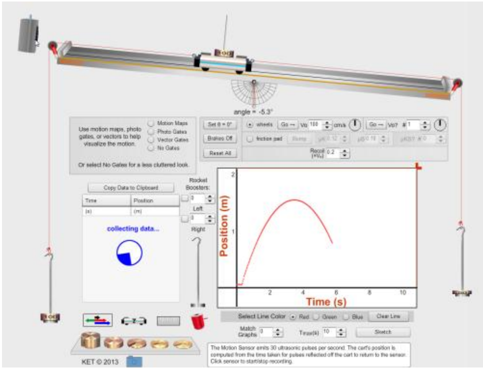
Quizzes/Homework

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 POSTED ON BLACKBOARD on 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).

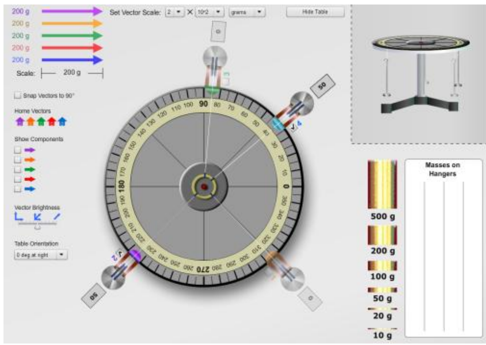
Practical Exercises (Lab Activities)

At the end of each week (on Fridays) students will have the chance to practice their understanding of the concepts discussed in class. They will work in small groups on practical exercises using the interactive simulations available at the Virtual Physics Labs from KET (http://virtuallabs.ket.org/physics). The KET virtual equipment and apparatus allows students to engage in real experimentation, collect their own data, and develop their own analysis. The following concepts will be explored:

- Week 1: students will use the **"Dynamics Track" apparatus** to explore kinematics concepts such as average and instantaneous velocity, and explore the effects of constant acceleration and friction in one-dimensional motion. The virtual apparatus allow students to change experimental conditions and run multiple experiments, create graphs of position vs. time and velocity vs. time, calculate acceleration, generate sketches of these graphs, and use them to describe different types of motion. They will be able to distinguish scalar from vector quantities, distance from displacement, and speed from velocity. Students will also use the **"Force Table" apparatus** to explore vector addition and subtraction, investigate the effects of two-dimensional forces, calculate the resultant of up to four different forces acting in different directions, and how the angle of application of a force can affect equilibrium.



The "Dynamics Track" apparatus



The "Force Table" apparatus

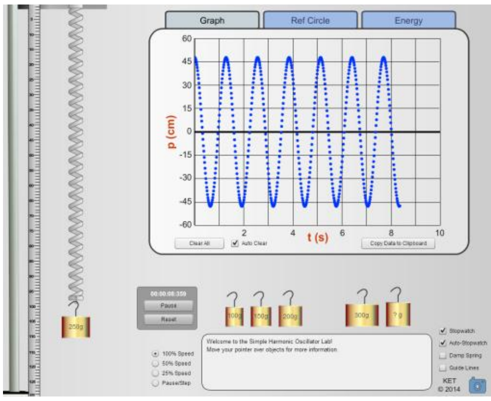
- Week 2: students will use the **"Centripetal Force" apparatus** to explore circular motion, investigate the effect of static friction, and explore the relationship between force and angular speed. The virtual apparatus allow students to explore and quantify the factors affecting the forces required to keep an object in uniform circular motion, to use graphical analysis techniques to derive and verify the equation for centripetal force, and to investigate the behavior of friction in circular motion.

The "Centripetal Force" apparatus

Students will also use the **"Pendulum" apparatus** to measure the period of a pendulum and investigate the effects (on the period) of length of pendulum, amplitude of swing, mass of pendulum bob, and acceleration due to gravity. After running multiple experiments under varying conditions, students will derive an equation describing these effects and test this equation by comparing its prediction with the known value of gravity on the moon.

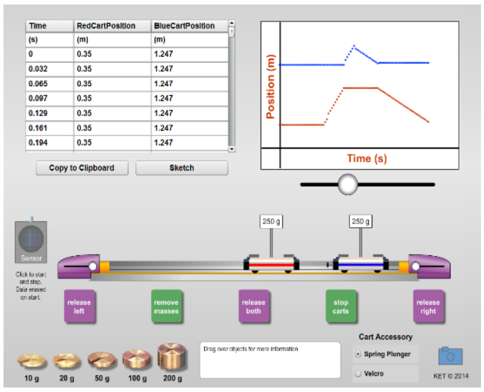
The "Pendulum" apparatus

- Week 3: students will use the **"Mass and Spring" apparatus** to explore simple harmonic motion and the conservation of mechanical energy principle. They will apply Hooke's law to calculate the spring constant (k), use the principle of springs to determine the weight of an unknown mass, and learn how simple harmonic motion is related to trigonometric functions. The virtual apparatus allow students to use a variety of masses (from 100 g to 300 g), to damp the spring, to control the spring movement, and to graph the position of the mass on the spring during the simple harmonic motion. It also provides a graphical visual of the changes between kinetic, potential, and total energy of the system, to help students visualize conservation of mechanical energy of the spring/mass system.



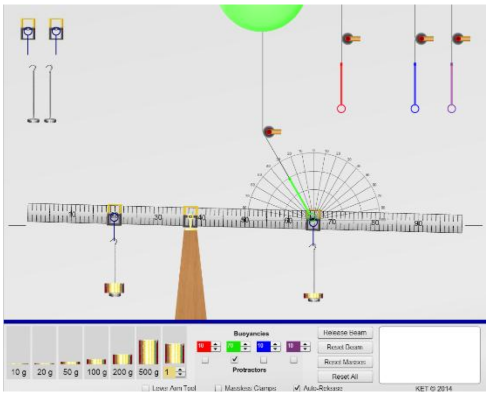
The "Mass and Spring" apparatus

- Week 4: students will use the **"Virtual Momentum" apparatus** to explore conservation of momentum for a pair of carts involved in a collision on a frictionless track. The virtual apparatus allow students to investigate the behavior of objects colliding in elastic and inelastic collisions, as well as explore the effect of different collisions on the change in kinetic energy of the system. Students will use the apparatus' graphing tool to predict the behavior of a number of experimental collisions.



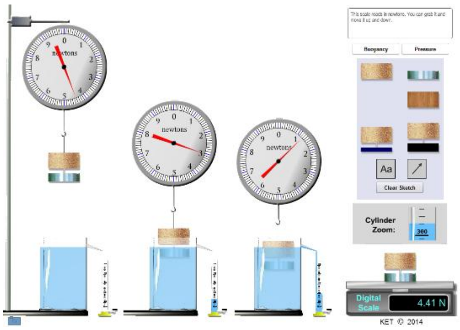
The "Virtual Momentum" apparatus

Students will also use the **“Torque” apparatus** to investigate rotational equilibrium with multiple downward forces from adjustable masses, as well as upward and angled forces from adjustable helium balloons. The virtual apparatus allow students to adjust the lever arm of a horizontal lever, weight an unknown mass with a balance beam, and analyze systems where the forces are not perpendicular to the lever.



The “Torque” apparatus

- Week 5: students will use the **“Buoyancy” apparatus** to investigate the Archimedes’ principle, and the behavior of buoyant forces on fully and partially submerged bodies of water. The virtual apparatus allow students to examine the causes of buoyancy, by varying the pressure of the fluid. They will also use the apparatus to determine the density of an unknown material.



The “Buoyancy” apparatus

Attendance Policy

Attendance at lectures, recitations, and labs is expected. 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.

Class Schedule

Week 1

Lecture 1: Introduction to Mechanics – 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: Velocity (Dynamics Track Apparatus) + Vectors (Force Table Apparatus)

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: Circular Motion (Centripetal Force Apparatus) + Harmonic Oscillator (Pendulum)

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 Equilibrium – Torque, Balance, and Center of Gravity (Chapter 8)

Lecture 15: Rotational Inertia and Conservation of Momentum (Chapter 8)

Lab 4: Conservation of Momentum (Elastic + Inelastic Collisions) + Torque

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)

Lab 5: Archimedes’ Principle + Buoyancy

Final Exam Review Session

Final Exam (Chapters 1 to 9)

Academic Honesty

Jinan University defines academic misconduct as any act by a student that misrepresents the students’ own academic work or that compromises the academic work of another. Academic misconduct 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 substantially similar papers, to meet the requirements of more than one course without the approval and consent of the instructors; sabotaging another ́s work. Instructors will ultimately 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 ranging from a lower grade in the assignment to a final grade of E for the entire course.