Syllabus for ‘General Physics I’

I. Basic Information

Title	General Physics I (Mechanics and Wave)	**Course #**	PHYS1034
Category	Major Basic	**Audience**	Physics (normal) - International class
Credits	4	**Hours**	52
Instructor	CHEN, Kang (陈康)	**Revised**	Sep. 27, 2021
Textbook	Hugh D. Young and Roger A. Freedman, *Sears and Zemansky's University Physics with Modern Physics (12th Edition)*, Pearson Education, Inc. and China Machine Press, 2011		

II. Goals and Objectives

A. Overall goals

Through this course, the students should 1) learn the laws for the mechanical motion of bodies and preliminarily build the scientific view of space and time; 2) learn how to build an ideal model for an actual mechanical phenomenon and analyze it using math tools; 3) develop the skills and habits of scientific reasoning, critical thinking, logical argumentation and factualism, which will be benefits for their whole lives.

B. Objectives

Objective 1： In the chapters relating to the topics such as rockets, aerospace, and gyroscope, stories of Chinese scientists and engineers of the older generation in developing the technologies will be shared. Their great efforts, devotions, and perseverance will stimulate the students’ enthusiasm for learning science and encourage them to serve our country.

Objective 2： Mechanics is the first course of physics, by which the students should not only learn the knowledge of classical mechanics and feel the power of math tools, but also learn the methodology of physics, including observations, designed experiments, idealized models and assumptions, theory and analyze, etc. Such trainings set up a foundation for their future study and research.

Objective 3： Show, as many as possible, examples that are closely related to daily life, so that, the students can learn how to use the knowledge of mechanics to solve practical problems. Also,

each student is asked to find and analyze an actual mechanical phenomenon by himself and hand in a report at the end. To develop the habit of self-education, the students are asked to preview the context before class and moreover study the chapters of elasticity and fluid mechanics by themselves.

Objective 4： By discussions of the fundamental concepts, such as frame of reference, force, implications behind Newton's laws, the students are guided to think about the fundamentals of our universe and to feel the art of logic and reasoning. These deep discussions could motivate their interests in science and pursuit of truth. All-English teaching would improve their ability in communicating internationally and reading the scientific materials in English.

C. Correlations—Objectives, graduation requirements, teaching contents

Table 1: Correlations between course objectives, graduation requirements and teaching contents

Objectives	Teaching contents	Graduation requirements
Objective 1	Contents of all chapters. Examples include: Chapter 0 Introduction (China's contribution in SI unit "Kilogram"); Chapter 2 Particle Dynamics (C. N. Yang's contribution in Gauge Theory); Chapter 4 Momentum, Impulse and Collisions (China's achievements in developing missiles and rockets); Chapter 5 Rotation of Rigid Bodies (Application of gimbal and observation of precession of the equinoxes in ancient China; Story of China's laser gyroscope); Chapter 7 Gravitation (China's achievements in aerospace engineering).	Requirements 3
Objective 2	Contents of All chapters in which "Chapter 0: Introduction and Review of Calculus and Vectors" reviews the prerequisite math tools.	Requirements 2-1 to 2-3, 3
Objective 3	Contents of All chapters in which "Chapter 6 Elasticity" and "Chapter 9 Fluid Mechanics" are for self-taught.	Requirements 2-1 to 2-3, 7, 8
Objective 4	Contents of All chapters. Deep discussions on the concepts of reference frame, force, space, etc. are given mostly in "Chapter 1 Kinematics" and "Chapter 2 Particle Dynamics"	Requirements 2-1 to 2-3, 5, 7, 8

III. Teaching Contents

Chapter 0 Introduction

1. Teaching objectives

To learn some basic aspects of physics and mechanics

2. Focus and/or Difficulties

Expressions of a vector and its derivative in different coordinate systems; To understand that if a quantity is called a vector, it not only has a magnitude and a direction but also must obey the rules of vector operations.

3. Teaching contents

The nature of physics; physical quantities; idealized model; review of calculus; vectors and coordinate systems

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 1 Kinematics

1. Teaching objectives

To learn the general relations between displacement, velocity and acceleration.

2. Focus and/or Difficulties

Write the correct expressions for the relations between displacement, velocity and acceleration in both differential and integral form.

3. Teaching contents

The frame of reference; motion along a straight line; motion in two or three dimensions; relative motion

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 2 Particle Dynamics

1. Teaching objectives

To learn and apply Newton’s laws for mass point.

2. Focus and/or Difficulties

The inertial forces in rotating frame of reference; derivation of the Coriolis force.

3. Teaching contents

Inertia; Inertia mass, momentum and force; applications of Newton's laws; noninertial systems and inertial forces

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 3 Work and Energy

1. Teaching objectives

To learn the concepts of work, potential energy, kinetic energy, and conservative force.

2. Focus and/or Difficulties

Potential, conservative force and their relations; Phase diagram.

3. Teaching contents

Work, power and kinetic energy; potential energy; conservative forces; equilibrium and stability; phase diagram

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 4 Momentum, Impulse and Collisions

1. Teaching objectives

To learn the principle of conservation of momentum and its applications.

2. Focus and/or Difficulties

Kinetic energy before and after collision; judgement of whether the momentum is conserved or not.

3. Teaching contents

Momentum and impulse; center of mass; particle collision

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 5 Rotation of Rigid Bodies

1. Teaching objectives

To learn and apply the dynamical equations of rotation.

2. Focus and/or Difficulties

Decomposition of translation motion and rotation; analysis of forces and torques; judgement of whether the momentum, angular momentum and mechanical energy are conserved or not, when translational motion, rotation and collision are combined.

3. Teaching contents

Angular velocity and acceleration; the motion of a rigid body; angular momentum and torque; Dynamics of rotation about an axis; brief introduction of symmetry and conservation laws; gyroscope

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 6 Elasticity

1. Teaching objectives

To learn the quantities describing the elastic deformation.

2. Focus and/or Difficulties

The expressions of elastic potential energy density.

3. Teaching contents

Tension and compression; bulk stress and strain; shear deformation; bending and torsion; elasticity and plasticity.

4. Teaching method

Self-taught

5. Evaluations

Course report and examinations

Chapter 7 Gravitation

1. Teaching objectives

To learn and apply the Kepler's laws and the Newton's law of universal gravitation.

2. Focus and/or Difficulties

Understand the motion of a planet or a satellite; be able to analyze the switch of trajectories.

3. Teaching contents

Kepler's laws; Newton's law of universal gravitation; the motion of planets; some related topics

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 8 Oscillation and Wave

1. Teaching objectives

To learn the phenomena and the expressions for harmonic oscillations and waves.

2. Focus and/or Difficulties

Wave functions; wave equations; displacement, velocity and elastic deformation of the medium during the propagation of a mechanical wave.

3. Teaching contents

Simple harmonic motion (SHM); composition of SHM; decomposition of oscillations; coupled oscillations and normal modes; damped oscillation; forced oscillation; harmonic wave; wave equation; energy in wave motion; superposition and wave interference; Doppler effect

4. Teaching method

Lecture plus short assigned presentations by students

5. Evaluations

Homework, presentation, course report and examinations

Chapter 9 Fluid Mechanics

1. Teaching objectives

To learn the concept of ideal fluid and the dynamical equation for the steady flow.

2. Focus and/or Difficulties

Derivation and application of Bernoulli's equation.

3. Teaching contents

Fluid statics; fluid dynamics

4. Teaching method

Self-taught

5. Evaluations

Course report and examinations

IV. Teaching Hours

Table 2: Chapters and teaching hours

Chapters	Contents	Hours
Chapter 0	Introduction	2
Chapter 1	Kinematics	4
Chapter 2	Particle Dynamics	6
Chapter 3	Work and Energy	4
Chapter 4	Momentum, Impulse and Collisions	4
Chapter 5	Rotation of Rigid Bodies	12
Chapter 6	Elasticity	0
Chapter 7	Gravitation	6
Chapter 8	Oscillation and Wave	10
Chapter 9	Fluid Mechanics	0

V. Teaching Schedule

Table 3: Schedule

Week	Chapter	Contents	hours	Assignments	Note
1	N/A	N/A	N/A	N/A	

2	N/A	N/A	N/A	N/A	
3	N/A	N/A	N/A	N/A	
4	N/A	N/A	N/A	N/A	
5	Chapter 0 and 1	Introduction; Kinematics	2+2	Homework: Selected problems; One short presentation at each class	
6	Chapter 1 and 2	Kinematics; Particle Dynamics	2+2	Homework: Selected problems; One short presentation at each class	
7	Chapter 2	Particle Dynamics	4	Homework: Selected problems; One short presentation at each class	
8	Chapter 3	Work and Energy	4	Homework: Selected problems; One short presentation at each class	
9	Chapter 4	Momentum, Impulse and Collisions	4	Homework: Selected problems; One short presentation at each class	
10	Chapter 5	Rotation of Rigid Bodies	4	Homework: Selected problems; One short presentation at each class	
11	Chapter 5	Rotation of Rigid Bodies	4	Homework: Selected problems; One short presentation at each class	
12	Chapter 5	Rotation of Rigid Bodies	4	Homework: Selected problems; One short presentation at each class	
13	Midterm Exam; Chapter 7	Midterm Exam: Chapter 0 to 4; Gravitation	2+2	Homework: Selected problems; One short presentation at each class	
14	Chapter 7	Gravitation	4	Homework: Selected	

				problems; One short presentation at each class	
15	Chapter 8	Oscillation and Wave	4	Homework: Selected problems; One short presentation at each class	
16	Chapter 8	Oscillation and Wave	4	Homework: Selected problems; One short presentation at each class	
17	Chapter 8; Review of the course	Oscillation and Wave; Review of the course	2+2	None	

VI. References

1. Daniel Kleppner and Robert J. Kolenkow, *An Introduction to Mechanics*, McGraw-Hill, Inc., 1973; Cambridge University Press, 2010 (2nd Edition in 2013).
2. Jearl Walker, *Fundamentals of Physics (Halliday & Resnick)*, John Wiley & Sons, Inc., 2018 (11th Edition).
3. Charles Kittel, Walter D. Knight and Malvin A. Ruderman, *Mechanics, Berkeley Physics Course-Volume I*, McGraw-Hill Education and China Machine Press, 2011.
4. Richard P. Feynman, Robert B. Leighton and Matthew Sands, *The Feynman Lectures on Physics-Volume I*, Addison-Wesley Publishing Company, 1965.
5. Dexin Lu, *University Physics*, Higher Education Press, 2003.
6. 赵凯华，罗蔚茵，《新概念物理教程-力学》，高等教育出版社，2004.
7. 漆安慎，杜婵英，《普通物理学教程-力学》，高等教育出版社，2012.
8. 张汉壮，王文全，《力学》（第三版），高等教育出版社，2015.

VII. Teaching method

1. Lecture: PPT plus writing on the blackboard. Outlines, examples, schematic pictures and cartoon or movies are shown by PPT while derivations and solutions are performed on the blackboard. Examples are selected from the above listed reference books.
2. Presentation by students: Each student has one chance to give a short presentation on an assigned topic. Their performances are scored.
3. Course report: Each student should hand in a course report on a freely-chosen topic that is related to mechanics by the end the course.
4. Preview: All students are asked to preview the context before class.
5. Self-education: Students need to study “Chapter 6 Elasticity” and “Chapter 9 Fluid Mechanics” by themselves.

VIII. Assessment and Grading

A. Correlations between assessment and course objectives

Table 4: Correlations between assessment and course objectives

Objectives	Assessment points	Way of assessment
Objective 1	All teaching contents	Performance + Midterm Exam + Final Exam
Objective 2	All teaching contents	Performance + Midterm Exam + Final Exam
Objective 3	All teaching contents	Performance + Midterm Exam + Final Exam
Objective 4	All teaching contents	Performance + Midterm Exam + Final Exam

B. Grading

1. Grading Scheme

Performance 30% (including Presentation 5%, Quiz one 5%, Quiz two 5%, and course report 15%); Midterm Exam 30%; Final Exam 40%.

2. Percentages in the assessment and Degrees of accomplishment of the objectives

Table 5: Percentages in the assessment and Degrees of accomplishment of the objectives

Percentages / Objectives	Performance	Midterm Exam	Final Exam	Degree of accomplishment
Objective 1	30%	30%	40%	Performance + Midterm Exam + Final Exam
Objective 2				
Objective 3				
Objective 4				

C. Standards

Objectives	Standards				
	90-100	**80-89**	**70-79**	**60-69**	**＜60**
	优	**良**	**中**	**合格**	**不合格**
	A	**B**	**C**	**D**	**F**
Objective 1	Performance + Midterm Exam + Final Exam				
Objective 2					
Objective 3					
Objective 4					