Syllabus of University Physics I

1 Course information

Course name: University Physics I
Course object: Undergraduates majoring in science and engineering
Course code: SCI4B3B001
Course category: Professional basic courses, compulsory
Prerequisite course: Advanced mathematics.
Total period: 51+17 (class :51, continue :17)
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Syllabus reviewer: Denghui Xu, Aicong Geng

Physics is the natural science about the basic structure, basic motion form and interaction. Its basic theory permeates every field of natural science and is applied in many domains of production technology, which is the foundation of other natural science and engineering technology.

In the process of pursuit of truth and exploration of the unknown world, physics has presented a series of scientific world views and methodology, which profoundly affects human's basic understanding of the material world, thinking mode and social life. It is the cornerstone of human civilization development and plays an important role in the cultivation of scientific quality of talents.

University physics I consists of the basic concepts and rules of mechanical, thermal, mechanical vibration, mechanical wave and wave optics, and it's an important general professional basic course for students in major machinery, automation, electrical, computer, software, information, mathematics, chemistry, food, environment, biology, materials science and engineering in our school. The basic concepts, theories and methods taught in this course are important parts of students' scientific literacy, which are necessary for scientists and engineers.

University physics I plays an important role that can not be replaced by other courses in setting up the necessary physical foundation for students systematically, cultivating students' scientific world view, enhancing students' ability to analyze and solve problems, and cultivating students' exploration spirit and innovation consciousness.

Through this course, students should have a systematic and correct understanding of the basic concepts, theories and research methods of mechanics, heat, mechanical vibration, mechanical wave and wave optics in physics, so as to lay a solid foundation for further study. In the course of each section, not only knowledge should be taught, at the same time, but also pay attention to the cultivation of students' ability to analyze and solve problems, the cultivation of students' exploration spirit and innovative consciousness, and strive to achieve the coordinated development of students' knowledge, ability and quality.

2 Textbooks and teaching resources

2.1 Textbooks

General physics (6th edition), volume 1 and volume 2, edited by Shouzhu Cheng and Zhiyong Jiang, Higher Education Press, 2006.

2.2 Teaching resources

- General physics (6th edition), problem analysis and solution, Naijiang Sui, Panxin Hu, Higher Education Press, 2006.
- General physics (6th edition), analysis and development of thought problems, Panxin Hu, et al, Higher Education Press, 2006.
- Case base of university physics peer teaching(1st edition), Xiaobai Chen, Baohe Li, et al, China Machine Press, June 2014.

- University physics problem seminar guide(1st edition), Huijun Shen, Huzhu Wang, Tsinghua University Press, June 1991.

3 Course assessment

The grades are assessed by 30% and 70% respectively according to the normal time and the exam, including attendance, discussion, unit test, etc., and the final exam is a closed-book exam with 100 minutes.

4 Teaching content and teaching hours allocation

4.1 Total teaching hours

The total teaching hours of this course are 68, including 51 class hours of classroom teaching and 17 class hours of continuous teaching.

4.2 Content and teaching hours allocation

Chapter 1 Mechanics (15 credit hours + 6 continuing hours)

1 Force and motion

Teaching content: Particle, reference system, position vector, displacement, velocity, acceleration, tangential acceleration, normal acceleration, motion equation, angular displacement, angular velocity, angular acceleration, relationship between angular quantity and linear quantity, relative motion. Newton's laws of motion, inertia, mass, force and inertial system.

Teaching requirements:

- Understanding the importance of scientific research methods for establishing particle models.
- Mastering the position vector, displacement, velocity, acceleration, angular velocity, angular acceleration and other physical quantities describing the motion of particles. The proper reference system and coordinate system can be selected to calculate the velocity and acceleration of the one-dimensional and two-dimensional motion of the particle in rectangular coordinate system
- Knowing Galileo's relativity principle, Galileo's coordinate, velocity transformation and relative motion.
- Mastering the content and application conditions of Newton's three laws. Understanding the concepts of inertia, mass, force and inertial systems. Mastering the method of force analysis by selecting isolator. Understanding the laws of common forces and mastering the basic ideas and methods of solving problems with Newton's laws. Using calculus method to solve the simple dynamics problem of particle under variable force.

2 Conserved quantities of motion and conservation laws

Teaching content: Work of constant force and variable force, power, kinetic energy, kinetic energy theorem, conservative force, non-conservative force, potential energy, principle of work and power, conservation law of mechanical energy. Impulse, momentum, momentum theorem, momentum conservation law, collision. Center-of-mass, the motion theorem of center-of-mass. Angular momentum of particle, theorem of angular momentum, conservation law of angular momentum.

Teaching requirements:

- Mastering the concepts of momentum and impulse, the momentum theorem and the law of conservation of momentum and its applicable conditions.

- Mastering the concepts of work, kinetic energy and potential energy, understanding the characteristics of work of conservative force, calculating the work of variable force in the case of linear motion, skillfully calculating gravitational potential energy, elastic potential energy, calculating attractive potential energy. Mastering the law of kinetic energy, principle of work and power, the law of conservation of mechanical energy and its applicable conditions.
- Knowing the concept of the center-of-mass, understanding the motion theorem of the center-of-mass.
- Mastering one-dimensional and two-dimensional problems of particle motion. Collisions require only the understanding of perfectly elastic and perfectly nonelastic collisions.

3 Fixed axis rotation of rigid body

Teaching content: Rigid body, translation of rigid body, fixed axis rotation of rigid body, angular momentum, rotational kinetic energy, rotational inertia of rigid body, moment of force, law of rotation, angular momentum theorem and conservation law of angular momentum, precession.

Teaching requirements:

- Understanding the rigid body model, knowing the concept of rotational inertia.
- Mastering the concept of moment of force, understanding the law of fixed axis rotation of rigid body and its applicable conditions.
- Understanding the concept of angular momentum, the angular momentum theorem and the conservation law of angular momentum and its applicable conditions.
- Knowing the concept of precession

Chapter 2 Thermology (12 credit hours + 4 continuing hours)

4 Kinetic theory of gas

Teaching content: The state parameters of the gas, the equilibrium state and equilibrium process, the state equation of ideal gas , the formula of pressure and temperature of ideal gas, theorem of energy according to the degrees of freedom equipartition, the internal energy of ideal gas, Maxwell speed distribution, the average rate, square root rate, most probable rate, average collision frequency and the mean free path of gas.

Teaching requirements:

- Understanding the concept of equilibrium state.
- Expounding the statistical method, explaining the difference and connection between macroscopic quantity and microcosmic quantity, understanding the macroscopic property of thermodynamic system is the statistical expression of molecular thermal motion. Mastering the essence and statistical significance of concepts such as pressure, temperature and internal energy. Understanding the pressure and temperature formula.
- Understanding the molecular model of an ideal gas, the average energy of gas molecules according to the equalization theorem of degrees of freedom, mastering the internal energy of ideal gas.
- Knowing the physical significance of Maxwell rate distribution rate, distribution function and rate distribution curve. Understanding the meaning and application of arithmetic mean rate, square root rate, most probable rate of molecular motion.
- Knowing the concept of average collision frequency and average free path of gas molecules.

5 Thermodynamic basis

Teaching content: Internal energy, work, heat, the first law of thermodynamics and its application in four quasi-static processes of equal volume, equal pressure, equal temperature and adiabatic of ideal gas, molar heat capacity of a gas, cyclic process, Carnot cycle, Carnot theorem, thermal efficiency, the second law of thermodynamics, reversible and irreversible processes, entropy and entropy increasing principle.

Teaching requirements:

- Mastering the concepts of internal energy, work and heat, understanding the quasi-static process, mastering the first law of thermodynamics and its application. mastering the calculation of work, heat and internal energy changes in equal volume, equal pressure, equal temperature and adiabatic of ideal gas. Aanalyzing and calculating the simple cycle efficiency of ideal gas.
- Knowing two expressions of the second law of thermodynamics and their equivalence, knowing reversible and irreversible processes.
- Knowing the statistical significance of the second law of thermodynamics, the Boltzmann expressions of entropy and entropy and the principle of entropy increase.

Chapter 3 Mechanical vibrations and mechanical waves (12 credit hours + 3 continuing hours)

6 Mechanical vibration

Teaching content: Equation of simple harmonic vibration, amplitude, period, frequency, circular frequency, phase, rotation vector method, energy of simple harmonic vibration, damped vibration, forced vibration, resonance, synthesis of harmonic vibration in same and different frequencies in the same direction.

Teaching requirements:

- Mastering the basic characteristics of simple harmonic vibration and the concepts of amplitude, period, frequency, circular frequency and phase. One dimensional differential equation of simple harmonic vibration can be established. The motion equation of one-dimensional harmonic vibration can be obtained according to the initial conditions.
- Understanding the rotation vector method, using the rotation vector to analyze the simple harmonic vibration problem.
- Knowing the phenomena of damped vibration, forced vibration and resonance.
- Understanding the law of simple harmonic vibration synthesis in the same direction and frequency, and knowing the beat phenomenon.

7 Mechanical wave

Teaching content: Production and propagation of mechanical wave in elastic medium, transverse and longitudinal wave, velocity, frequency, wavelength and their relationship, planar simple harmonic wave equation, energy of mechanical wave, energy flow and energy flow density, Huygens' principle, the diffraction of the wave, principle of wave superposition, phase difference, half wave loss, wave interference, standing wave, the Doppler effect.

Teaching requirements:

- Understanding the conditions under mechanical waves arise and propagate in an elastic medium, mastering the concept of waves, understanding the transverse and longitudinal

wave, mastering the relationship among wave speed, frequency and wavelength, understanding the wave function, establishing the wave function of planar simple harmonic according to the known conditions.

- Understanding the physical meaning and waveform curves of wave functions.
- Understanding the laws of energy propagation and change in mechanical waves, knowing the concept of energy flow and energy density.
- Knowing Huygens' principle.
- Understanding the principle of superposition and the coherent conditions of wave. The enhancement and attenuation conditions of coherent superposition can be determined by phase difference and wave path difference analysis.
- Knowing the formation conditions of standing waves and the characteristics of standing waves, the positions of nodal and ventral of waves can be determined, understanding half wave loss.
- Knowing the Doppler effect and its causes, Doppler frequency movement formula can be used to calculate when the wave source or observer moves separately with respect to the medium and the direction of motion is along the line between them.

Chapter 4 Wave optics (12 credit hours + 2 continuing hours)

8 Interference of light

Teaching content: Light source, monochromatism and coherence of light, acquisition of coherent light, Young's double slit interference, optical path, optical path difference, equal thickness interference, equal dip interference, Michelson interferometer.

Teaching requirements:

- Knowing the properties of light source, understanding the monochromatism and coherence of light, and how to obtain coherent light.
- Mastering the coherence conditions, understanding half wave loss, mastering the concept of optical path and the relationship between optical path difference and phase difference.
- Analyzing Young's double slit interference and equal thickness interference, knowing equal inclination interference and the principle of Michelson interferometer.

9 Diffraction of light

Teaching content: Huygens-Fresnel principle, single slit diffraction, grating diffraction, resolution of optical instruments, X-ray diffraction.

Teaching requirements:

- Knowing Huygens-Fresnel principle, understanding the law of single slit Fraunhofer diffraction, knowing the method of half-wave band method to analyze the light and dark of the stripe, analyzing the influence of the width and wavelength of the slit on the diffraction fringe.
- Understanding the law of grating diffraction and the condition of missing order, the position of grating diffraction spectral line can be determined, and the influence of grating constant and wavelength on the distribution of grating diffraction spectral line can be analyzed..
- Knowing the resolution of optical instruments and X-ray diffraction.

10 Polarization of the light

Teaching content: Natural and polarized light, acquisition and examination of linear polarized light, polarization of reflected and refracted light, Brewster's law, Marius' law

Teaching requirements:

- Understanding the concepts and basic characteristics of natural and linearly polarized light, understanding the generation and examination of linearly polarized light.
- Understanding Brewster's law and Marius' law.

5 Continuing teaching arrangement

Teaching hours :51 credit hours +17 continuing hours
Teaching hours allocation:

Content	Credit hours	Continuing hours
1 Force and motion	4	2
2 Conserved quantities of motion and conservation laws	5	2
3 Fixed axis rotation of rigid body	6	2
4 Kinetic theory of gas	5	2
5 Thermodynamic basis	7	2
6 Mechanical vibration	5	1
7 Mechanical waven	7	2
8 Interference of light	12	2
Review		2
Sum	51	17