FISICA I J - Pr

FIS/01 - 9 CFU - 2° Semester

Teaching Staff

ROBERTO BARBERA

Email: roberto.barbera@ct.infn.it
Office: Dipartimento di Fisica e Astronomia - Via S. Sofia, 64 - Edificio 6 - Stanza T19 (piano terra)
Phone: +390953785504
Office Hours: Mercoledì e Venerdì dalle 14:00 alle 15:00 Eventuali avvisi di indisponibilità del docente saranno diramati esclusivamente attraverso Studium (http://studium.unict.it).

LEARNING OBJECTIVES

The course aims at providing basic knowlegde of classical mechanics and thermodynamics topics included in the Course Content (see below) as well as the capability to apply the Scientific Method to the resolution of real and concrete problems.

In particular, the course has the objectives to provide pupils with the following knowledge and abilities.

Knowledge and understanding abilities

Knowledge of the main phenomenological aspects related to classical mechanics and thermodynamics and understanding of their physical implications and their mathematical description.

Applying knowledge and understanding ability

Ability to recognize the main physical laws that govern a mechanic or thermodynamic phenomenon, and to apply them to solve problems and exercises at different levels of complexity and therefore of approximation, with the use of appropriate analytical and numerical techniques.

Ability of making judgements

Evaluation of the order of magnitude of the variables that describe a mechanic or thermodynamic phenomenon. Evaluation of the relevance of a physical law (axiom, principle of conservation, universal law, theorem, law in global/integral or local/differential form and its generality, properties of materials, etc.).

Communication skills

Capability to expose scientific concepts in a proper and inambiguous manner, at various levels.

Learning skills

Application to Physics of theoretical/mathematical techniques.

COURSE STRUCTURE

Prerequisites

Although no prerequisites are officially imposed, it is extremely useful that students master the subjects of elementary mathematics (algebra, geometry, trigonometry, analytic geometry) and have knowledge of those of differential and integral calculus.

Attendance to lectures

Although it is not mandatory, attendance to classroom lectures is strongly recommended.

Didactic activity

Didactic activity consists of classroom lectures and exercises. Exercises can be both assignments of the teacher for the homework or driven by the teacher - or by tutors, if available - in the classroom.

Didactic material

A collection of exercises, many of which were assigned during the written exam sessions, is available on the web page of the course in the Studium portal (http://studium.unict.it), inside the section called Documenti.

Learning verification

The final exam consists of a written test followed by an oral exam. The written test, lasting 2 hours, consists of the resolution, justified and clearly commented, of 2 problems of Mechanics and of 2 problems of Thermodynamics. At the resolution of each problem will be assigned a score between 0/30 and 7.5/30. During the written test, it is possible use any support deemed useful (textbooks, notebooks, lists of formulas, calculator, etc.) **except** workbooks (i.e., books containing problems and relative solutions) and communication devices (smartphones, tablets, personal computers, etc.).

Students who obtain a score lower than 15/30 in the written test are advised against taking the oral exam. To be advised against is not equivalent to a formal prohibition to take the oral exam.

The oral exam consists in the discussion of at least 3 different topics, of which the first is chosen by the student.

During the oral examination students may be asked to demonstrate theorems and important results included in the program with numerical evaluations of the order of magnitude of the physical quantities involved in a given phenomenon.

Ongoing tests ("prove in itinere") are not planned.

Dates of the exams

Check the following web pages

- http://portalestudente.unict.it
- http://www.dieei.unict.it/corsi/l-8-ele/esami

and the notices on the course page on the Studium portal (http://studium.unict.it) for details on the time and place of the exams and any changes

Examples of asked questions and exercises

Usually, the oral exam begins with the presentation of a topic chosen by the candidate. The questions asked during the oral exam will be related exactly to the topics of the program. For example:

- "enunciate and demonstrate the principle of conservation of mechanic energy"
- "present and discuss the 3 Newton's laws of mechanics"
- "enunciate and demonstrate the principle of momentum conservation"
- "discuss the dymanics of a rigid body: degrees of freedom, equations of motions and conservation laws"
- "tell me about the thermodynamic equilibrium and the principle of thermal equilibrium"
- "say aloud the enunciates of the second principle of thermodinamycs and demonstrate their equivalence"
- "evaluate the internal energy of monoatomic gas and that of a biatomic one"
- etc.

During the oral exam it may be necessary to demonstrate theorems and important results included in the program with numerical evaluations of the order of magnitude of the physical quantities involved in a given phenomenon.

A collection of exercises, many of which were assigned during the written exam sessions, is available on the course page on the Studium portal (http://studium.unict.it), in the Documents section.

Course structure

1. Physical quantities and units of measure (4 hours) - Reference textbook 1 - Appendix B
2. Scalars and vectors (5 hours) - Reference textbook 1 - Appendix C
3. Kinematics (9 hours) - Reference textbook 1 - Chapter 1; Reference textbook 2 - Chapter 8
4. Dynamics of the material point (12 hours) - Reference textbook 1 - Chapters 2 and 3; Reference textbook 2 - Chapters 9 and 12
5. Work and energy (6 hours) - Reference textbook 1 - Chapter 2; Reference textbook 2 - Chapters 4, 10, 13 and 14
6. Dynamics of systems of material points (5 hours) - Reference textbook 1 - Chapter 4; Reference textbook 2 - Chapter 19
7. Gravitation (4 hours) - Reference textbook 1 - Chapter 5; Reference textbook 2 - Chapter 7
8. Dynamics of the rigid body (6 hours) - Reference textbook 1 - Chapter 6; Reference textbook 2 - Chapter 20
9. Oscillations and waves (6 hours) - Reference textbook 1 - Chapter 9; Reference textbook 2 - Chapters 21 and 23
10. First Principle of Thermodynamics (8 hours) - Reference textbook 1 - Chapter 10; Reference textbook 2 - Chapter 44
11. Ideal gases (6 hours) - - Reference textbook 1 - Chapter 11; Reference textbook 2 - Chapter 39
12. Second Principle of Thermodynamics (8 hours) - Reference textbook 1 - Chapter 12; Reference textbook 2 - Chapters 45 and 46

DETAILED COURSE CONTENT

Physical quantities and units. The scientific method. Physical quantities and units. The International System (SI). Scientific notation. Dimensional issues. Fundamental and derived physical quantities. Measurement errors and approximations. Significant figures. Functions' approximations..

Scalars and vectors. Scalar and vector quantities. Invariance and symmetry. Vector algebra. Vector calculus: derivatives and integrals of vectors.

Kinematics. Speed, velocity, acceleration and time dependence of motion. Straight and uniformly accelerated rectilinear motion. Vertical motion. Simple harmonic motion. Rectilinear motion exponentially damped. Motion in a plane: velocity and acceleration. Circular motion. Parabolic motion. Motions in space.

Dynamics of the material point. Principle of inertia and the concept of force. Second and third Newton's law. mpulse and momentum. Resulting force: binding reactions and equilibrium. Examples of forces: weight force, sliding friction force, viscous friction force, centripetal force, elastic force. Inclined pkane. Simple pendulum. Wire tension. Reference systems. Relative speed and acceleration. Inertial reference systems. Relativity of Galilei.

Work and energy. Work, power and kinetic energy. The theorem of the kinetic energy. Examples of works done by forces. Conservative forces and potential energy. Non-conservative forces. Principle of conservation of mechanical energy. Relationship between force and potential energy. Angular momentum. Torque. Central forces.

Dynamics of systems of material points. Systems of points. Internal and external forces. Center of mass and its properties. Principle of conservation of the momentum. Principle of conservation of the angular momentum. The König theorems. Theorem of the kinetic energy.

Dynamics of the rigid body. Definition of rigid body and its properties. Motion of a rigid body. Continuous bodies, density and the position of the center of mass. Rigid rotations around an axis in an inertial reference system. Rotational energy and work. Moment of inertia. Huygens-Steiner's theorem. Compound pendulum. Pure rolling motion. Energy conservation in the motion of a rigid body. Rolling friction.

Oscillations and waves. Properties of the differntial equation of the harmonic oscillator. Simple harmonic oscillator: motion equation and its solution. Motion of a mass connected to a spring. Energy of a simple harmonic oscillator. Sum of harmonic motions in one and in two dimensions. Damped and forced harmonic oscillators. Resonance. Fourier analysis.

Gravitation. Kepler's laws. The Universal Gravitation Law. Inertial mass and gravitational mass. Gravitational field and gravitational potential energy. Determination of the trajectory of a body in the gravitational field of another body..

First Principle of Thermodynamics. Thermodynamic systems and states. Thermodynamic equilibrium and the Principle of Thermal Equilibrium. Temperature and thermometers. Equivalence of work and heat: Joule's experiments. First Principle of Thermodynamics. Internal energy. Thermodynamic transformations. Work and heat. Calorimetry. Phase transitions. Heat transmission.

Ideal gases. Laws of the ideal gas. Equation of state of the ideal gas. Constant volume gas thermometer. Transformations of a gas. Work. Specific heat and internal energy of the ideal gas.

Analytical study of some transformations. Enthalpy. Ciclic transformations. The Carnot cycle. Kinetic theory of gases.Equipartition of energy.

Second Principle of Thermodynamics. Statements of the Second Principle of Thermodynamics. Reversibility and irreversibility. Carnot's theorem. Absolute thermodynamic temperature. Clausius theorem. Entropy state function. The principle of increasing entropy. Entropy variations' calculations. Entropy of the ideal gas. Unusable energy. Entropy and probability.

TEXTBOOK INFORMATION

1. P. Mazzoldi, M. Nigro e C. Voci, *Fisica – Volume I - Seconda Edizione* (EdiSES, Napoli, 2003);

2. R. P. Feynman, R. B. Leighton e M. Sands, *La Fisica di Feynman – Vol. 1, Parte 1 e Parte 2* (Zanichelli, Bologna, 2007) - for additional reading - this book is also in English.
