. - Physics

## Prof. Umberto Catellani

***Text under revision. Not yet approved by academic staff.***

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The course aims to provide students with an adequate theoretical understanding of the fundamentals of Classical Physics (Mechanics, Fluids and Thermodynamics), as well as a good ability in solving problems on the Laws of motion, forces, work and energy, necessary for acquiring "problem-solving" skills that are also useful in other curricular disciplines.

Another aim is to provide students with the language of Physics as a model for rigorous scientific communication.

At the end of the course, students will be able to:

* Recognise the types of motion and indicate the relative laws;
* Solve problems both in the traditional way and with the use of energy conservation laws;
* Understand the basic nature of thermodynamic phenomena by applying the relevant laws;
* Apply the laws of mechanics to the study of fluids.

COURSE CONTENT

The course will cover the basic concepts of Classical Physics, starting from its description and then covering the equations of motion (Kinematics), forces (Dynamics), the action of constant and variable forces (work and energy), the application of Fluid mechanics, and the fundamental laws of thermodynamics (zero principle, 1st, 2nd and 3rd laws of Thermodynamics). Heating and refrigeration machines and their relative yields. The functions of state (internal energy, entropy).

|  |  |
| --- | --- |
|  | ECTS |
| INTRODUCTION AND 1D and 2D KINEMATICS. Unit of measurement; measurement systems: SI; conversion of quantities, scalar and vector quantities. 1D motions: displacement, speed and acceleration; compound motions: projectile motion and keynotes on uniform circular motion. | 0.5 |
| DYNAMICS. The concepts of force and mass. Inertia. Newton's laws. Braking forces.  | 1.0 |
| WORK AND ENERGY. Operational definition of work. Work of constant and variable forces. Kinetic energy. Theorem of living forces. Potential energy. Conservation of mechanical and total energy. | 1.0 |
| GASES. Variables of the state of gases and the law of ideal gases | 0.5 |
| FLUIDS. Fluid statics: Stevino's law, Pascal's law; Archimedes principle. Fluid dynamics: continuity equations, Bernoulli's theorem, Torricelli's theorem and the Venturi effect. | 1.0 |
| THERMODYNAMICS. Thermal equilibrium; Zeroth law of thermodynamics; Thermometric scales; thermal expansion; specific heats; calorimetry; latent heats; 1st law of thermodynamics; thermodynamic transformations; 2nd law of thermodynamics; Carnot cycle; efficiency of thermal machines; entropy. | 1.5 |
| Tutorials. Exercises and problems related to the full range of course topics | 0.5 |

READING LIST

Preferred texts:

D.C. GIANCOLI, *Fisica Principi e Applicazioni 3rd Ed.* Zanichelli 2017.

R.A. Serway, J.W. Jewett, *Fondamenti di Fisica 6th Ed*. EdiSES (Naples) 2022.

TEACHING METHOD

1. Frontal and dialogue-based theoretical lectures, where the key concepts of the subject are explored with a few applied examples of Physical laws;
2. Frontal tutorials with guided problem solving;
3. Exercises at home with the aid of materials provided by the lecturer on the Blackboard platform;
4. The course also includes 10 hours of support where any problems are broken down and solved slowly, step by step;
5. The course includes 10 pre-course hours: participation in the pre-courses is highly recommended for all students who come from institutions where the study of physics was not continued through to the fifth year.

ASSESSMENT METHOD AND CRITERIA

A written exam involving the solving of problems of varying difficulty.

Admission to the exam and interim tests is subject to the presentation of a series of problems that will be handed out during the year. Students must submit a notebook containing all the exercises one week before the test.

The test assesses the student's ability to interpret the proposed problem from a physics perspective and to correctly set the solving process in theoretical and calculus terms. During the course, there will be an optional interim test on the first part of the course (Mechanics), passing which allows the student to take the final exam on just the remaining topics of the course.

NOTES AND PREREQUISITES

The following prerequisites are essential to properly address the course and will not be reviewed in any way during the lectures.
All the contents are addressed comprehensively in the 10-hour pre-course, during which the mathematical bases mentioned in the prerequisites are also presented.

Polynomial algebra, 1st and 2nd degree equations and inequalities, powers, scientific notation, trigonometry (graphs and fundamental relationships of sine, cosine, tangent, including inverse functions). Functions, Cartesian graphical representation of a function, derivatives and integrals.
Vector algebra and breakdown of vectors into Cartesian components.

NOTES AND PREREQUISITES

The course comes with:

* 12 hours of problem-solving tutorials in the classroom;
* 10 hours of support for those who encounter greater difficulties, with guided and slower solving of problems; this is aimed at preparing students to pass the interim test.

Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=Eng or on the Faculty notice board.