COURSE DATA

Data Subject	
Code	34242
Name	Mechanics I
Cycle	Grade
ECTS Credits	6.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	2	First term
1928 - Double Degree Program Physics-Mathematics	Double Degree Program Physics and Mathematics	2	Second term
1929 - Double Degree Program in Physics and Chemistry	Double Degree Program Physics and Chemistry	2	First term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	6 - Mechanics and waves	Obligatory
1928 - Double Degree Program Physics-Mathematics	2 - Segundo Curso (Obligatorio)	Obligatory
1929 - Double Degree Program in Physics and Chemistry	2 - Segundo Curso (Obligatorio)	Obligatory

Coordination

Name	Department
ALOY TORAS, MIGUEL ANGEL	16 - Astronomy and Astrophysics
PEÑARROCHA GANTES, JOSE ANTONIO	185 - Theoretical Physics
QUILIS QUILIS, VICENTE	16 - Astronomy and Astrophysics

SUMMARY

Mechanics I is a quarterly subject of the second year pertaining to the matter "Mechanics and Waves" which has allocated 6 credits (45 hours of theoretical and practical classes and 15 hours of supervised work sessions to resolve problems in small groups).

The descriptors proposed in the document Curriculum provide the following: curvilinear coordinates (cylindrical and spherical) and differential operators in the context of mechanics, Newtonian Mechanics (point and particle systems), collision, central fields, non-inertial systems and rigid solid.

Relation with other subjects of the same degree:

The subject Physics I of the "Physics" matter imparted on the first course of the degree is devoted to the contents of mechanics at a much basic and conceptual level, focusing on the basics, problem solving and experimental exercises and demonstrations. While the basic objectives of this course "Mechanics I" are to acquire a knowledge of mechanics with a higher degree of generalization, formalizing and deepening problems of great interest from a classic Newtonian approach. This spirit is shared by the other subjects of the same mater as "Oscillations and Waves" and "Mechanics II." Although the course "Mechanics I" is independent of the subject " Experimental Laboratory of Mechanics and Waves" the relationship between the two is very close, and the labs cover almost the entire set of topics of “Mechanics I” (collisions, movements in the field gravitational, gyroscopic motion, etc.) and in all cases these subjects deal with the experimental results from the knowledge and appropriateness of the theoretical model.

In short, this subject has a fundamental character and a great relevance for the degree. It deals with a certain degree of mathematical formalization but primarily aimed at providing basic tools to address fundamental problems of mechanics, focusing on the physical contents rather than in their formulation as a theoretical body, which is the goal of the course "Mechanics II."

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The subject of "Mechanics" I, like others of the second and third year of the Degree in Physics, deepens in the aspects introduced in the Mechanics contents of the subject Physics I, in the first course. For this reason, it is essential to have successfully completed this course. You also need to master the mathematical basis acquired on the subject "Mathematics" in the first course and previous courses (high school). We refer in particular to trigonometry, vector and matrix algebra, eigenvalues and eigenve

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1105 - Degree in Physics

- Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.
- To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.
- Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .
- Theoretical understanding of physical phenomena: have a good understanding of the most important physical theories (logical and mathematical structure, experimental support, described physical phenomena).
- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.
- Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.
- Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.
- Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.
- Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

- Know how to approach the kinematic and dynamic problems in the appropriate coordinate system.
- Be able to describe the properties of force fields in terms of differential operators in different types of coordinates and knowing how to calculate the associated potentials in the case of conservative fields.
- Be able to derive the conserved quantities in a problem based on invariance of the potential.
- Know how to pose the equations of motion from Newton's equations for different types of applied forces, solving equations in general and determining the constants of the solutions from initial conditions.
- Know how to use the laws of conservation in the study of motion of particle systems and extract reasonable conclusions from these laws. Use these laws in collision processes between bodies with translational motion.
- Be able to describe the movements in non-inertial systems, particularly in rotating systems, understanding the difference between the description of the movements made by inertial and non-inertial observers.
- Know how to analyze and obtain the different types of orbits of a particle in central fields in particular and in greater detail in a Newtonian/Coulomb field. To understand the concept of cross section and differential cross section and its connection to the potential of interaction in problems of particle scattering, particularly in the case of the Coulomb potential (Rutherford scattering).

Understand the degrees of freedom in the motion of a rigid body, and learn to pose the equations of motion. To be able of calculating the elements of the inertia tensor of a rigid body, in particular in the case of simple regular figures and to recognize the principal axes or the mass distributions whose symmetry leads exclusively to diagonal terms of the inertia tensor.

DESCRIPTION OF CONTENTS

1. INTRODUCTION-APPENDIX

Curvilinear coordinates: Cylindrical and spherical. Unit vectors and transformation matrix. Scalar and vector fields. Operators and integral theorems in Cartesian and curvilinear coordinates.

2. Kinematics of the point

Introduction. Reference system. Biography, space travel and the position vector of a point. Speed and acceleration. Examples of movements. Frenet trihedral. Position, velocity and acceleration of a point in curvilinear coordinates: Cylindrical and spherical. Galilean transformations. Galileo's Principle of Relativity.

3. Dynamics of the point

Newton's laws: Statement and discussion. Equations of motion according to the type of strength and resolution. Examples. Fundamental Interactions and Forces. Conservative and dissipative forces. Conservation of linear and angular moment of a particle. Work, kinetic energy and potential energy. Conservation of mechanical energy of a particle. Dimensional potential and introduction to small oscillations.

4. Particle Systems

Center of mass and relative coordinates. The case of two bodies. Internal and external forces. Conservation of linear momentum of a system. Variable mass systems and examples. Conservation of angular momentum of a system. Kinetic and potential energy of a system, internal energy. Conservation of mechanical energy of a system. The two-body system. Virial Theorem. Symmetries of the potential energy and conservation laws.

5. Fields and movement in central fields

Conservative fields and central fields. Newtonian/Coulomb Potential and Field of a system of discrete and continuous sources: spherical distribution. Poisson equation. Motion in a central potential. Law of the areas. Effective potential and orbits. Problem of two bodies. Orbits in a gravitational field.

6. Collisions and Scattering

Introduction. Collisions in two dimensions, types of collisions. Elastic collisions: Laboratory System and center of mass system. Inelastic collisions: variation of energy in the collision. Reactions. Elastic scattering by a hard sphere. Cross section. Scattering by a central potential: Rutherford Scattering.

7. Non-inertial systems

Relative motion. Instantaneous angular velocity. Coriolis theorem. Fictitious forces. Effective gravity. Movement in the Earth's surface. Deviation to the east. Foucault Pendulum.

8. Kinematics and dynamics of the rigid solid

Movement and degrees of freedom. Instantaneous angular velocity. Euler angles: rotation and angular velocity. Kinetic energy, angular momentum and inertia tensor. Euler equations. Free body movement.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Tutorials	15,00	100
Development of individual work	20,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	40,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course will consist of two types of classes with differentiated methodology:

a) Theoretical-practical classes (3 hours per week)

In the theoretical and practical classes the basic theoretical contents of the subject will be taught, as well as practical examples of problems and exercises that best illustrate them. In combination with discussions and deductions on the board, graphic tools can be used that include images, videos and animations that allow illustrating some of the phenomena explained, as well as experimental demonstrations. The basic summaries of the contents of the subject explained in class will be made available to students in the virtual classroom. Although most of the aspects of the program will be addressed directly in these classes, some specific or monographic aspects of the syllabus may be indicated for study without being discussed directly. In fact, the student will be encouraged and guided in the expansion of these contents through the recommended bibliography, as well as the possibility of expanding knowledge in future subjects.

b) Sessions of supervised work in small groups (1 hour each week)

In these classes of problems in small groups, a bulletin will be made available to the students with problems and exercises that will be programmed to be solved by the students before each class. In them, students must publicly solve and explain the problems, adequately justifying the calculations made and raising any doubts that have arisen or aspects that present conceptual or calculation difficulties. The professors will monitor the work and progress of the students, in addition to solving the questions raised. During the development of the sessions themselves, basic exercises will be assigned to facilitate the understanding of the fundamentals of the subject.

c) Tutoring

There is no specific allocation of weekly tutoring hours, but it is recommended that students make use of this possibility of interacting directly with teachers. The use of forums in the Virtual Classroom will be encouraged to discuss points of common interest by various students.

EVALUATION

he assessment system is as follows:

1) Written examinations: One part will assess the understanding of the theoretical-conceptual and formal nature of the subject, both through theoretical questions, conceptual questions and numerical or simple particular cases. Another part will assess the applicability of the formalism, by solving problems and critical capacity regarding the results. Proper argumentations and adequate justifications will be important in both cases. **Mark A (between 0 and 9).**

It is necessary that the mark of the written exam be larger or equal than 4 over 10 (3,6 over 9) in order to add the mark of the continuous evaluation to that of the exam.

2) Continuous evaluation:

1. assessment of exercises and problems presented by students, questions proposed and discussed in class, oral presentation of problems solved or any other method that involves an interaction with students. **Mark B1 (between 0 and 1).**
2. Control-exams during the theory lectures. **Mark B2 (between 0 and 1).**

The full mark of the continuous evaluation is **B = B1 + B2**. **Mark B (between 0 and 2).**

Final Mark: min (10, A+B)

Subject to compliance with the compensation criteria established for this purpose, note this course can be averaged with other others belonging to the same matter, so as to pass the course.

REFERENCES

Basic

- Classical Dynamics of Particles and Systems. Stephen T. Thornton, Jerry B. Marion Brooks Cole (2004)
  Classical Mechanics. Tom W. B. Kibble and Frank H. Berkshire. Imperial College Press (2005)
  Classical Mechanics. John R. Taylor, University Science Books (2005)

Additional

- "Classical Mechanics A modern perspective". V. Barger and M. Olsson. McGraw-Hill (1995)
  "Dinámica clásica". A. Rañada. Ed. Alianza (1990)
  "Fonaments de Física. Vol. 1,2". V. Martinez (Enciclopedia Catalana)
  "Física I: Mecánica", Alonso Finn. Adison Wesley, 1986
  Física. Feynman, vol. I, ed Pearson.
  "Mechanics. Berkeley Physics Course I". Kittel-Knight-Ruderman. Ed Reverté (1999)
  Mecánica Newtoniana, MIT Physics Course, A. P. French, Ed. Reverté.
  "Introduction to Electrodynamics" David J. Griffiths, Prentice Hall (1999)
  "Mathematical methods for physics and engineering" K. F. Riley et al., Cambridg. Univ. Press. (1998)

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

In case that health situation requires blended teaching, the teaching model approved by the Academic Degree Committee on July 23, 2020 will be adopted.
For lectures this model consist of 50% student attendance in the classroom, while the rest of students attend the class in streaming broadcast. Two groups will be set with alternate days attendance to the classroom in order to guarantee 50% of teaching hours attendance for all students.
The rest of the teaching activities (laboratories, computer rooms, tutorials) will have a 100% attendance.
If a total reduction in attendance is necessary, classes will be broadcast by synchronous videoconference at their regular schedule, along the period determined by the Health Authority.