Course guide
200021 - FIS - Physics

Last modified: 23/06/2024

Unit in charge: School of Mathematics and Statistics
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 7.5 **Languages:** Catalan

LECTURER

Coordinating lecturer: JUAN JOSE SANCHEZ UMBRIA

Others: Segon quadrimestre:
ALVARO MESEGUER SERRANO - M-A
JUAN JOSE SANCHEZ UMBRIA - M-A

PRIOR SKILLS

Calculus in one and several variables: derivation and integration. Linear Algebra.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.

Generical:
5. CB-2. Know how to apply their mathematical knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader or multidisciplinary contexts related to Mathematics.
6. CB-3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements.
7. CG-1. Show knowledge and proficiency in the use of mathematical language.
10. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
11. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

TEACHING METHODOLOGY

The teaching activity is divided into three hours of theory (description and development of the topics presented in the syllabus) and two hours devoted to solving execices as direct aplications of the theory. This division is approximated and flexible. Students will have access to summaries or slides of each topic and a collection of related exercices that will be available in the web. During the problems sessions representative selected exercises will be solved.

LEARNING OBJECTIVES OF THE SUBJECT

Knowledge of the kinematics and dynamics of particles and rigid bodies.
Knowledge of the kinematic and dynamics in accelerated systems.
Understanding the concepts of field, work and energy.
Understanding and knowing how to apply the conservation laws.
Knowledge on the electric and gravitational fields.
Knowledge of the conduction laws and electrical circuits.
Knowledge of the magnetic fields.
Knowledge of Maxwell's equations in the vacuum.

STUDY LOAD

Type	Hours	Percentage
Self study	112,5	60.00
Hours small group	30,0	16.00
Hours large group	45,0	24.00

Total learning time: 187.5 h

CONTENTS

1. Kinematics of the particle. Changes of reference system.

Description:
Position, velocity and acceleration vectors. Intrinsic componentes of the acceleration. Curvature, torsion and Frenet trihedral. Changes of reference frame. Coriolis theorem. Angular velocity and acceleration.

Full-or-part-time: 22h 30m
Theory classes: 6h
Practical classes: 3h
Self study : 13h 30m

2. Dynamics of particles and systems of particles.

Description:
Inertial and non-inertial systems. Newton's laws. Movement of the center of mass of a system of particles. Description of some types of forces. Friction forces. Movement in non-inertial frames. Inertial forces and geophysical and astrophysical effects. Integration of the equations of motion. Reduction to quadratures. Dimensions and units. Dimensional analysis.

Full-or-part-time: 22h 30m
Theory classes: 5h
Practical classes: 4h
Self study : 13h 30m

3. Momentum. Angular momentum and energy.

Description:
Momentum and angular momentum for a system of particles. Decomposition of the angular momentum. Moment of a system of forces; properties. Linear and angular impulse theorems. Conservation theorems. Force fields and circulation. Power, work and kinetic energy. Conservative forces and potential energy. Gravitational and electrostatic cases. Mechanical energy and conservation theorem. Problems with a degree of freedom. Central fields and Kepler laws.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 4h
Self study : 15h

4. Kinematics and dynamics of a rigid body.

Description:
Kinematics of a rígid body. Angular velocity and acceleration. Geometrical description of the movement. Instantaneous axis of rotation and sliding. The two-dimensional case. Instantaneous center of rotation. Angular momentum and energy. Tensor of inertia; properties and symmetries. Principal axes of inertia. Euler's equations for the movement of a rigid body. Some particular cases. The dynamics in the two-dimensional case.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 4h
Self study : 15h

5. Electrostatics.

Description:
Electric charge. Coulomb's law. Charge distributions. Superposition principle. Electrostatic field and potential. Electrostatic dipole. Gauss law (application to the calculation of gravitatorial and electrostatic fields). Conductors in electrostatic equilibrium. Poisson and Laplace equations. Method of images. Electric energy.

Full-or-part-time: 22h 30m
Theory classes: 5h
Practical classes: 4h
Self study : 13h 30m

6. Electrical conduction.

Description:
Description of the electrical current. Continuity equation. 0hm's law. Electrical resistance. Dissipated power. Electrical circuits. Generators. Kirchhoff's laws.

Full-or-part-time: 20h
Theory classes: 5h
Practical classes: 3h
Self study : 12h

7. Magnetostatics.

Description:
Lorentz force. Sources of magnetic field. Biot-Savart law. Potential vector. Ampère's law. Poisson equation for the potential vector. Aplication to the calculation of magnetic fields.

Full-or-part-time: 25h
Theory classes: 6h
Laboratory classes: 4h
Self study : 15h

8. Maxwell's equations.

Description:
Faraday-Lenz law. Mutual induction, self-induction and inductances. Energia magnètica. Ampère-Maxwell law and displacement current. Poynting theorem. Maxwell's equations in the vacuum. Electromagnetic potentials. The electromagnetic field in the vacuum. The waves equation. Electromagnetic waves.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 4h
Self study : 15h

GRADING SYSTEM

The subject is divided into two parts, Mechanics and Electromagnetism. There will be two partial exams, one on each part, and regular final exam. The grade of the subject shall be one of the following:
(a) The average of the two partial exams.
(b) The final exam score, which will be mandatory for students whose mark (a) is less than 5, and optional for those whose mark (a) is equal or greater than 5 (in this case the mark of (a) is waived).
There will be an extraordinary exam in July for students who have failed the subject in the regular call.

BIBLIOGRAPHY

Basic:
- Taylor, John. Classical mechanics [on line]. Sausalito: University Science Books, cop. 2005 [Consultation: 23/06/2022]. Available on : https://web-s-ebscohost-com.recursos.biblioteca.upc.edu/ehost/ebookviewer/ebook?sid=50467605-d9e7-4542-9aa6-406be93984e1%40redis&vid=0&format=EB. ISBN 189138922X.
- Alonso, Marcelo; Finn, Edward J. Física. México: Pearson & Addison-Wesley, cop. 2000. ISBN 9684444265.
- Reitz, John R.; Milford, Frederick J.; Christy, Robert W. Fundamentos de la teoría electromagnética. 4a ed. Wilmington: Addison-Wesley, 1996. ISBN 020162592X.
- Wangsness, Roald K. Campos electromagnéticos. Limusa, 1983. ISBN 9681813162.

Complementary:
- Knudsen, J.M., Hjorth, P.G. Elements of newtonian mechanics [on line]. Springer, cop. 1995 [Consultation: 27/06/2023]. Available on : https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3089857. ISBN 3540583645.
- Symon, Keith R. Mechanics. 3rd ed. Addison-Wesley, 1971. ISBN 0201073927.
- Agulló i Batlle, Joaquim. Mecánica de la partícula y del sólido rígido. OK punt, 2000. ISBN 8492085053.
- Cheng, David K. Fundamentos de electromagnetismo para ingeniería. Addison-Wesley, cop. 1997. ISBN 9780201653755.
- Jackson, Jackson D. Electrodinámica clásica. 2a ed. Madrid: Alhambra, 1980. ISBN 8420506559.

RESOURCES

Other resources:
Slides on Mechanics (available through "Atenea").
Notes on Electromagnetism (available through "Atenea").
Suggested exercises (available through "Atenea").