Course guide
240013 - 240013 - Basic Mechanics

Last modified: 02/07/2024

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: **Academic year:** 2022 **ECTS Credits:** 6.0
Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Berart Diez, Sergio

Others: Salud Puig, Josep
Canales Gabriel, Manel
Sempau Roma, Josep
Zaragoza Serrano, Francisco Jose
Grossi, Claudia
Talavera Sanchez, Pedro
Levit Valenzuela, Rafael

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

TEACHING METHODOLOGY

Halfway through the course, and therefore within the learning process, the student will perform one evaluation tests. These tests will have a relative difficulty depending on the period in which they take place and will be used to evaluate and guide each student with respect to the success in acquiring the required competencies and capacities.

Towards the end of the academic period practical laboratory sessions will take place. Each laboratory session must be conveniently prepared by the student considering those concepts acquired during the course.
Finally, evaluation tests, of those competencies and capacities acquired during the course, will take place at the end of the learning period. These tests have a relative significance as it is detailed in the "Qualification system" section.

LEARNING OBJECTIVES OF THE SUBJECT

Acquiring the capacity to correctly interpret and apply fundamental laws of mechanics.
· Identifying a common methodology in the description of different mechanical phenomena, no matter if it is a single particle's movement or a solid object
· Efficient use of graphic language to solve and interpret problems.
· Acquiring ability to execute measures and later treating the obtained data.
· Solving problems on simple mechanical applications.
· Having the capacity to identify each magnitude that appears in different formulas.
· Having the capacity to express magnitudes in the International System units.
· Having the capacity to choose a problem's fastest and simpler resolution option.
· Having the capacity to correctly use vector notation when necessary.

STUDY LOAD

Type	Hours	Percentage
Hours large group	52,0	34.67
Self study	90,0	60.00
Hours small group	8,0	5.33

Total learning time: 150 h

CONTENTS

Topic 1: Physic and mathematic fundaments of mechanics

Description:
1) Space, time and reference systems.
2) Coordinate systems. Cartesian Euclidian coordinates. Distance.
3) Vector and scale magnitudes. Operations with vectors: Sum. Scalar product. Vector product. Vector derivation and integration.
4) Symmetry principle.
5) Experimental data measure and treatment.
6) First Newton's law. Inertial reference systems: translations, rotations and speed transformations. Galileo's and Einstein's relative principle.
7) Kinematics of the point: position, trajectory, speed and acceleration.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 21h 30m
Theory classes: 2h 24m
Practical classes: 0h 48m
Laboratory classes: 2h
Self study : 16h 18m

Topic 2: Dynamics of a single particle

Description:
1) Second Newton's law. Force and mass. Predictive mechanics. Superposition.
2) Force and momentum.
3) Force momentum and angular momentum.
4) Work, kinetic energy and potential energy.
5) Examples: F=0, F=ct, F=-kx, central forces, gyroscopic forces, friction forces.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 21h 42m
Theory classes: 4h 30m
Practical classes: 1h 36m
Self study : 15h 36m

Topic 3: Dynamics of N particles

Description:
1) Third Newton's law: forces between particles.
2) Centre de masses.
3) Momentum.
4) Angular momentum.
5) Work, kinetic energy and potential energy.
6) Collisions.
7) Gravitational and electromagnetic interaction.
8) constraints and reactions. Possible displacements and virtual displacements. Ideal reactions.
9) Dynamics general equation or d'Alembert's principle.
10) Conservative system with constraints. Energy conservation
11) Rigid solid.
12) Topics on kinematics of the solid.
13) Equations of motion of the rigid solid.
14) Couple.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 33h 54m
Theory classes: 6h 48m
Practical classes: 9h 36m
Self study : 17h 30m

Topic 4: Rigid solid statics

Description:
1) Solid's statics.
2) Weight and gravity centre.
3) Forces on solids due to gravitating solids. Archimedes' principle.
4) Supports and reaction forces. Free solid diagram.
5) Solid systems' statics.
6) Virtual work principle.
7) Balance and stability.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 24h 18m
Theory classes: 4h 24m
Practical classes: 8h 12m
Self study : 11h 42m

Topic 5: Rigid solid dynamics in the plane

Description:
1) Translation equation.
2) Rotation equation. Angular momentum. Inertia momentum.
3) Rotation and translation kinetic energy.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 23h 12m
Theory classes: 3h 12m
Practical classes: 5h
Laboratory classes: 2h
Self study : 13h

Topic 6: Small oscillations

Description:
1) Small oscillations near the equilibrium.
2) Simple harmonic motion.
3) Damped harmonic motion.
4) Forced harmonic motion.

Related competencies :
CE2. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.

Full-or-part-time: 25h 36m
Theory classes: 2h 54m
Practical classes: 4h 42m
Laboratory classes: 2h
Self study : 16h

ACTIVITIES

LABORATORY PRACTICES

Description:
Towards the end of the academic period, students will take 3 laboratory sessions.

Session 1: A practice related to Topic 1
(1) Data treatment.

Session 2 and 3: two practices related with topics 4 and 5
(2) Maxwell's wheel.
(3) Reversible pendulum.

Full-or-part-time: 10h
Laboratory classes: 6h
Self study: 4h

GRADING SYSTEM

NTOT = MAX(0,6 NEF + 0,25 NMQ+ 0,15 NLAB; 0,85 NEF + 0,15 NLAB)

NTOTR= 0,85 NEFR+ 0,15 NLAB

NTOT: Subject's final mark.
NEF: Final exam mark.
NMQ: Midterm's mark.
NLAB: Average mark of the laboratory reports.

EXAMINATION RULES.

Half-term test will consist primarily of a multiple choice test with closed questions (no justification needed) that could be supplemented with an exercise reasoned.

Final exam will consist of 2 parts. The first one will be a multiple choice test with closed questions (no justification needed) . In the second part, each student will have to solve a series of exercises reasoning each answer .
In every test/exam, students will be allowed to use an official formulary given by the professor at the beginning of the course. They will also be allowed to used a non-programable calculator.

BIBLIOGRAPHY

Basic:
- Jaen Herbera, Xavier ; Salud Puig, Josep ; Serra de Larrocha, Carina ; Calaf Zayas, Jaume ; Khoury, Maria. Mecànica fonamental : mecànica newtoniana per a l'enginyeria [on line]. Barcelona: Iniciativa Digital Politècnica. Oficina de Publicacions Acadèmiques Digitals de la UPC, 2019 [Consultation: 17/07/2020]. Available on: https://upcommons.upc.edu/handle/2117/166409. ISBN 9788498807721.

Complementary:
- Juana Sardón, José María de. Física general Volumen I. 2a ed. Madrid: Pearson Educación, 2007. ISBN 9788483019245.
- Serway, Raymond A. Física: para ciencias e ingenierías : Volumen I. 7a ed. México: Cengage Learning, 2009. ISBN 9789706868220.
- Ortega Girón, Manuel R. Lecciones de Física : Mecánica 1. 8a ed. Córdoba: Universidad de Córdoba. Departamento de Física Aplicada, 1995-. ISBN 8440442904.
- Ortega Girón, Manuel R. Lecciones de Física : Mecánica 2. 8a ed. Córdoba: Universidad de Córdoba. Departamento de Física Aplicada, 2006. ISBN 8440442904.

RESOURCES

Hyperlink:
- Classes virtuals de Mecànica fonamental (Xavier Jaén). https://sites.google.com/upc.edu/mecanicafonamental/index- Apunts de Mecànica fonamental (Manel Canales). https://upcommons.upc.edu/handle/2117/334815- Curso Interactivo de Física en Internet. Ángel Franco García. http://www.sc.ehu.es/sbweb/fisica- OpenStax. https://openstax.org/details/books/university-physics-volume-1