Course guide
240133 - 240133 - Mechanics

Last modified: 08/04/2026

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: BARJAU CONDOMINES, ANA

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge on machines and mechanisms theory principles.

Generical:
9. PROJECT MANAGEMENT: Being able to present, execute and direct Industrial Engineering projects, by means of applying scientific and technologic knowledge , attitudes and procedures, once conditions have been identified or valued.

Transversal:
2. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
3. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
4. 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.
5. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
6. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
7. ENTREPRENEURSHIP AND INNOVATION: Knowing about and understanding how businesses are run and the sciences that govern their activity. Having the ability to understand labor laws and how planning, industrial and marketing strategies, quality and profits relate to each other.
8. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

The objectives of the syllabus require a deep understanding of concepts. Such insight is a prerequisite to confidently tackle the great variety of engineering problems at hands. In order to achieve this understanding, all the lectures include the study and resolution of conceptual questions. Some of the lectures include also direct demonstrations with mechanical devices and computer simulations illustrating the concepts concerning the 3D motion of rigid bodies.
Problem-solving sessions are organized around open questions and problem statements that depart from routine rehash. The students are required to think about the behavior of mechanical systems, previously presented in a figure, and discover the most interesting aspects to be studied. Once the questions to be answered have been formulated, a road-map is proposed and followed. The validity of the final results is then assessed, and the relevant mechanical parameters in the system are identified.
The lab sessions confront the students with real mechanical systems. The students are required to apply fast analyses based on rigorous concepts to understand their behavior, and thus discover how misleading intuition can be.
The Digital Campus is used to provide the figures associated with the questions and exercises discussed in the classroom, collections of questions for self-evaluation generated automatically under the student request, aa well as the lab sessions description.

LEARNING OBJECTIVES OF THE SUBJECT

General goal
To deepen in the study of Mechanics so that problems encountered in the field of Industrial Engineering and, more particularly, in that of Mechanical Engineering, can be solved with rigor.

Specific goals
To describe with accuracy the general 3D motion of rigid bodies.
To practice the rigorous application of laws and theorems governing the dynamics of rigid bodies systems.
To analyze the results and assess their validity.

STUDY LOAD

Type	Hours	Percentage
Hours small group	5,0	3.33
Hours large group	55,0	36.67
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Space and time. Vector time derivation

Description:
Newtonian mechanics absolute time. Reference frames. Time derivative of vector through mobile vector bases. Angular velocity vector. Simple rotation. Rotations composition. Euler angles.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 17h
Theory classes: 6h
Laboratory classes: 1h
Self study : 10h

Point kinematics

Description:
Position, velocity and acceleration. Intrinsic components of velocity and acceleration. Composition of velocities and accelerations. Frame motion. Coriolis acceleration.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 15h
Theory classes: 6h
Self study : 9h

Rigid body kinematics

Description:
Velocity and acceleration of rigid body points. Instantaneous axis of rotation and translation. Plane motion: instantaneous center of rotation. Basic constraint conditions: contact and non sliding.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 21h
Theory classes: 8h
Self study : 13h

Kinematics of multibody systems

Description:
Generalized coordinates. Independent coordinates. Generalized velocities. Degrees of freedom. Geometrical and kinematical constraints. Holonomy.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 6h
Theory classes: 2h
Laboratory classes: 1h
Self study : 3h

Particle dynamics

Description:
Principles of dynamics for inertial reference frames. Usual inertial reference frames. Extension of dynamics to non inertial frames: inertia force associated with the frame motion and the Coriolis inertia force.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 21h
Theory classes: 8h
Self study : 13h

Interaction forces

Description:
Formulation of interaction forces: gravitation, springs, dampers, dry friction... Constraint forces: characterization. Constraint torsor characterization: immediate and analytical. Limit conditions for constraints.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 11h
Theory classes: 4h
Laboratory classes: 1h
Self study : 6h

Geometry of masses

Description:
Center of mass. Moment of inertia. Inertia tensor. Steiner theorem. Symmetrical rotor, spherical rotor.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

Vectorial theorems

Description:
Linear momentum theorem. Angular momentum theorem for a fixed point, a mobile point, and the center of mass. Rigid body case.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 37h
Theory classes: 14h
Laboratory classes: 1h
Self study : 22h

Energy theorem

Description:
Energy theorem. Kinetic energy. Work and power done by a force. Work of the system internal forces. Rigid body case. Conservative forces and potential energy. Dissipative forces. Mobile obstacles. Impossibility of continuous motions.

Related competencies :
CE13. Knowledge on machines and mechanisms theory principles.

Full-or-part-time: 16h
Theory classes: 6h
Self study : 10h

ACTIVITIES

PARTIAL EXAM

Specific objectives:
Assessment of acquired knowledge.

Material:
Standard summary of equations.

Full-or-part-time: 1h 15m
Theory classes: 1h 15m

FINAL EXAM

Specific objectives:
Assessment of acquired knowledge.

Material:
Standard summary of equations.

Full-or-part-time: 3h 30m
Theory classes: 3h 30m

REASSESSMENT

Specific objectives:
Assessment of acquired knowledge.

Material:
Standard summary of equations.

Full-or-part-time: 3h 30m
Theory classes: 3h 30m

PARTIAL ASSIGNMENTS

Specific objectives:
Assessment of the comprehension of the subject

Material:
All material related to the study of the course

Full-or-part-time: 2h
Theory classes: 1h 30m
Practical classes: 0h 30m

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GRADING SYSTEM

It is based on 3 elements of evaluation:
. Partial assignments (entire syllabus) NTP
· Partial exam (kinematics and particle dynamics) NEP
· Final exam (entire syllabus) NEF
The final mark of the student is:
Nfinal = max (0,3 NEP + 0,7 NEF; NEF; 0,15 NTP + 0,25 NEP + 0,6 NEF; 0,15 NTP + 0,85 NEF)

The reassessment exam will cover the entire syllabus (NER). In that case, the final mark will be:
Nfinal = max (0,3 NEP +0,7 NER; NER; 0,15 NTP + 0,25 T2 + 0,6 NER; 0,15 NTP + 0,85 NER)

EXAMINATION RULES.

Only the use of a standard equations summary is allowed.

BIBLIOGRAPHY

Basic:
- Agulló i Batlle, Joaquim. Mecànica de la partícula i del sòlid rígid. 3a ed. Barcelona: OK Punt, 2002. ISBN 8492085061.
- Agulló i Batlle, Joaquim. Mecànica : resolucions de qüestions i problemes : vol. 1. Barcelona: OK Punt, 2005. ISBN 8492085088.
- Agulló Batlle, Joaquim ; Barjau Condomines, Ana. Rigid body kinematics [on line]. Cambridge: Cambridge University Press, 2020 [Consultation: 21/03/2025]. Available on: https://www-cambridge-org.recursos.biblioteca.upc.edu/core/books/rigid-body-kinematics/39486736674235C90D0D4B4283EB286B. ISBN 9781108479073.
- Agulló Batlle, Joaquim ; Barjau Condomines, Ana. Rigid body dynamics [on line]. Cambridge: Cambridge University Press, 2022 [Consultation: 21/03/2025]. Available on: https://www-cambridge-org.recursos.biblioteca.upc.edu/core/books/rigid-body-dynamics/EE5207FB0B0F5A0E9C1F72A9FB7EA0E0. ISBN 9781108842136.

Complementary:
- Beer, Ferdinand Pierre. Mecánica vectorial para ingenieros [on line]. 11a ed. México: McGraw Hill, 2017 [Consultation: 07/05/2020]. Available on: http://www.ingebook.com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8077. ISBN 9781456255268.
- Riley, William F. Ingeniería mecánica. Barcelona: Reverté, 1996. ISBN 842914255X.
- Bedford, A. Mecánica para ingeniería. 5a ed. México: Pearson, 2008. ISBN 9789702612155.
- Baruh, Haim. Analytical dynamics. Boston: McGraw Hill, 1999. ISBN 0071160949.
- Meriam, J. L. Mecánica para ingenieros : Dinámica. 3a ed. Barcelona: Reverté, 1999. ISBN 8429142592.
- Goldstein, Herbert. Mecánica clásica. 2a ed. Barcelona: Reverté, 1992. ISBN 8429143068.

RESOURCES

Other resources:
What can be found in the Digital Campus:
- Work material for theory and practical lectures, and lab sessions guidelines.
- Self-evaluation questions.
- A significant sample of past exams, with the complete resolution of exercises and the answer to the multiple-choice tests.
- Information concerning the course organization, the compilation of formulae to be used in exams, the grade lists, the test solutions and problem resolutions of the exams corresponding to the running semester.