Course guide
2500202 - MECANICA - Mechanics

Last modified: 01/10/2023

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: LUCIA GRATIELA BARBU, MICHELE CHIUMENTI

Others: LUCIA GRATIELA BARBU, MICHELE CHIUMENTI, SERGIO JIMÉNEZ REYES

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14445. Recognize the biological bases and foundations of the plant and animal field in engineering: notions of genetics, biochemistry and metabolism, physiology, organisms and environment, population dynamics, flows of matter and energy and changes in ecosystems, biodiversity, principles of the kinetics of microbial growth and reactor theory.
14446. Solve mathematical problems that may arise in engineering by applying knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, optimization, ordinary differential equations.
14447. Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.
14448. Manage the basic concepts about the general laws of mechanics and thermodynamics, concept of field and heat transfer, and apply them to solve engineering problems.
14449. Apply the basic principles of general chemistry, organic and inorganic chemistry and their applications in engineering.
14450. Describe the global functioning of the planet: atmosphere, hydrosphere, lithosphere, biosphere, anthroposphere, biogeochemical cycles (C, N, P, S), soil morphology and apply it to problems related to geology, geotechnics, edaphology and climatology.

Generical:
14440. Identify, formulate and solve problems related to environmental engineering.
14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.

TEACHING METHODOLOGY

The teaching methodology is based on 3 points:
1. Preliminary study through videos and recommended readings, before the classroom class.
2. Development of basic concepts through specific directed activities in class, with the help and full support of the teaching staff.
3. Autonomous activities at home: resolution of small practices to internalize the concepts acquired. Deeper and more critical study for a broader development of the topic covered in class using the subject reference books. Preparation for the next class.
This pedagogical model requires the active participation of the student at all times, inside and outside the classrooms, encouraging questions, discussions and the application of concepts in practical activities. Personal learning is encouraged by making the most of the student-teacher relationship inside and outside the classroom.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

In this subject, the basic physical principles that occur in the natural physical environment are reviewed. Emphasis is placed on the concepts of Kinematics (reference systems, relative movement, absolute movement), Dynamics (particles, internal / external forces, center of mass, introduction to continuous media), Work and Energy, Thermodynamics and on Electric and Magnetic Fields).

1. Solve kinematics problems for both point and solid.
2. Apply the conservation equations of mass, momentum and energy to both the material and solid points.
3. Apply the concepts of mechanics (kinematics, statics and dynamics) to the calculation of elementary structures.
4. Deduce the applicability of the concepts of fields and waves in engineering, specifying the field of sound propagation.

Mechanics. Knowledge of classical, static, dynamic and kinematic mechanics and ability to apply to scientific-technological and engineering subjects environmental in general. Introduction to wave propagation, and in particular to acoustic problems.

The objective of the Mechanics course is to introduce Newton's laws for the analysis of motion in terms of Kinematics and Dynamics. The concepts will be applied to the particle, to a system of particles, as well as to the rigid solid. The concept of equilibrium and its application to the statics of elementary structures will be introduced.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Vectorial calculus

Description:
Fixed vector, sliding vector, free vector
Unit vector (versor)
Cartesian components
Modulus of a vector
Addition
Subtraction
Scalar product
Vector product
Problems solved in class

Full-or-part-time: 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m

Forces and moments

Description:
Definition and calculation of moments of a vector
Varignon theorem for vector systems
Problems solved in class

Full-or-part-time: 7h 11m
Theory classes: 1h
Practical classes: 1h
Laboratory classes: 1h
Self study : 4h 11m

Kinematics of a particle

Description:
Position, displacement, velocity, and acceleration
Position, displacement, velocity and acceleration
Rectangular components
Normal and tangential components
Circular motion
Polar components
Angular velocity
Problems solved in class
Relative movement using translation axes
Relative position
Relative speed
Relative acceleration
Inertial system
Problems solved in class

Full-or-part-time: 19h 12m
Theory classes: 5h
Practical classes: 2h
Laboratory classes: 1h
Self study : 11h 12m

Rigid Body Kinematics

Description:
Translational motion
Rotation about a fixed axis
General motion of rigid body
Relative speed
Center of instantaneous rotation
Relative acceleration
Relative motion using rotating axes: non-inertial systems
Problems solved in class

Full-or-part-time: 19h 12m
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 3h
Self study : 11h 12m

Centroids and centers of mass

Description:
Definition of area and mass
Definition of first-order static moments
Definition of centroid (geometric center) and center of mass (center of gravity)
Symmetry
Calculation method by integration
Calculation method for compound sections
Problems solved in class

Full-or-part-time: 9h 36m
Theory classes: 2h
Practical classes: 1h
Laboratory classes: 1h
Self study : 5h 36m

Moments of inertia

Description:
Area Moments of Inertia
Product of Inertia
Radius of Gyration
Parallel Axes Theorem
Calculation method by integration
Calculation method for compound sections
Definition
Theorem of parallel axes
Calculation methods
Problems solved in class

Full-or-part-time: 14h 23m
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 1h
Self study : 8h 23m

Basic principles of statics

Description:
Conditions for the equilibrium of a particle and a rigid body, Newton's laws, Restrictions on the supports and degree of constraint
Degree of indetermination, concepts of isostatic and hyperstatic
Free body diagram
Problems solved in class

Full-or-part-time: 12h
Theory classes: 3h
Practical classes: 1h
Laboratory classes: 1h
Self study : 7h

Introduction to structural analysis

Description:
Connections between structural elements
Idealized model of a structure
Equilibrium conditions
Free body diagram for each structural element
Equilibrium equations for the structure

Full-or-part-time: 7h 11m
Theory classes: 2h
Laboratory classes: 1h
Self study : 4h 11m

Dynamics of a particle

Description:
Newton's Laws
System of Particles
Problems solved in class

Full-or-part-time: 12h
Theory classes: 2h
Practical classes: 2h
Laboratory classes: 1h
Self study : 7h

Rigid Body Dynamics

Description:
Equations of rectilinear translational motion
Equations of curvilinear translational motion
Equations of rotational motion with respect to a fixed axis
General plane motion
Problems solved in class

Full-or-part-time: 14h 23m
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 1h
Self study : 8h 23m

Work and energy methods

Description:
Kinetic energy in a translational motion
Kinetic energy in a rotational motion about a fixed axis
Kinetic energy in a general plane motion
Gravitational potential energy
Elastic potential energy
Work of a variable force
Work of a constant force
Work of a weight force
Work of a spring force
Work of a couple
Forces that have 0 work
Principle of work and energy
Principle of conservation of energy
Problems solved in class

Full-or-part-time: 19h 12m
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 3h
Self study : 11h 12m

GRADING SYSTEM

To pass the course it is MANDATORY to carry out the different Continuous Assessment Practices that will be proposed throughout the course in classrooms and at home. These practices will give an average grade of practices PR_1.

There are also 2 exams planned in the semester:

EX_1. Kinematics
EX_2. Dynamic

The final mark of the course will be calculated according to the mark of practices and exams, with the following expression:

NOTA = 0.3 * EX_1 + 0.5 * EX_2 + 0.2 * PR_1

ALL the Evaluation Tests are MANDATORY and can be recovered only in case of justification (medical justification, etc.). In the case of not having one or more Assessment notes, the final grade will be a NP (not presented).

Criteria for qualification and admission to RE-EVALUATION: Students suspended in the ordinary evaluation who have regularly submitted to the evaluation tests of the suspended subject will have the option to take a re-evaluation test in the period set in the academic calendar . Students who have already passed it or students qualified as not presented may not take the re-evaluation test of a subject. The maximum grade in the case of taking the re-evaluation exam will be five (5.0). The non-attendance of a student summoned to the re-evaluation test, held in the established period, may not lead to another test with a later date. Extraordinary evaluations will be carried out for those students who, due to accredited force majeure, have not been able to take any of the continuous evaluation tests.

These tests must be authorized by the corresponding head of studies, at the request of the professor responsible for the subject, and will be carried out within the corresponding school period.

The final mark obtained as well as the marks of the continuous evaluations will not be saved for the academic year of the following year.

EXAMINATION RULES.

Continuous assessment tests are MANDATORY. If not all continuous assessment tests are performed in the scheduled period, the final grade will be NP (Not Presented).

BIBLIOGRAPHY

Basic:
- Hibbeler, R.C. Ingeniería mecánica: dinámica. 14a ed. Ciutat de Mèxic: Pearson, 2016. ISBN 9786073236973.
- Nelson, E.W.; Best, C.L.; McLean W.G. Mecánica vectorial: estática y dinámica. 5a ed. Madrid: Mc Graw Hill, 2004. ISBN 84-481-2950-4.

Complementary:
- Hibbeler, R.C. Mecánica vectorial para ingenieros: dinámica. 10a ed. México: Pearson Educación, 2004. ISBN 970-26-0500-8.