Course guide
820423 - ELAS - Elasticity

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Unit in charge: Barcelona East School of Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering.

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

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

LECTURER

Coordinating lecturer: DANIEL DI CAPUA

Others:

Primer quadrimestre:
GABRIEL CONESA BUSTO - Grup: M11, Grup: M12, Grup: M13, Grup: M14
IGNASI DE POUPLANA SARDÀ - Grup: T11, Grup: T12, Grup: T13
DANIEL DI CAPUA - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: T11, Grup: T12, Grup: T13
JUAN DANIEL GARCÍA RUEDA - Grup: T11, Grup: T12, Grup: T13
FRANCISCO GOITIA - Grup: T11, Grup: T12, Grup: T13

Segon quadrimestre:
GABRIEL CONESA BUSTO - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15, Grup: M16
IGNASI DE POUPLANA SARDÀ - Grup: T11, Grup: T12, Grup: T13
DANIEL DI CAPUA - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15, Grup: M16
JUAN DANIEL GARCÍA RUEDA - Grup: T11, Grup: T12, Grup: T13

REQUIREMENTS

SISTEMES MECÀNICS - Prerequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
5. Understand and apply the fundamentals of the elasticity and strength of materials to the behaviour of real solids.

Transversal:
3. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

TEACHING METHODOLOGY

The course consists of 3 hours per week of classroom sessions that will be held in two sessions of 1 and 2 hours respectively. In these sessions theoretical classes and problems will be combined. Additionally, laboratory practices will be held 2 hours every two weeks. Attendance at laboratory practices is compulsory.

LEARNING OBJECTIVES OF THE SUBJECT

The study of the mechanics of continuous media precedes and establishes the principles and fundamental laws used after the resistance of materials. Consequently, the course aims to establish the scientific techniques required for the study of the strength characteristics of materials and for an understanding of the mechanisms of durable and solid mechanical kinematic response bases. It is intended that students acquire a knowledge of the stress state and strains that are created in solids when subjected to a given solicitation. An important academic aspect is that the student, at the end of the course, must distinguish the domains of elastic and plastic response of materials under different loading conditions, and be able to apply the corresponding quantitative theories to each domain to describe the response of solid mechanics analyzed.
Since the elastic and linear response is critical in engineering practice, an important part of the subject moves in the field of linear elasticity, reasoning on a theoretical model of elastic solid: mechanical prism, which we assume has the properties homogeneity, continuity and isotropy.

General objectives of this subject in relation to students be considered:

1. Introduction to the basic concepts of continuum mechanics, with special emphasis on the mechanics of solids.
2. Acquisition of basic vocabulary while specific area of ??continuum mechanics.
3. Ability to read, interpret correctly and understand texts, figures and tables in technical literature related to the mechanics of solids.
4. Ability for effective and accurate oral or written expression, on matters within the scope of continuum mechanics.
5. Understanding the equations that describe and relate the states of stress and strain in the elastic and plastic domain domain response of solid mechanics.
6. To acquire knowledge and computing capacity in both domains: domain linear elastic and plastic range.
7. Ability to describe and use different rheological models.
8. Ability to associate the main criteria ruling resistant, prescribed in different technical codes, different types of materials and stress states.
9. Ability to handle basic finite element software.
10. Develop skills in experimental techniques and analysis of results.
11. To acquire knowledge of the basic literature and ability to perform literature searches related to the field of solid mechanics.
12. Knowledge of information sources, institutional and private, related to solid mechanics, strength of materials and structural analysis.
13. Ability for independent learning on matters within the field of solid mechanics, strength of materials and structures in Engineering.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Topic 1: Introduction to Elasticity and Strength of Materials

Description:
Introduction. Basics concepts of elasticity and strength of materials. Differences. Definition of continuous medium. Elements of tensor algebra.

Specific objectives:
Know and be able to describe the differences and similarities between the theory of elasticity and strength of materials. Know and be able to explain the concept of continuous medium and its potential in solving problems in solid mechanics. Know and be able to apply the notation and basic properties of tensor algebra.
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Full-or-part-time: 31h
Theory classes: 9h
Laboratory classes: 4h
Self study : 18h

Topic 2: Cinemàtica

Description:
Introduction. Equations of motion. Movement description. Local, convective and material derivative. Material and control surface. Material and control volume. Deformation gradient tensor. Displacements. Finite and infinitesimal strains.

Specific objectives:
Be able to explain the concepts and derive the equations of motion in solid mechanics. Know and be able to describe the concept of deformation. Knowing the different possibilities of measures deformations, their physical interpretations and properties.

Full-or-part-time: 26h
Theory classes: 8h
Laboratory classes: 2h
Self study : 16h

Topic 3: Stresses

Description:
Introduction. Actions in the continuous medium. Cauchy postulates. Stress tensor. Properties of Cauchy stress tensor. Mohr circle in two and three dimensions. Other stress measures.

Specific objectives:
Know and be able to describe the concept of stress. Knowing the different stress mesurements, their physical interpretations and properties. Recognize the interpretation advantages offered by the geometric description of the stress state through the Mohr Circle. Be able to express the stress state using the plane representation of Mohr Circle. Being able to calculate representative values of the stress state from its graphical representation.

Full-or-part-time: 23h
Theory classes: 7h
Laboratory classes: 2h
Self study : 14h

Topic 4: Conservation and balance equations

Description:
Introduction. Postulate of conservation and balance. Conservation of mass. Balance equation of momentum. Balance equation of the moment of momentum. Theorem living forces and tensional potential. Energy conservation. First and second law of thermodynamics applied to solids.

Specific objectives:
Learn the foundational principles of solid mechanics.

Full-or-part-time: 23h
Theory classes: 7h
Laboratory classes: 2h
Self study : 14h

Topic 5: Constitutive equations

Description:
Introduction. Linear elasticity theory hypothesis . Linear elastic and isotropic materials. The elastic problem approach. Uniqueness of the solution. Saint-Venant's Principle. Superposition principle. Linear thermoelasticity. Thermal stresses and deformations. Plane stress and plane strain states. Elastic problem in bidimensional elasticity. Introduction to plasticity. Space of principal stresses. Friction rheological models. Phenomenology of plasticity. Plasticity in one dimension. Plasticity in two or three dimensions. Elastoplastic constitutive equation. Yield surface. Failure criteria.

Specific objectives:
Ability to deduce the fundamental relationship between the state of tension and the state of deformation in the linear elasticity theory. Analyze and know how to apply several simplifications of thelinear elasticity theory: isotropic materials, plane stress and plane strain states. Being able to set the elastic problem. Demonstrate the need of a plasticitytheory . Ability to derive the fundamental equations that relate the state of stress and strain state in the theory of plasticity. Know different rheological models. Ability to associate the main failure criteria, prescribed in different technical codes, to different materials types and stress states.

Full-or-part-time: 20h
Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

Topic 6: Energy and variational principles

Description:
Introduction. Internal strain energy potential. Virtual work principle. Minimization of potential energy. Introduction to finite element method.

Specific objectives:
Knowing the different expressions of the internal potential. Ability to set the differential equations of government of the mechanical problem in a comprehensive way, so that these equations are presented in a useful format for their numerical resolution by the finite element method.

Full-or-part-time: 27h
Theory classes: 8h
Laboratory classes: 3h
Self study : 16h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

Mid-term exam 1: 17%
Mid-term exam 2: 17%
Laboratory Practices: 17%
Final Exam: 49%

The subject has not re-evaluation test.

EXAMINATION RULES.

If any of the ongoing evaluation activities are not performed in the scheduled period a zero mark will be assigned to that activity.
In case of failure to attend an assessment test due to a justifiable reason, the student must notify the professor in charge of the course BEFORETHE TEST and hand in an official certificate excusing his absence. In this case, the student will be allowed to take the test another day, ALWAYS BEFORE THE FOLLOWING ASSESSMENT.

BIBLIOGRAPHY

Basic:
- Oliver, J.; Agelet de Saracibar, C. Mecánica de medios continuos para ingenieros [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 04/05/2020]. Available on: http://hdl.handle.net/2099.3/36197. ISBN 848301582X.
- Chaves, Eduardo W. V.. Mecánica del medio continuo : conceptos básicos. 3a ed. Barcelona: CIMNE, 2012. ISBN 9788494024382.
- Holzapfel, Gerhard A. Nonlinear solid mechanics : a continuum approach for engineering. Chichester: John Wiley & Sons, cop. 2000. ISBN 0471823198.
- Chaves, Eduardo W.V.. Mecánica del medio continuo : problemas resueltos. Barcelona: CIMNE, 2014. ISBN 9788494330759.

Complementary:
- Mase, George E. Mecánica del medio continuo. México [etc.]: McGraw-Hill, cop. 1977. ISBN 9684512759.
- Ortiz Berrocal, Luis. Elasticidad [on line]. 3ª ed. Madrid [etc.]: McGraw-Hill, cop. 1998 [Consultation: 29/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=3965. ISBN 9788448182298.

RESOURCES

Hyperlink:
- http://www.gidhome.com/. Resource