Mechanics of Continua (250401)

General Information

School	ETSECCPB
Departments	Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE) Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	9.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012) PARS: ENGINYER/A DE CAMINS, CANALS I PORTS (pla 2022)
Course	2024/25

Main teaching language at each group

- Group 10EN1 English (Q1)
- Group 10EN2 English (Q2)

Faculty

Responsible Faculty: Oriol Lloberas Valls
Faculty: Ramon Codina Rovira, Oriol Lloberas Valls, Rubén Zorrilla Martínez

Objectives of Education

Students will acquire advanced knowledge of the laws of thermodynamics for continuous media and learn how they apply to engineering disciplines such as fluid mechanics, mechanics of materials and structural theory.

Upon completion of the course, students will be able to:

Describe motion, deformation and stress;
Apply conservation equations to structural problems in hydraulics and geotechnics;
Model the behaviour of solid and fluid materials and interpret the results.

History of the mechanics of continuous media in the context of civil engineering; Describing motion: Lagrange-Euler formulation; Deformations of a continuous medium and compatibility equations; Motion and deformations in cylindrical and spherical coordinates; Cauchy stress, postulates and equations; Mohr's circle stress analysis; Equations of conservation of mass, momentum and energy; Thermodynamics of continuous media; Fundamentals of constitutive equations; Theory of elasticity, plasticity, fracture criteria and viscoplasticity; Principle of virtual work; Fluid constitutive behaviour; Fluid mechanics; Equations of motion; Turbulence.

Competencies

Especific

Comprehension and mastery of the laws governing the thermomechanics of continuous media for their application in fields of engineering such as fluid mechanics, the mechanics of materials, structural theory, etc.

Transversal

EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	41.94 h	51.78 %
	Medium group	19.53 h	24.11 %
	Laboratory classes	19.53 h	24.11 %
	Guided Activities	0.0 h	0.00 %
Self Study		144.0 h	

Contents

Introduction

Introduction to the course and review of tensor algebra.

Review Tensorial Algebra

Reinforcement of basic concepts of Tensor Algebra: Concept of tensor, operations with tensors, index notation, differential operators.

Specific Objectives

Reinforce and review the basic concepts of Tensor Algebra: Concept of tensor, operations with tensors, index notation, differential operators.

Description of Motion

Theory
Problems

Deformation and Strain

Theory
Problems

Compatibility Equations

Theory and problems

Stress

Theory
Problems

Conservation and Balance Equations

Theory
Problems

Linear Elasticity

Theory
Problems

Plane Linear Elasticity

Theory

Plasticity

Theory
Problems

Constitutive Equations in Fluids

Theory

Fluid Mechanics

Theory
Problems

Variational Principles

Theory and problems

Teaching Methodology

The course uses the "flipped classroom" methodology where the student, by means of specific group-dynamics techniques, extends and consolidates the knowledge acquired during the out-of-class preparation, in advance, of basic elements corresponding the following classes. The out-of-class preparation is carried out by the student, supported by videos, transparencies, books and bibliographic material, provided on the website of the course, and according to the directions of the teacher. Then, the in-class group dynamics consists of providing the group of students the required additional knowledge, according to the possible weaknesses identified by the teacher, perform practical exercises, answer questions, deepen the students knowledge on the subject and promote teamwork.

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.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The evaluation of the course will be made from two grades:
a) A grade based on the performance of midterms, multiple-question type. Four partial tests, on contents grouped by topics of the course, will be made. These tests will be about one hour long, and will be done along the course during lecture hours. The final mark of the assessment will result into a "Mid-terms evaluation mark" (NAP) to be obtained as a the arithmetic average of partial evaluations, on 10 points.
b) A grade based on individual perception, by the lecturer, about the "global" knowledge of the subject by each student, the involvement in the learning dynamics proposed in classes and the group-work skills acquired over the course. This assessment will be done on the basis of the continuous in-class lecturer-students interaction throughout the course and the final perception of the lecturer. The grading will result in a "teachers perception mark" (NP) on 10 points.
The final mark (NF) will be weighted between the two marks as
NF=max(NAP; 0.8*NAP+0.2*NP) rounded to the lower multiple of 0.1.
To pass the course, the student will need to obtain a mark (NF) equal to or greater than 5.

Test 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 BEFORE OR IMMEDIATELY AFTER THE 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.

Office Hours

Office hours to be arranged with the lecturers of the course.

Bibliography

Basic

- Oliver Olivella, X.; Agelet de Saracíbar, C. Mecánica de medios continuos para ingenieros. 2a ed. Barcelona: Edicions UPC, 2002. ISBN 848301582X.
- Oliver Olivella, X.; Agelet de Saracíbar, C. Mecànica de medis continus per a enginyers. Barcelona: Edicions UPC, 2003. ISBN 8483017199.
- Oliver, X.; Agelet de Saracíbar, C. Problemas de mecánica de medios continuos. Barcelona: CPET, 2004.

Complementary

- Chaves, E.W.V. Notes on continuum mechanics. Barcelona: Springer : CIMNE, 2013. ISBN 9789400759855.
- Chaves, E.W.V. Mecánica del medio continuo: conceptos básicos. 3a ed. Barcelona: Centro Internacional de Métodos Numéricos en Ingeniería (CIMNE), 2012. ISBN 9788494024382.
- Chaves, E.W.V. Mecánica del medio continuo: modelos constitutivos. 2a ed. Barcelona: Centro Internacional de Métodos Numéricos en Ingeniería (CIMNE), 2014. ISBN 9788496736689.
- Fung, Y.K. Foundations of solid mechanics. Englewood Cliffs, NJ: Prentice-Hall, 1965.
- Holzapfel, G.A. Nonlinear solid mechanics : a continuum approach for engineering. Chichester: Wiley & Sons, 2008. ISBN 0471823198.
- Malvern, L.E. Introduction to the mechanics of a continous medium. Englewood Cliffs, NJ: Prentice-Hall, 1969. ISBN 0134876032.
- Spencer, A.J.M. Continuum mechanics. Mineola: Dover Publications, 2004. ISBN 0486435946.