Course guides
250401 - MECMEDCON - Mechanics of Continua

Last modified: 06/10/2020

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

Degree: MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Compulsory subject).

Academic year: 2020 **ECTS Credits:** 9.0 **Languages:** Catalan, English, Spanish

LECTURER

Coordinating lecturer: FRANCISCO JAVIER OLIVER OLIVELLA

Others: ORIOL LLOBERAS VALLS, FRANCISCO JAVIER OLIVER OLIVELLA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
8226. 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:
8562. 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.

8563. 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.

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.

LEARNING OBJECTIVES OF THE SUBJECT

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.

STUDY LOAD

Type	Hours	Percentage
Practical classes	19,5	8.67
Guided activities	3,0	1.33
Theory classes	39,0	17.33
Self study	144,0	64.00
Laboratory classes	19,5	8.67

Total learning time: 225 h

CONTENTS

Introduction

Description:
Introduction to the course and review of tensor algebra.

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Description of Motion

Description:
Theory
Problems

Full-or-part-time: 14h 23m
Theory classes: 3h 30m
Practical classes: 2h 30m
Self study : 8h 23m

Deformation and Strain

Description:
Theory
Problems

Full-or-part-time: 24h
Theory classes: 7h 30m
Practical classes: 2h 30m
Self study : 14h

Compatibility Equations

Description:
Theory and problems

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

Stress

Description:
Theory
Problems

Full-or-part-time: 21h 36m
Theory classes: 7h 30m
Practical classes: 1h 30m
Self study : 12h 36m

Conservation and Balance Equations

Description:
Theory
Problems

Full-or-part-time: 31h 12m
Theory classes: 9h
Practical classes: 3h
Laboratory classes: 1h
Self study : 18h 12m

Linear Elasticity

Description:
Theory
Problems

Full-or-part-time: 27h 36m
Theory classes: 7h 30m
Practical classes: 4h
Self study : 16h 06m

Plane Linear Elasticity

Description:
Theory

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Plasticity

Description:
Theory
Problems

Full-or-part-time: 22h 48m
Theory classes: 5h
Practical classes: 3h 30m
Laboratory classes: 1h
Self study : 13h 18m

Constitutive Equations in Fluids

Description:
Theory

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Fluid Mechanics

Description:
Theory
Problems

Full-or-part-time: 19h 12m
Theory classes: 5h
Practical classes: 3h
Self study : 11h 12m

Variational Principles

Description:
Theory and problems

Full-or-part-time: 4h 48m
Theory classes: 1h
Laboratory classes: 1h
Self study : 2h 48m

GRADING SYSTEM

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 combination of the arithmetic average (with a weight of 0.9) and the geometric average (with a weight of 0, 1) 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.

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 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.

BIBLIOGRAPHY

Basic:
- Oliver Olivella, X.; Agelet de Saracíbar, C. Mecánica de medios continuos para ingenieros [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 29/04/2020]. Available on: http://hdl.handle.net/2099.3/36197. ISBN 848301582X.
- Oliver Olivella, X.; Agelet de Saracíbar, C. Mecànica de medis continus per a enginyers [on line]. Barcelona: Edicions UPC, 2003 [Consultation: 29/04/2020]. Available on: http://hdl.handle.net/2117/97013. 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 [on line]. Barcelona: Springer : CIMNE, 2013 [Consultation: 05/02/2020]. Available on: http://dx.doi.org/10.1007/978-94-007-5986-2. 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.