Course guide
250121 - MECMEDCON - Continuum Mechanics

Last modified: 27/10/2022

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

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

Academic year: 2022 **ECTS Credits:** 9.0 **Languages:** Spanish, English

LECTURER

Coordinating lecturer: CARLOS AGELET DE SARACIBAR BOSCH

Others: CARLOS AGELET DE SARACIBAR BOSCH

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
3026. Ability to analyse and understand how the characteristics of structures influence their behaviour. Ability to apply knowledge of the resistance dynamics of structures in order to dimension them in accordance with existing regulations using analytical and numerical calculation methods.
3028. Understanding and mastery of the laws of thermodynamics of continuous media and the ability to apply them in the fields of engineering such as fluid mechanics, material mechanics, structures theory, etc.

Transversal:
592. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
596. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
599. 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.
602. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
584. 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 course consists of 6 hours a week of on-campus classes taught in two-hour lectures. These lectures will combine theory and problems. Additionally, students will be given assignments they must perform on their own to consolidate the general and specific learning objectives.

The teaching methodology of the subject may also include a "flipped classroom" methodology. In this case, the individual preparation of the content assigned by the teacher for the class is carried out by the student personally, and prior to the class, with the support of videos, transparencies, the subject book and bibliographic material. provided on the subject's website, following the teacher's instructions. The dynamics of the face-to-face class then consists of making a summary exposition of the main theoretical contents and concepts, carrying out practical exercises, clarifying doubts, and consolidating knowledge.

Although most of the sessions will be given in the language indicated, sessions supported by other invited experts may be held in other languages. The language may change due to force majeure.

LEARNING OBJECTIVES OF THE SUBJECT

Students will acquire an understanding of the laws of thermomechanics of continuous media and learn to apply them in engineering-related areas, such as fluid mechanics, mechanics of materials, structural theory, etc.

Upon completion of the course, students will have acquired the ability to: 1. Describe movement, deformations and stresses. 2. Apply conservation equations to structural, hydraulic and geotechnical problems. 3. Develop and understand behavioural models of both solid and fluid materials.

History of the mechanics of continuous media in the context of civil engineering; Description of motion, including Lagrangian and Eulerian formulations; Deformation of a continuous medium and compatibility equations; Motion and deformation in cylindrical and spherical coordinate systems; Cauchy's stress principle, postulates and equations; Analysis of stress states using Mohr's circle; Equations of conservation of mass, momentum and energy; Thermodynamics of continuous media; Fundamental concepts of constitutive equations; Theory of elasticity, plasticity, failure criteria and viscoplasticity; Principle of virtual work; Constitutive behaviour of fluids; Fluid mechanics; Equations of motion; Turbulence

Provide the student with a comprehensive and unified vision of deformable Solid Mechanics and Fluid Mechanics in engineering. Provide specific expertise which may be used in other disciplines (Structural Analysis, Soil Mechanics, Hydraulics, Hydrodynamics, etc.).

STUDY LOAD

Type	Hours	Percentage
Guided activities	9,0	4.00
Hours medium group	30,0	13.33
Hours large group	45,0	20.00
Self study	126,0	56.00
Hours small group	15,0	6.67

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: 15h 36m
Theory classes: 4h
Practical classes: 2h 30m
Self study : 9h 06m

Deformation and Strain

Description:
Theory
Problems

Full-or-part-time: 25h 12m
Theory classes: 8h
Practical classes: 2h 30m
Self study : 14h 42m

Compatibility Equations

Description:
Theory
Problems

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

Stress

Description:
Theory
Problems

Full-or-part-time: 24h
Theory classes: 8h
Practical classes: 2h
Self study : 14h

Conservation and Balance Equations

Description:
Theory
Problems

Full-or-part-time: 36h
Theory classes: 9h
Practical classes: 4h
Laboratory classes: 2h
Self study : 21h

Linear Elasticity

Description:
Theory
Problems

Full-or-part-time: 30h
Theory classes: 8h
Practical classes: 4h 30m
Self study : 17h 30m

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: 27h 36m
Theory classes: 5h 30m
Practical classes: 4h
Laboratory classes: 2h
Self study : 16h 06m

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: 21h 36m
Theory classes: 6h
Practical classes: 3h
Self study : 12h 36m

Variational Principles

Description:
Theory

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

GRADING SYSTEM

The evaluation of the course will be made from two grades:
a) A grade based on the performance of test, multiple-question type. Four 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. 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 "teacher's 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

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

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. 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 Olivella, X.; Agelet de Saracíbar, C. Mecánica de medios continuos para ingenieros [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 10/05/2021]. Available on: http://hdl.handle.net/2099.3/36197. ISBN 848301582X.
- 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: CIMNE, 2012. ISBN 9788494024382.
- Chaves, E.W.V.. Mecánica del medio continuo : modelos constitutivos. Barcelona: 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 continuous medium. Englewood Cliffs, NJ: Prentice-Hall, 1969. ISBN 0134876032.
- Spencer, A.J.M. Continuum mechanics. Mineola: Dover Publications, 2004. ISBN 0486435946.