Course guide
250439 - MODNUMECE - Numerical Models in Civil and Structural Engineering

Last modified: 17/06/2024

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). (Optional subject).
MASTER'S DEGREE IN NUMERICAL METHODS IN ENGINEERING (Syllabus 2012). (Optional subject).
MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: MICHELE CHIUMENTI

Others: LUIS MIGUEL CERVERA RUIZ, MICHELE CHIUMENTI, NARGES DIALAMI SHABANKAREH, JOSE FRANCISCO ZARATE ARAIZA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
8228. Knowledge of and competence in the application of advanced structural design and calculations for structural analysis, based on knowledge and understanding of forces and their application to civil engineering structures. The ability to assess structural integrity.

Transversal:
8559. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
8560. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

8561. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

TEACHING METHODOLOGY

The subject consists of 3 hours a week of face-to-face classes in a classroom: 2 hours are of theoretical classes and 1 hour to practice the concepts learned in class in order to consolidate the general and specific learning objectives.

Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: content, programming of evaluation and directed learning activities and bibliography.

LEARNING OBJECTIVES OF THE SUBJECT

Specialty subject in which knowledge in specific skills is intensified. Knowledge at a specialization level that must allow the development and application of advanced level techniques and methodologies. Master's level specialization content related to search or innovation in the field of engineering.

This subject aims to give a vision of the possibilities offered by numerical simulation in civil and structural engineering.
The student will have the possibility of touching different aspects related to structural calculation and in particular touching nonlinear analysis (plasticity and damage) and transient analysis (thermal and thermo-mechanical).
All the necessary knowledge will be reviewed and the appropriate calculation instruments (software, interfaces, etc.) will be provided.
To carry out the different tasks, the student will have maximum freedom to solve the proposed problems looking for the best solution in each case.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	9,8	7.83
Hours small group	9,8	7.83
Self study	80,0	63.95
Hours large group	25,5	20.38

Total learning time: 125.1 h

CONTENTS

Introduction

Description:
Introduction: The aim of the course, format of lessons, tasks

Full-or-part-time: 2h 24m
Theory classes: 1h
Self study : 1h 24m

Brief review of Continuum Mechanics

Description:
Review of concepts and definitions in Continuum Mechanics
Review of the theory of elasticity and elastic problem definition

Full-or-part-time: 12h
Theory classes: 5h
Self study : 7h

Geometric modeling and meshing

Description:
Downloading and installing GiD for pre-processing (CAD data) and post processing (results).
Guided tutorial for geometric modeling (GID).
Guided tutorial for finite element meshing

Full-or-part-time: 9h 36m
Practical classes: 4h
Self study : 5h 36m

Structural Analysis

Description:
Tutorial guide on using the software interface for structural analysis with FEM (COMET).
Tutorial on Post-Processing (GID).
Description of the different failure criteria for ductile and brittle materials.

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

Transient Analysis

Description:
Thermal and thermo-mechanical problems.
Case studies: the numerical simulation of casting and welding processes.
Tutorial guide to the software interface for thermo-mechanical FEM analysis (COMET).
Guided exercises to solve thermal and thermo-mechanical problems.

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

Nonlinear analysis

Description:
Computational methods for nonlinear analysis.
Numerical techniques for nonlinear analysis: Newton-Raphson, Picard, arc length, prediction techniques, etc ...
Elasto-plasticity and elasto-damage constitutive equations for the most common materials in civil engineering (steel, concrete, soil). Yield strength, hardening and softening variables inelastic deformations and damage.
Tutorial on solving nonlinear problems.

Full-or-part-time: 31h 12m
Theory classes: 7h
Practical classes: 3h
Laboratory classes: 3h
Self study : 18h 12m

GRADING SYSTEM

The evaluation consists of a final exam (25% of the final grade) and 5 assignments (15% of the final grade each) that correspond to the main topics covered in the course. These works are developed in class and finished at home with the delivery of a final report. It is possible to perform the work individually or with another student of the course. The final mark is calculated as the sum of the grade of the exam and the evaluation of the notes relative to all the works. It is mandatory to carry out all the proposed works. Otherwise, the final grade will be Not Presented (NP).

EXAMINATION RULES.

The assignments proposed during the course as part of the evaluation are mandatory.
If one or more assignments are not presented the final mark will be: Not Presented (NP).

BIBLIOGRAPHY

Basic:
- Fung, Y.C. A first course in continuum mechanics: for physical and biological engineers and scientists. 3rd ed. Englewood Cliffs: Prentice Hall, 1994. ISBN 0130615242.
- Malvern, L.E. Introduction to the mechanics of a continuous medium. Englewood Cliffs, NJ: Prentice-Hall, 1969. ISBN 0134876032.
- Mase, G.T.; Smelser, R.E.; Mase, G.E. Continuum mechanics for engineers. 4th ed. Boca Raton, FL: CRC Press, 2020. ISBN 9781482238686.
- Fung Y.C.; Tong, P.; Chen, X. Classical and computational solid mechanics. 2nd ed. Singapore: World Scientific Publishing Co. Pte. Ltd, 2017. ISBN 9789814713641.
- Bathe, K.-J. Finite element procedures. [S. l.]: l'autor, 2006. ISBN 9780979004902.
- Zienkiewicz, O.C.; Taylor, R.L.; Zhu, J.Z. The Finite element method: its basis & fundamentals. 7th ed. Amsterdam: Elsevier Butterworth-Heinemann, 2013. ISBN 9781856176330.
- Zienkiewicz, O.C.; Taylor, R.L.; Fox, D.D. The Finite element method: for solid & structural mechanics. 7th ed. Amsterdam: Elsevier Butterworth-Heinemann, 2014. ISBN 9781856176347.
- Borst, R. de; Crisfield, M.A. Nonlinear finite element analysis of solids and structures [on line]. 2nd ed. Hoboken: Wiley, 2012 [Consultation: 05/02/2020]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118375938. ISBN 9781118375938.

Complementary:
- West, H.H. Fundamentals of structural analysis. 2nd ed. New York: Wiley, 2002. ISBN 0471355569.
- Ghali, A.; Neville, A.M. Structural analysis: a unified classical and matrix approach. 7th ed. Boca Raton: CRC Press, Taylor and Francis Group, 2017. ISBN 9781498725064.
- Utku, S.; Norris, C.H.; Wilbur, J.B. Elementary structural analysis. 4th ed. New York: McGraw-Hill, 1991. ISBN 0071008365.