Numerical Models in Civil and Structural Engineering (250439)

General information

School:	ETSECCPB
Departments:	751 - Departament d'Enginyeria Civil i Ambiental
Credits:	5.0 ECTS
Programs:	1161 - MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012), 872 - MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012), 1140 - MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)
Course:	2015/2016
Course language:	Castellano

Faculty

Responsible faculty: Michele Chiumenti

Teachers: Luis Miguel Cervera Ruiz, Michele Chiumenti, Jose Francisco Zarate Araiza

Generic objectives

Specialization subject in which knowledge on specific competences is intensified.

Knowledge and skills at specialization level that permit the development and application of techniques and methodologies at advanced level.

Contents of specialization at master level related to research or innovation in the field of engineering.

This course aims to give an overview about the possibilities offered by the numerical simulation in civil engineering.

The student will be able to study different topics including the structural analysis and particularly the shape optimization, the transient analysis (thermal and thermo-mechanical problems) and finally the nonlinear analysis.

The necessary knowledge will be reviewed and the appropriate tools (software, interface, etc..) will be made available.

To carry out the different tasks, the student will have maximum freedom solving the problems proposed and searching for the best solution in each case.

Skills

Specific skills

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.

Generic skills of subject

INNOVATION, EMPLOYABILITY, DEVELOPMENT AND RESEARCH: The ability to develop one's creative and innovative tendencies with the ultimate aim of serving the development and progress of society. The ability to work on a research topic. Employability in managerial posts in all types of companies and public authorities, coupled with initiative and decision-making abilities. The ability to develop one's creative and innovative tendencies with the ultimate aim of serving the development and progress of society. The ability to work on a research topic. Employability in managerial posts in all types of companies and public authorities, coupled with initiative and decision-making abilities.

SUSTAINABILITY AND THE ENVIRONMENT: The capacity for engineering development in the framework of globalisation, sustainability and environmental protection. The ability to analyse the entire life cycle of an engineering project.

KNOWLEDGE DEVELOPMENT: The ability to develop new analytical methods and processes at all levels: conception, design and development. The ability to propose and develop specifications, regulations and rules in engineering following safety and efficiency criteria and using sustainable resources.

ECTS credits: total hours of student work

		Dedication	
		Hours	**Percent**
Supervised Learning	**Theory**	18.00	40.0%
	Assignments	12.00	26.7%
	Laboratory	9.00	20.0%
	Supervised activities	6.00	13.3%
Self-Learning		80.00	

Contents

Introduction

Dedication

1.0h. Theory

Description

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

Brief review of Continuum Mechanics

Dedication

5.0h. Theory

Description

Review of concepts and definitions in Continuum Mechanics

Review of the theory of elasticity and elastic problem definition

Geometric modeling and meshing

Dedication

4.0h. Assignments

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

Structural Analysis

Dedication

2.0h. Theory + 3.0h. Assignments + 3.0h. Laboratory

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.

Transient Analysis

Dedication

3.0h. Theory + 2.0h. Assignments + 3.0h. Laboratory

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.

Nonlinear analysis

Dedication

7.0h. Theory + 3.0h. Assignments + 3.0h. Laboratory

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.

Activities

Geometric modeling and meshing

Dedication

3.0 h. Supervised activities

Description

Guided tutorial on geometric modeling and finite element meshing (GID).

PostProcessing (GiD).

Dedication

3.0 h. Supervised activities

Description

Guided tutorial on PostProcessing (GiD).

Grading rules (*)

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

Continuous assessment by different activities, individual or group based will be made during the course.

The assignments consist of a set of application home-works according to the themes developed in the course.

The final mark will be computed as average of the assignments done along the course.

Test 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).

Teaching methodology

The course consists of 1,5 hours per week of classroom activity (large size group) and 0,8 hours weekly with half the students (medium size group).

The 1,5 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 0,8 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Office hours

Every day from 14:30 to 15:30 in the office 113 of module C1.

Basic bibliography

- Fung, Y.C.. **A First Course in Continuum Mechanics**. Prentice-Hall. 1977.
- Malvern, L.E.. **Introduction to the Mechanics of a Continuous Medium,** . Prentice-Hall. 1969.
- Mase, G.T. & Mase, G.E. . **Continuum Mechanics for Engineers, 2nd edition,** . CRC Press. 1999.
- 1.Fung Y.C., Tong P.. **Classical and Computational Solid Mechanics**. 2001.
- Bathe K.J. . **Finite Element Procedures**. Prentice Hall. 1996.
- Zienkiewicz, O.C., Taylor, R.L., Zhu, J.Z. . **The Finite Element Method: Its Basis and Fundamentals**. Elsevier Butterworth-Heinemann. 2005.
- Zienkiewicz, O.C., Taylor, R.L. . **The Finite Element Method for Solid and Structural Mechanics**. 2005.
- Crisfield, M.A. **Non-Linear Finite Element Analysis of Solids and Structures**. John Wiley & Sons.. 1991.

Complementary bibliography

- West, H.H. & Geschwindner, L.H. . **Fundamentals of Structural Analysis**. Wiley. 2002.
- Ghali, A., Neville, A.M. & Brown, T.G. . **Structural Analysis: A Unified Classical and Matrix Approach**. Spon Press.. 2003.
- Utku, S., Norris, C.H. & Wilbur, J.B.. **Elementary Structural Analysis**. McGraw-Hill.. 1991.