Course guide
250405 - ENGINESTR - Structural Engineering

Last modified: 28/03/2024

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). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: RAMON CODINA ROVIRA

Others: RAMON CODINA ROVIRA, ALEJANDRO CORNEJO VELÁZQUEZ, JOSE FRANCISCO ZARATE ARAIZA

TEACHING METHODOLOGY

The course consists of 2.7 hours a week of classes in the classroom where the teacher presents the concepts and basics of the course. Also 0.9 hours per week is spending in a middle group format, to problem solving with more interaction with the student. Practical exercises are solved to consolidate the general and specific learning objectives.
Support material is used in the form of detailed teaching plan stored at the Virtual Center http://www.cimne.com/cdl1/ctrhome/2: content, programming and evaluation activities directed learning and literature.

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.

LEARNING OBJECTIVES OF THE SUBJECT

Students will learn to apply their knowledge of structural engineering and to use advanced calculation methods to analyse, dimension and interpret the resistance behaviour of structures.

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

Apply their knowledge of structural engineering and use advanced calculation methods to analyse, dimension and interpret the resistance behaviour of structures;
Use dynamic analysis to examine the seismic behaviour of structures and apply advanced design techniques to improve seismic response;
Use advanced coupled nonlinear models to analyse and diagnose the possible limit states and ultimate limit states encountered during the life cycle of a structure;
Evaluate and mitigate structural seismic hazards;
Conduct durability and vulnerability studies.

Concepts and formulations of the finite element method: Application to the structural analysis of classic and advanced (composite) materials under static and dynamic conditions; Linear problems and introduction to nonlinear problems; Methods applicable to common engineering structures and materials, including dams, tunnels, tanks, sheets, buildings, bridges, mechanical components and plates: Fundamental theoretical aspects and main computational aspects; Hands-on sessions on engineering applications and structures

STUDY LOAD

Type	Hours	Percentage
Hours small group	13,0	8.67
Hours large group	28,0	18.67
Hours medium group	13,0	8.67
Self study	96,0	64.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
Introudccion and discrete systems

Specific objectives:
Describe the course and present the analogy with discrete and bar systems.

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

2D Solids

Description:
Structural analysis in plane stress and strain assumtions as well in axisimetric 3D structures.
Introduction to Programming the FEM in MAT LAB
Learning a finite element program
Solution of two-dimensional structures using FEM

Specific objectives:
Present the finite element method in two-dimensional elasticity problems
Learn to programming and solve with the program the finite element method
Consolidate the use of computers for solving problems using FEM

Full-or-part-time: 28h 47m
Theory classes: 8h
Practical classes: 4h
Self study : 16h 47m

3D Solid

Description:
Define the finite element method in three-dimensional elasticity problems.
solution of 3D structures using the FEM

Specific objectives:
consolidate the MEF study by its matrix formulation.
Consolidate the use of computers to solve problems by the FEM

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

Beams

Description:
Study the theories of Timoshenko and Euler_Bernulli for solving bending beams.

Specific objectives:
Studying higher-order elements and know the complications that can present the numerical solution of a problem by the FEM

Full-or-part-time: 14h 23m
Theory classes: 6h
Self study : 8h 23m

Evaluation

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

Plates

Description:
Further application of FEM for thin and thick plates analysis using theKirchhoff and Reissner-Mindlin theories. Analyse the application to composite materials.
Solving plate structures using the FEM

Specific objectives:
Extending theories of beams to two-dimensional case
Consolidate the use of computers to solve problems by the FEM

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Shells

Description:
Develop the FEM to the analysis of thin and thick shells extending Kirchoff theories and Reissner-Mindlin as well as the 2D plane stress to the 3D flat shells analysis.
Shells structures solution using the FEM

Specific objectives:
Expanding and combining elasticity theories applied to the FEM
Consolidate the use of computers to solve problems using the FEM

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

real examples

Description:
Presentation of real studies conducted by engineering firms.

Specific objectives:
Knowing the actual use of the method and its scope.

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

Introduction to dynamic analysis

Description:
Introduction to dynamic analysis of structures using the FEM

Specific objectives:
show the scope of the FEM in the structures design.

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

Introduction to nonlinear problems

Description:
Introduction to nonlinear analysis and coupled problems, using the FEM

Specific objectives:
show the scope of the FEM in structural design.

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

GRADING SYSTEM

The mark will be obtained from continuous assessment (40%) and the average of two exams (60%).
Continuous assessment involves solving individual exercises. These exercises will be graded with a maximum score of four (4) points: One (1) point for the practical exercises solved at class time and three (3) points for the finite element method applied to a practical case.
The exams consist of a questionnaire to be answer individually, without the help of any literature. Each questionnaire adheres to the concepts taught in the course. This exams have a maximum mark of six (6) points.

EXAMINATION RULES.

If there is any exam or continuous assessment within the scheduled period, a zero score will be considered.

BIBLIOGRAPHY

Basic:

- Oñate. E. Cálculo de estructuras por el método de los elementos finitos: análisis estático lineal. 2a ed. Barcelona: Centro Internacional de Métodos Numéricos en Ingeniería, 1995. ISBN 8487867006.
- Oñate. E. Structural analysis with the finite element method. Linear statics volume i : basis and solids. 1. Barcelona: SPRINGER - CIMNE, 2008. ISBN 978-1-4020-8732-5.
- Oñate. E. Structural analysis with the finite element method. Linear statics volume ii : beams plates and shells Barcelona. 1. Barcelona: SPRINGER - CIMNE, 2010. ISBN 978-84-96736-18-4.