Course guide
250958 - ANAAVAESTR - Computational Structural Mechanics and Dynamics

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 NUMERICAL METHODS IN ENGINEERING (Syllabus 2012). (Compulsory subject).
ERASMUS MUNDUS MASTER'S DEGREE IN COMPUTATIONAL MECHANICS (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: NARGES DIALAMI SHABANKAREH

Others: LUIS MIGUEL CERVERA RUIZ, NARGES DIALAMI SHABANKAREH, JOSE MANUEL GONZALEZ LOPEZ, JOSE FRANCISCO ZARATE ARAIZA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
8378. Practical numerical modeling skills. Ability to acquire knowledge on advanced numerical modeling applied to different areas of engineering such as: civil or environmental engineering or mechanical and aerospace engineering or bioengineering or Nanoengineering and naval and marine engineering, etc..
8379. Knowledge of the state of the art in numerical algorithms. Ability to catch up on the latest technologies for solving numerical problems in engineering and applied sciences.
8380. Materials modeling skills. Ability to acquire knowledge on modern physical models of the science of materials (advanced constitutive models) in solid and fluid mechanics.
8382. Experience in numerical simulations. Acquisition of fluency in modern numerical simulation tools and their application to multidisciplinary problems engineering and applied sciences.
8383. Interpretation of numerical models. Understanding the applicability and limitations of the various computational techniques.
8384. Experience in programming calculation methods. Ability to acquire training in the development and use of existing computational programs as well as pre and post-processors, knowledge of programming languages ??and of standard calculation libraries.

TEACHING METHODOLOGY

The course consists of 0.6 hours per week of classroom activity (large size group) and 1.2 hours weekly with half the students (medium size group).

The 0.6 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 1.2 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.

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

This course introduces the concepts, formulations, and applications of the finite elements method (FEM) for the analysis of structures composed of classical and innovative construction materials (composite materials) under static and dynamic loading. The course focuses on linear problems, however it provides a small introduction to the non linear analysis of structures. The different methods presented will cover the majority of the structural tipologies in engineering such as dams, tunnels, tanks, shells, buildings, bridges, structural and mechanical components, etc. The details for the formulation with finite elements are provided together with the most important computational aspects, allowing the students to get involved in FEM programming for structural analysis problems.

* To know the theoretical and practical basis of the finite elements method for the analysis of structures sunjected to dynamic and static loading; * to identify the fundamental theoretical aspects for each structural tipology and their inherent computational aspects. * To identify properly the theories associated to each structural tipology for the correct analysis with the finite elements method (FEM); * to be able to analyse the structures commonly found in practice by means of the FEM, using commercial codes and simultaneously developing a personal code with the basic aspects. * The students will develop practical skills to work with tensors and formulate and develop the analysis of several problems of solids and fluids in engineering.

* Basic concept of matrix in the analysis of bar elements structures.
* Solids in 2D.
* Axisimétric solids.
* Solids in 3D.
* Beams.
* Thick and thin plates.
* Folded and curved shells
* Axisimétricas shells
* Dynamic Analysis of structures
* Introduction to the non-linear analysis of structures.
* Additional subjects.

Learning Resources:
o O.C. Zienkiewicz and R.L. Taylor. The finite element method. Vols. 1 and
2, 5th Edition, Butterworth-Heinemann, 2003

STUDY LOAD

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

Type	Hours	Percentage
Hours small group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

The Direct Stiffness Method

Description:
The Direct Stiffness Method

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

Introduction to FEM

Description:
Introduction to FEM

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

ElastoStatics

Description:
ElastoStatics. Theory
ElastoStatics. Practice
ElastoStatics. Laboratory

Full-or-part-time: 38h 24m
Theory classes: 2h 30m
Practical classes: 6h
Laboratory classes: 7h 30m
Self study : 22h 24m

Beam, Plates and Shells

Description:
Beams, Plates and Shells. Theory
beam, Plates and Shells. Practice
Beams, Plates and Shells. Laboratory
Introduction to Non-Linear Analysis. Practice

Full-or-part-time: 44h 24m
Theory classes: 2h
Practical classes: 9h
Laboratory classes: 7h 30m
Self study : 25h 54m

ElastoDynamics

Description:
ElastoDynamics. Theory
ElastoDynamics. Practice
ElastoDynamics. Laboratory

Full-or-part-time: 15h 36m
Theory classes: 1h
Practical classes: 3h
Laboratory classes: 2h 30m
Self study : 9h 06m

Introduction to Nonlinear Analysis

Description:
Introduction to Non-Linear Analysis. Theory

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

GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

EXAMINATION RULES.

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

BIBLIOGRAPHY

Basic:
- Felippa, C.A. Introduction to finite element methods [on line]. Boulder, Colorado: University of Colorado, 2004 [Consultation: 11/02/2021]. Available on: https://vulcanhammernet.files.wordpress.com/2017/01/ifem.pdf.
- 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.
- Felippa, C. Advanced finite element methods [on line]. Praha, Czech Republic: Institute of Theoretical Physics, Faculty of Mathematics and Physics, Charles University, 2000 [Consultation: 25/03/2020]. Available on: http://utf.mff.cuni.cz/~houfek/esources12/Books/Numerical%20Methods,%20Programming,%20Software/Differential%20Equations/Finite%20Element%20Method/.