ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000445 - Computational mechanics

DEGREE PROGRAMME

04AM - Master Universitario Ingenieria De Estructuras, Cimentaciones Y Materiales

ACADEMIC YEAR & SEMESTER

2018/19 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000445 - Computational mechanics
No of credits	4.5 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	04AM - Master universitario ingenieria de estructuras, cimentaciones y materiales
Centre	04 - Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos
Academic year	2018-19

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Juan Carlos Garcia Orden (Subject coordinator)	ETSI Caminos	juancarlos.garcia@upm.es	Tu - 11:00 - 13:00 W - 11:00 - 13:00 F - 11:00 - 13:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

El plan de estudios Master Universitario Ingenieria de Estructuras, Cimentaciones y Materiales no tiene definidas asignaturas previas recomendadas para esta asignatura.

3.2. Other recommended learning outcomes

- Some programing experience in any high-level language is highly desirable. Specifically, programming skills with Matlab/Octave are very valuable, since most of the proposed exercises will demand programming in this environment.

4. Skills and learning outcomes *

4.1. Skills to be learned

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CE13 - - Capacidad para el ejercicio profesional de alta especialización o para la investigación predoctoral mediante la utilización de recursos de modelización predictiva en Análisis y diseño estructural en régimen dinámico y/o no lineal.

CE5 - Capacidad para la participación en actividades de I+D+i mediante la utilización de recursos de modelización predictiva en Métodos computacionales para Mecánica estructural

CG1 - Polivalencia para extender a ámbitos afines las competencias generales adquiridas en el ámbito temático del título.

CG4 - Capacidad de comunicación académica de contenido técnico y científico, oral y escrita en lengua inglesa.

CT1 - Capacidad de preparar y presentar comunicaciones orales, escritas y gráficas, estructurada y argumentadamente.

CT3 - Compromiso y capacidad de aplicación de los estándares de deontología en investigación y ejercicio profesional avanzado

4.2. Learning outcomes

RA13 - Sintetiza e integra con polivalencia y autonomía las competencias específica de formación científico-técnica para iniciación en I+D+i, para la alta especialización y para la investigación doctoral.

RA9 - Participa en debates en lengua inglesa

RA8 - Utiliza con eficacia recursos de modelización predictiva en una o más de las materias del módulo

RA2 - Presenta comunicaciones orales, escritas y gráficas, estructurada y argumentadamente, en lengua española e inglesa

RA4 - Utiliza con eficacia recursos de información y comunicación

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

The main objective of this course is to present the main numerical methods applied to computational mechanics and their corresponding mathematical analysis. At the end of the course a student should have become familiar with the most important algorithms and must know how to choose the most suitable for certain common problems of structural engineering. Concrete objectives are:

1. Acquire the necessary knowledge of programming in Matlab / Octave that allows to apply the different methods studied for the solution of mechanical problems

2. To know the basic concepts related to the numerical techniques for the solution of structural problems.

3. To know and to program the most common algorithms for the numerical solution of linear and nonlinear static problems

4. To know and to program the most common algorithms for the numerical solution of nonlinear dynamical problems

5.2. Syllabus

1. Introduction to Matlab/Octave

2. Basic concepts on numerical methods. Floating-point representation of real numbers. Roundoff errors

3. Statics of solids and structures

   3.1. Nonlinear static problems. Systems of non-linear algebraic equations

   3.2. Linear static problems. Systems of linear algebraic equations

      3.2.1. Small-medium size models. Direct methods

      3.2.2. Large models. Iterative methods

4. Nonlinear dynamics of solids and structures

   4.1. General concepts about the numerical solution of systems of nonlinear ordinary differential equations.Direct integration methods.

   4.2. One-step methods

   4.3. Multi-step methods

   4.4. Structural methods

   4.5. Geometric methods

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**Presentation** Duration: 01:00 Lecture **Tema 1. Introduction to Matlab/Octave (I)** Duration: 02:00 Lecture			
2	**Tema 1. Introduction to Matlab/Octave (II)** Duration: 01:00 Lecture **Tema 2. Basic concepts about numerical methods. Floating point representation of real numbers. Roundoff errors** Duration: 02:00 Lecture			
3	**Tema 3.1, Nonlinear static problems (I)** Duration: 02:00 Lecture			**Oral presentations, Unit 1** Individual presentation Continuous assessment Duration: 01:00
4	**Tema 3.1. Nonlinear static problems (II)** Duration: 02:00 Lecture			**Oral presentations, Unit 2** Individual presentation Continuous assessment Duration: 01:00
5	**Tema 3.1. Nonlinear static problems (III)** Duration: 03:00 Lecture			
6	**Tema 3.2.1. Linear static problems (I). Small-medium size models. Direct methods** Duration: 02:00 Lecture			**Oral presentations, Unit 3.1** Individual presentation Continuous assessment Duration: 01:00
7	**Tema 3.2.1. Linear static problems (II). Precision** Duration: 03:00 Lecture			
8	**Tema 3.2.2. Linear static problems (III). Large models. Iterative methods.** Duration: 03:00 Lecture			
9	**Tema 3.2.2. Linear static problems (iV). Large models. Iterative methods** Duration: 02:00 Lecture			**Oral presentations, Unit 3.2.1.** Individual presentation Continuous assessment Duration: 01:00

10	**Tema 4.1. Nonlinear dynamics. General concepts** Duration: 03:00 Lecture			
11				
12	**Tema 4.2. Nonlinear dynamics. One-step methods** Duration: 02:00 Lecture			**Oral presentations, Unit 3.2.2** Individual presentation Continuous assessment Duration: 01:00
13	**Tema 4.3. Nonlinear dynamics. Multi-step methods** Duration: 03:00 Lecture			
14	**Tema 4.4. Nonlinear dynamics. Structural methods (I)** Duration: 02:00 Lecture			**Oral presentations, Units 4.1, 4.2** Individual presentation Continuous assessment Duration: 01:00
15	**Tema 4.4. Nonlinear dynamics. Structural methods (II)** Duration: 02:00 Lecture **Tema 4.5. Geometric methods (I)** Duration: 01:00 Lecture			
16	**Tema 4.5. Geometric methods (II)** Duration: 02:00 Lecture			**Oral presentations, Units 4.3, 4.4** Individual presentation Continuous assessment Duration: 01:00
17				**Final exam** Problem-solving test Final examination Duration: 03:00

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Oral presentations, Unit 1	Individual presentation	Face-to-face	01:00	0%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6
4	Oral presentations, Unit 2	Individual presentation	Face-to-face	01:00	10.83%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6
6	Oral presentations, Unit 3.1	Individual presentation	Face-to-face	01:00	10.83%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6
9	Oral presentations, Unit 3.2.1.	Individual presentation	Face-to-face	01:00	10.83%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6
12	Oral presentations, Unit 3.2.2	Individual presentation	Face-to-face	01:00	10.83%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13

							CB6
14	Oral presentations, Units 4.1, 4.2	Individual presentation	Face-to-face	01:00	10.83%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6
16	Oral presentations, Units 4.3, 4.4	Individual presentation	Face-to-face	01:00	10.83%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final exam	Problem-solving test	No Presential	03:00	100%	/ 10	CB9 CG1 CG4 CE5 CT1 CT3 CE13 CB6

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Students will be evaluated, by default, through continuous evaluation. The student wishing to give up the continuous evaluation and to opt for the evaluation by final exam (formed by one or more evaluation activities of the course), must write through the platform Moodle to the coordinator of the course before the seventh week.

The evaluation will check if the students have acquired the competences of the course. Therefore, the final exam will use the same types of evaluation techniques used in the continuous evaluation (EX), and will be carried out at the final dates and times approved by the Academic Board for the current course and semester, except those activities of evaluation of learning results of difficult qualification in a final exam. In this case, these evaluation activities may be carried out throughout the course.

The evaluation in the extraordinary call will be made exclusively through the final exam procedure.

The grade of the course through continuous evaluation will be determined according to two elements: 1) Attendance and participation (35% of the grade); 2) Exercises and problems proposed and presented throughout the course (65% of the grade).

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
García Orden, J.C. "Computational Mechanics"	Bibliography	Course notes
Página web de la asignatura	Web resource	https://moodle.upm.es/titulaciones/oficiales/course/view.php?id=4366
J.W. Eaton, David Bateman, and Soren Hauberg. GNU Octave. A high- level interactive language for numerical computations	Bibliography	
A. Quarteroni and F. Saleri. Scientific Computing with MATLAB and Octave. Springer, 2006.	Bibliography	

A. Quarteroni, R. Sacco, and F. Saleri. Numerical Mathematics. Texts in Applied Mathematics. Springer, 2007.	Bibliography	
J.W. Demmel, Applied numerical linear algebra, SIAM, Philadelphia, 1997.	Bibliography	
T.R.J. Hughes. The Finite Element Method. Prentice Hall, 1987.	Bibliography	
Javier Bonet and Richard D. Wood. Nonlinear continuum mechanics for finite element analysis. Cambridge University Press, second edition, 2008.	Bibliography	
Uri M. Ascher and Linda R. Petzold. Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations. SIAM, Philadelphia, USA, 1998.	Bibliography	
M. Geradin and D. Rixen. Mechanical vibrations. Wiley, 1997.	Bibliography	