Course guides

300285 - CE - Computational Engineering

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 748 - FIS - Department of Physics.
Degree: MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2021). (Optional subject).
Academic year: 2021 ECTS Credits: 5.0 Languages: English

LECTURER

Coordinating lecturer: Juan Pedro Mellado
Others:

PRIOR SKILLS

Linear algebra, calculus, theoretical modelling of engineering and physics problems.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE3 MAST. (ENG) CE3: Aplicar los métodos numéricos para ingeniería aeroespacial con especial énfasis en sus aplicaciones, y en especial en la dinámica de fluidos.

General:
CG1 MAST. (ENG) CG1: Identificar y conocer las principales actividades de I+D+i en el campo aeroespacial que se llevan a cabo actualmente a nivel internacional en el ámbito académico, la industria y las mayores agencias espaciales.
CG2 MAST. (ENG) CG2: Identificar y aplicar los análisis teóricos, experimentales y numéricos fundamentales de uso actual en ingeniería aeroespacial.
CG4 MAST. (ENG) CG4: Participar en un proyecto de I+D+i del ámbito aeroespacial aportando una visión y conocimientos novedosos asociados con las técnicas de uso más puntero en el campo.

Transversal:
CT3. 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.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Basic:
CB6. (ENG) 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.
CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB9. (ENG) 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.
CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.
TEACHING METHODOLOGY

Course lectures are presentational and attendance is compulsory. Course materials consist of slide presentations and numerical codes/scripts. Sessions are generally structured as a 2h theory exposition in a classroom, followed by a numerical lab session to implement practical examples of the concepts just learnt.

The methodologies involved are:
MD1: Theory sessions
MD2: Interactive sessions
MD3: Lab sessions
MD5: Autonomous work
MD6: Group work
MD7: Tutorials

LEARNING OBJECTIVES OF THE SUBJECT

The course is a hands-on introduction to the numerical solution of linear and nonlinear systems, optimization, and ordinary and partial differential equations. The emphasis is on understanding fundamental aspects of numerical methods and the challenges associated with their implementation and validation. After the course, the students are able to find the methods in standard libraries that are more suitable for a particular problem, and they can assess the trade-offs between accuracy and cost. As software, we use python.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>45,0</td>
<td>36.00</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
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</tbody>
</table>

Total learning time: 125 h

CONTENTS

Introduction.

Description:
- Computational engineering.
- Python3. Optionally, Spyder3 as programming environment.

Related activities:
A01: Theory session
A04: Lab session
A09: Self study

Full-or-part-time: 15h
- Theory classes: 4h
- Self study : 11h
Linear systems of equations.

Description:

Related activities:
A01: Theory sessions
A02: Interactive sessions
A03: Problem resolution
A04: Lab sessions
A05: Discussion sessions
A08: Tutorials
A09: Self study
A10: Home exercises
A11: Home project
A12: Graded home exercises/activities

Full-or-part-time: 22h
Theory classes: 8h
Self study: 14h

Nonlinear systems and optimisation.

Description:

Related activities:
A01: Theory sessions
A02: Interactive sessions
A03: Problem resolution
A04: Lab sessions
A05: Discussion sessions
A08: Tutorials
A09: Self study
A10: Home exercises
A11: Home project
A12: Graded home exercises/activities

Full-or-part-time: 22h
Theory classes: 8h
Self study: 14h
Ordinary differential equations.

Description:

Related activities:
A01: Theory sessions
A02: Interactive sessions
A03: Problem resolution
A04: Lab sessions
A05: Discussion sessions
A08: Tutorials
A09: Self study
A10: Home exercises
A11: Home project
A12: Graded home exercises/activities

Full-or-part-time: 22h
Theory classes: 8h
Self study: 14h

Partial differential equations.

Description:
- Introduction to finite volume methods. Interpolation problem.

Related activities:
A01: Theory sessions
A02: Interactive sessions
A03: Problem resolution
A04: Lab sessions
A05: Discussion sessions
A08: Tutorials
A09: Self study
A10: Home exercises
A11: Home project
A12: Graded home exercises/activities

Full-or-part-time: 44h
Theory classes: 16h
Self study: 28h

GRADING SYSTEM

The evaluation is based on take-home assignments, where the students have to write python codes to solve specific problems with the algorithms discussed in class.

5 take-home assignments (100% of the final grade, each 20%).

In case of failing, the grade will be based on one additional written in-class exam on the date fixed in the calendar of final exams. The grade obtained in the additional written in-class exam will range between 0 and 10 and will replace that of the course based on the take-home assignments.
EXAMINATION RULES.

Open book exam

BIBLIOGRAPHY

Basic: