280801 - Advanced Mathematics for Ship and Ocean Engineering

Coordinating unit: 280 - FNB - Barcelona School of Nautical Studies
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
Degree: MASTER’S DEGREE IN NAVAL AND OCEAN ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)
ECTS credits: 5  Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: MARIA ÁNGELA GRAU GOTÉS

Opening hours
Timetable: Tuesday and Thursday from 2:00 pm to 3:30 pm; previous appointment in all cases.

Prior skills
Remember the mathematical concepts studied during the Degree in Naval Systems and Technology or the Degree in Marine Technologies or the Degree in Naval Architecture.

Requirements
Remember the mathematical concepts studied during the Degree in Naval Systems and Technology or the Degree in Marine Technologies or the Degree in Naval Architecture.

Degree competences to which the subject contributes

Basic:
1. That the students can apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their study area.
2. That students can communicate their conclusions and the knowledge and latest rationale underpinning to specialists and non-specialty clearly and unambiguously.
3. Students must possess the learning skills that enable them to continue studying in a way that will be largely self-directed or autonomous.

Transversal:
4. EFFECTIVE USE OF INFORMATION RESOURCES: Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty, and critically evaluate the results of this management.
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**Teaching methodology**

Three types of teaching methodologies are used:
- Face-to-face sessions of content exposition, in which the professor introduce the theoretical foundations of the subject illustrated with examples that facilitate their understanding.
- Face-to-face sessions of practical work with the development of exercises, problems and algorithms in which the teacher will guide the student in the application of the theoretical concepts.
- Autonomous work of study and realization of exercises and activities, in which the student will apply the knowledge acquired in the face-to-face sessions. Short practices in MATLAB are included that will require the delivery of a report.

**Learning objectives of the subject**

Ability to solve complex mathematical problems and their application to the resolution of naval engineering problems. Knowledge of existing numerical tools to solve these problems.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 45h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>100.00%</th>
</tr>
</thead>
</table>

# Content

## Root finding and nonlinear sets of equations

<table>
<thead>
<tr>
<th>Learning time: 10h</th>
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</thead>
<tbody>
<tr>
<td>Laboratory classes: 4h 30m</td>
</tr>
<tr>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td>Self study: 4h 30m</td>
</tr>
</tbody>
</table>

**Description:**
Iterative methods for systems of nonlinear equations: Newton method and fixed point methods.
The teacher will introduce the concepts corresponding to: classic methods of resolution, iterative methods, theorem of convergence, order and efficiency of the methods.
The student must attend the class, participate actively and solve the exercises proposed within the prescribed period.

**Related activities:**
1. Basic concepts on Matlab
2. Root finding
4. Practical work 1

## Numerical approximation of functions

<table>
<thead>
<tr>
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<tr>
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<tr>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td>Self study: 4h 30m</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
3. Approximation of functions
4. Practical work 1
### Numerical methods for partial and differential equations

**Learning time:** 15h  
- Laboratory classes: 8h  
- Guided activities: 1h  
- Self study: 6h

**Description:**  

**Related activities:**  
5.-Ordinary differential equations  
6.-Partial differential equations  
7.-Practical work 2

### Analysis of the dynamics of systems in the frequency domain

**Learning time:** 5h  
- Laboratory classes: 3h  
- Self study: 2h

**Description:**  
Fourier analysis. Wavelet transform and fast Fourier transform.  
Analysis of the dynamics of systems in the frequency domain.

**Related activities:**  
5.-Ordinary differential equations  
6.-Partial differential equations

### Numerical Methods for Continuous Mechanics Equations

**Learning time:** 5h  
- Laboratory classes: 3h  
- Self study: 2h

**Description:**  
Equations of continuous media dynamics.  
Introduction to Numerical Methods of Solving Continuous Media Dynamics Equations

**Related activities:**  
5.-Ordinary differential equations  
6.-Partial differential equations
In the evaluation of the course will participate together several concepts that will lead to the final grade:

\[ \text{NOTA\_CURS} = 0.1 \times \text{LABO} + 0.3 \times \text{PRAC} + 0.3 \times \text{TEO} + 0.3 \times \text{PROBS} \]

1. **Grade LABO.** The classes of laboratory-practice exercises in Matlab or Octave (1 point). Two or more tests.
2. **Grade PRAC.** Two reports of Matlab practices (3 points).
3. **Grade TEO.** Two or more test for the most basic concepts of theory (3 points). It consists of a short answer test questions. Will be held in class time.
4. **Grade PROBS.** Two or more test of problems with Matlab (3 points). Will be held in class time.

The students who in writing addressed to the professor responsible for the subject renounce the continuous evaluation, will have to present the PRAC assigned during the course (30%) and carry out a final exam of the subject whose content will be 30% Theory + 40% Problems. In that case the final grade:

\[ \text{NOTA\_CURS} = 0.3 \times \text{PRAC} + 0.3 \times \text{TEOR} + 0.4 \times \text{PROBS} \]

The technical skills are worth 60% of the course. The cross-competition is worth 40%. The note will be calculated cross competition from activities in the classroom and laboratory practices delivered.

### Regulations for carrying out activities

1. The duration of the continuous assessment tests will be between one hour and one hour and a half. It will be held during class hours.
2. Failure to attend one of these continuous assessment tests will have a score of 0 on the test note.
3. The duration of the PROBS exam will be between two hours and three hours. It is announced in the calendar of final exams.
4. It will be necessary to take identification to all the exams (DNI for example).
5. Any FRAUD in the punctual tests of the subject will apply the Academic Regulations of the University.
6. Any student who fails to take the final exam and does not perform any of the activities of the continuous assessment will be considered not submitted.
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Bibliography

Basic:


Complementary:


Others resources:

Cleve Moler is the president and chief scientist of The MathWorks. Mr. Moler was a professor of mathematics and computer science for nearly 20 years at the University of Michigan, Stanford University and the University of New Mexico. In addition to being the author of the first version of MATLAB, Mr. Moler is one of the authors of the LINPACK and EISPACK scientific subroutine libraries. He is also co-author of three textbooks on numerical methods.

Hyperlink

https://es.mathworks.com/moler
Cleve Moler textbooks

https://es.mathworks.com/matlabcentral/fileexchange/
Versions of classic algorithms worked in the classroom