Course guide
280801 - 280801 - Advanced Mathematics for Ship and Ocean Engineering

Last modified: 27/05/2025

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: MASTER'S DEGREE IN NAVAL AND OCEAN ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: JOAN CARLES LARIO LOYO

Others: Primer quadrimestre:
JOAN CARLES LARIO LOYO - MUENO

PRIOR SKILLS

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

Generical:
MUENO_CG1. Ability to solve complex problems and to make responsible decisions based on the scientific and technological knowledge acquired in basic and technological subjects applicable in naval and ocean engineering, and in management methods
MUENO_CG3. Ability to project ships and boats of all kinds
MUENO_CG6. Ability to conduct research, development and innovation in naval and ocean products, processes and methods

Transversal:
CT4. 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.
CT5. THIRD LANGUAGE Learning a third language, preferably English, with adequate oral and written and in line with the future needs of the graduates.

Basic:
CB6. Possess knowledge and understanding that provide a basis or opportunity be original in the development and / or application of ideas, often in a research context.
CB7. 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.
CB8. Students should be able to integrate knowledge and handle the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the responsibilities social and ethical linked to the application of their knowledge and judgments.
CB9. That students can communicate their conclusions and the knowledge and Latest rationale underpinning to specialists and non Specialty clearly and unambiguously.
CB10. Students must possess the learning skills that enable them continue studying in a way that will be largely self-directed or autonomous.

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

Type	Hours	Percentage
Hours large group	45,0	36.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

1. Iterative methods for nonlinear equations

Description:
Iterative methods for nonlinear equations: Newton method and fixed point methods. Order of the convergence and efficiency of a method.
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

Full-or-part-time: 39h
Theory classes: 9h
Laboratory classes: 2h
Guided activities: 12h
Self study : 16h

2. Numerical approximation of functions

Description:
Taylor series. Fourier series. Polynomial interpolation. Splines. Method of the least squares. Extrapolation of functions.

Related activities:
3.-Approximation of functions
4.-Practical work 1

Full-or-part-time: 34h
Theory classes: 6h
Laboratory classes: 2h
Guided activities: 11h
Self study : 15h

3. Numerical methods for partial and diferential equacions

Description:
Numerical Quadrature. Ordinary differential equations. Numerical methods for differential equations. Runge-Kutta Methods. Equations in partial derivatives. Laplace equation, wave equation, heat transfer equation. Analytical solution: existence and uniqueness of the solution. Numerical methods.

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

Full-or-part-time: 36h
Theory classes: 8h
Laboratory classes: 12h
Guided activities: 1h
Self study : 15h

4. Analysis of the dynamics of systems in the frequency domain

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

Related activities:
5.-Ordinay differential equations
6.-Partial differential equations

Full-or-part-time: 8h
Laboratory classes: 3h
Self study : 5h

5. Numerical Methods for Continuous Mechanics Equations

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

Related activities:
5.-Ordinay differential equations
6.-Partial differential equations

Full-or-part-time: 8h
Laboratory classes: 3h
Self study : 5h

GRADING SYSTEM

Continuous assessment

It is the recommended option for students who regularly attend class. A **minimum attendance** of **80%** of the sessions is recommended. It consists of different activities that are carried out throughout the course.

Continuous assessment activities:

In the evaluation of the course will participate together several concepts that will lead to the final grade:
COURSE_NOTE = max (0.3NAC + 0.35NEP1 + 0.35NEP2, NEF)

1. NAC: Continuous assessment note, exercises that students must submit throughout the course. (30%)
- Matlab® self-study courses.
- Two or more practices in MATLAB®. Personal work of analysis, synthesis and interpretation on proposed statements. A report and the corresponding code must be submitted.
2. NEP1: grade of the first partial exam (35%).
3. NEP2: mark of the second partial examination (35%).
4. NEF: final exam mark. The final exam includes all the course material. The date is set by the Faculty in the final exam calendar (100%).
5. Both the partial exams and the final exam consists of two different parts,
- Control of theory, test with the aim of monitoring the learning related to the properties of the models and algorithms studied. (40%)
- Laboratory controls, test with the aim of monitoring learning related to mathematical formulation, implementation and computational problem solving with MATLAB®. (60%)

Single assessment

Although it is not the most recommended option, it can be accepted by students who do not follow the continuous assessment. It is the most recommended option when you cannot attend class regularly.

The unique assessment consists of an exam, NEF, with part of theory and part of problems and practice, which assesses the knowledge of the whole subject. In the practice and problems section, the student is asked to use the MATLAB® software. The date is set by the Faculty in the final exam calendar.

EXAMINATION RULES.

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. It will be necessary to take identification to all the exams (DNI for example).
4. Any FRAUD in the punctual tests of the subject will apply the Academic Regulations of the University.
5. 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.

BIBLIOGRAPHY

Basic:
- Grau Sánchez, Miquel; Noguera Batlle, Miquel. Cálculo numérico [on line]. Barcelona: Edicions UPC, 2001 [Consultation: 14/07/2021]. Available on: http://hdl.handle.net/2099.3/36159. ISBN 8483014556.
- Grau Sánchez, Miquel; Noguera Batlle, Miquel. Càlcul numèric : teoria i pràctica [on line]. Barcelona: Edicions UPC, 2000 [Consultation: 14/07/2021]. Available on: http://hdl.handle.net/2099.3/36523. ISBN 8483013819.
- Burden, Richard L.; Faires, J. Douglas; Burden, Annette M. Análisis numérico. 10a ed. México DF: Cengage Learning, 2017. ISBN 9786075264042.
- Braun, Martin. Ecuaciones diferenciales y sus aplicaciones. México: Grupo Editorial Iberoamérica, 1990. ISBN 9687270586.
- Moler, Cleve. Numerical Computing with MATLAB [on line]. Natick: MathWorks, 2013 [Consultation: 14/07/2021]. Available on: https://es.mathworks.com/moler/index_ncm.html.
- Moler, Cleve. Experiments with MATLAB [on line]. Natick: MathWorks, 2011 [Consultation: 14/07/2021]. Available on: https://es.mathworks.com/moler/exm/chapters.html.

Complementary:
- John, Fritz. Partial differential equations. 4th ed. New York: Springer-Verlag, 1982. ISBN 3540906096.
- Chapra, Steven C.; Canale, Raymond P. Métodos numéricos para ingenieros [on line]. 7a ed. México: McGraw-Hill, 2015 [Consultation: 01/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8100. ISBN 9786071512949.
- Press, William H. Numerical recipes : the art of scientific computing. 3rd ed. Cambridge: Cambridge University Press, 2007. ISBN 9780521880688.
- Ogata, Katsuhiko. Ingeniería de control moderna [on line]. 5a ed. Madrid: Pearson Educación, 2010 [Consultation: 14/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259. ISBN 9788483226605.
- Oliver, J.; Agelet de Saracíbar, C. Mecánica de medios continuos para ingenieros [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 14/07/2021]. Available on: http://hdl.handle.net/2099.3/36197. ISBN 848301582X.

RESOURCES

Hyperlink:
- https://matlab.mathworks.com/. Login Matlab Online
- https://es.mathworks.com/moler. Cleve Moler textbooks
- https://matlabacademy.mathworks.com/es. Matlab Academy: Matlab online learning courses
- https://es.mathworks.com/matlabcentral/fileexchange/. Versions of classic algorithms worked in the classroom