

# Course guide

## 280669 - 280669 - Structures for Naval Engineering

Last modified: 11/07/2022

<b>Unit in charge:</b>	Barcelona School of Nautical Studies	
<b>Teaching unit:</b>	742 - CEN - Department of Nautical Sciences and Engineering.	
<b>Degree:</b>	BACHELOR'S DEGREE IN NAVAL SYSTEMS AND TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).	
<b>Academic year:</b> 2022	<b>ECTS Credits:</b> 6.0	<b>Languages:</b> Spanish

### LECTURER

<b>Coordinating lecturer:</b>	JAVIER MARTINEZ GARCIA
<b>Others:</b>	Primer quadrimestre: JAVIER MARTINEZ GARCIA - DT, GESTN FERMÍN ENRIQUE OTERO GRUER - DT, GESTN

### REQUIREMENTS

To take this course, it is necessary to have taken previously the course Mechanics Applied to Naval Engineering (code 280664)

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

#### Specific:

3. Ability to perform the calculation and control of vibration and noise on board ships and artifacts.
4. Knowledge of the elasticity and strength of materials and ability to perform calculations of elements for various solicitations.

#### Generical:

1. ABILITY TO IDENTIFY AND SOLVE PROBLEMS IN THE FIELD OF NAVAL ENGINEERING.  
Ability to approach and solve problems in the field of naval engineering technique taking initiatives, making decisions and implementing creative solutions as part of a systematic methodology.

#### Transversal:

CT6. GENDER PERSPECTIVE: An awareness and understanding of sexual and gender inequalities in society in relation to the field of the degree, and the incorporation of different needs and preferences due to sex and gender when designing solutions and solving problems.

### TEACHING METHODOLOGY

- Acquire, understand and summarize knowledge
- Define and solve problems with a critical approach
- Complete a team-work in collaboration with the group
- Complete individual assignments
- Analyse results and their implications
- Study and apply codes and standards for the design of practical cases
- Implement a design and validate the results
- Present the results of works completed sharing the diversity of experiences

It is vital to provide students with tools to identify gender stereotypes, bias and roles and, thus, contribute to developing their critical awareness and to gaining skills that will enable them to avoid gender blindness in their future professional practice. The promotion of collaborative methodologies in the classroom not only favours the incorporation of students' experiences as learning materials but also empowers them and makes them jointly responsible for their own learning process. In addition, the incorporation critical thinking helps them steer their thinking in new directions.

## LEARNING OBJECTIVES OF THE SUBJECT

Understands the concepts of elasticity and strength of materials.

Applies the concepts of elasticity and strength of materials to analyse elements subjected to different loads.

Knows the specific materials for machines, equipment and marine systems. Selects these materials based on the knowledge acquired and with sustainability criteria.

Designs and executes a good research strategy with specialized information resources. Identifies the relevance and the quality of the information using a critical view to detect gender gaps, questioning who did the research and what was the research about, when it was done and why it was done, paying attention to the androcentric aspects of the discipline.

Integrates the different needs and preferences due to sex and gender in the design of solutions and while solving problems in the field.

## STUDY LOAD

Type	Hours
Hours medium group	36,0
Self study	90,0
Hours large group	24,0

Total learning time: 150 h

**To avoid the transmission of an androcentric model in teaching and in the profession, students should be encouraged to identify gender biases and to question who researched and published what, when, why and how. At the same time, more humane technological solutions with social relevance should be sought and provided. These solutions should integrate the needs and preferences due to sex and gender in a contextualised way.**

## CONTENTS

### Review. Internal forces diagrams

#### Description:

Review of the solid equilibrium conditions and the representation of the solid internal forces using internal forces diagrams. Introduction to the structural analysis program Robot Structural Analysis.

#### Full-or-part-time: 14h

Theory classes: 2h

Practical classes: 4h

Self study : 8h

### Stress and strains produced by axial forces

#### Description:

Introduction to elasticity. Axial stress and strains. Solution of hyper-static structures loaded with axial loads.

#### Full-or-part-time: 15h

Theory classes: 2h

Practical classes: 4h

Self study : 9h

### Stresses produced by to bending moments

#### Description:

Stresses in beam elements due to bending moments. Stresses in beam elements produced by bending moments in two axes. Determination of the neutral axis. Stresses in beam elements produced by axial forces and bending moments.

#### Full-or-part-time: 24h

Theory classes: 3h

Practical classes: 7h

Self study : 14h



### Shear stresses and strains

**Description:**

Stress in beam elements produced by shear forces. Beam distortions produced by shear forces.

**Full-or-part-time:** 14h

Theory classes: 2h

Practical classes: 4h

Self study : 8h

### Stress and strains produced by torsion moments

**Description:**

Analysis of stress and strains produced by torsion moments. Torsion in solid cross sections. Torsion in closed thin-walled cross sections.

**Full-or-part-time:** 14h

Theory classes: 2h

Practical classes: 4h

Self study : 8h

### Beam deflections produced by bending moments

**Description:**

Differential equation for the elastic curve of a beam. Navier-Bresse equation. Solution of hyper-static structures using the compatibility method.

**Full-or-part-time:** 20h

Theory classes: 3h

Practical classes: 5h

Self study : 12h

### Elastic instability produced by compression forces. Buckling

**Description:**

Description of buckling phenomena. Calculation of the Euler critical load. Analysis of the buckling load produced by compression following the Eurocode 3 (EAE).

**Full-or-part-time:** 14h

Theory classes: 2h

Practical classes: 4h

Self study : 8h

### Fatigue limit state

**Description:**

Effect of cyclic loads on structures. Endurance stress. Analysis of structures subjected to cyclic loads. Combination of several cyclic loads applied to the structure. Fatigue limit stress analysis based on the Eurocode 3 (EAE) and based on classification societies (IACS-CSR).

**Full-or-part-time:** 14h

Theory classes: 2h

Practical classes: 4h

Self study : 8h



## Vibrations in structures

### Description:

Free, damped and forced vibrations in systems with one degree of freedom. Structural frequency modes.

**Full-or-part-time:** 2h

Theory classes: 2h

**The use of more collaborative methodologies also contributes to reducing power relationships in the classroom and promotes shared responsibility in the construction of knowledge. In addition, this more horizontal approach covers a wider range of solutions, favours more equal participation, values all contributions so that everyone feels represented, and generates more enthusiasm for the learning process.**

## ACTIVITIES

### Design and construction of a naval structure

#### Description:

The concepts learned during the course must allow the students succeed in the design of a structure in the field of their degree and validate its correct performance. The course project consists in the design of a beam structure based on a geometry and a set of loads defined, and in the construction of this structure to validate its functionality.

The analysis required to design the structure will be exemplified during the course by analysing a similar structure.

The course project will be developed by a group of students. Groups will be defined at the beginning of the course.

The marked obtained in this activity corresponds to the course project mark (Npc).

#### Specific objectives:

There are several objectives aimed with the course project. Among those, it is worthy to highlight the following ones:

Bring to a real case the knowledge learnt during the course.

Experiment with materials and structural solutions in order to facilitate the understanding of the strength mechanisms developed by the structures.

Promote the group work and collaboration among equals as an efficient strategy to solve problems.

Acknowledging that in engineering there are several solutions for a same problem, and that one solution does not have to be

better than another one. Different approaches to the problem will translate in different structures, representing different

sensibilities. Realize that this plural and diverse approach to the problem is beneficial and that it allows us to reach more inclusive solutions that improve the professional practice.

#### Material:

In order to design the structure, the students will have at their disposal the bibliography references, the class notes and the analysis made on a similar structure along the course. They will also have the software Robot Structural Analysis which will allow them conducting some validations more easily.

To construct the designed structure, the students will be able to use any material, which will be selected based on their preferences and needs. The motivation behind their election, the structure weight and its cost will be taken into account in the project evaluation.

#### Delivery:

The last day of the course the students will present the structures designed and constructed. All members of the each group will have participate in a brief presentation of their structure, justifying the reasons behind their design. Together with the structure, the groups will have to present a document showing the analysis made.

#### Related competencies :

CG8.GESTN. ABILITY TO IDENTIFY AND SOLVE PROBLEMS IN THE FIELD OF NAVAL ENGINEERING.

Ability to approach and solve problems in the field of naval engineering technique taking initiatives, making decisions and implementing creative solutions as part of a systematic methodology.

**Full-or-part-time:** 19h

Theory classes: 2h

Practical classes: 2h

Guided activities: 15h

**In project-based learning, a project is carried out through the planning, design and undertaking of a series of activities. When this activity is done in groups, the group members must respond by searching for information, reflecting, analysing and drawing conclusions, which helps to promote individual critical thinking. In addition, through teachers' guidance and support, contextualised solutions with social relevance can be sought. In this way, the discipline is humanised and future professionals are trained with a gender and inclusive perspective that is more useful for society.**

## GRADING SYSTEM

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The final mark obtained for the course will be calculated with the following formula:

$$N_{\text{final}} = 0.15 \cdot N_{\text{ae}} + 0.15 \cdot N_{\text{pc}} + 0.20 \cdot N_{\text{pp}} + 0.50 \cdot N_{\text{pf}}$$

$N_{\text{final}}$ : Final course mark

$N_{\text{ae}}$ : Qualification for class attendance and class assignments

$N_{\text{pc}}$ : Qualification obtained from the course project

$N_{\text{pp}}$ : Qualification obtained from the mid-term exam

$N_{\text{pf}}$ : Qualification obtained from the final exam

The mid-term mark will be obtained from two different exams that will take place in class hours.

## RE-EVALUATION

The re-evaluation exam consists on a single exam that will include all the course syllabus. The final mark obtained in the subject, and the re-evaluation, will be the mark obtained in this exam. This mark will be always equal or higher than the course mark previously obtained, and cannot be higher than 5.

## EXAMINATION RULES.

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The student that does not attend to the final exam will obtain a "abandoned" as the final mark for the course.

Students are allowed to bring a maximum of 5 pages with formulae to the exams.

## BIBLIOGRAPHY

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### Basic:

- España. Ministerio de Transportes, Movilidad y Agenda Urbana. Instrucción de Acero Estructural (EAE) [on line]. [Consultation: 13/07/2022]. Available on: <https://www.mitma.gob.es/organos-colegiados/comision-permanente-de-estructuras-de-acero/cpa/instrucciones/instruccion-eae-version-en-castellano>.
- International Association of Classification Societies. Common Structural Rules for Bulk Carriers and Oil Tankers [on line]. London: IACS, 2022 [Consultation: 08/07/2022]. Available on: <https://iacs.org.uk/publications/common-structural-rules/csr-for-bulk-carriers-and-oil-tankers/>.
- Cervera Ruiz, Miguel; Blanco Díaz, Elena. Mecánica de estructuras. Vol. 1, Resistencia de materiales [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 05/07/2022]. Available on: <http://hdl.handle.net/2099.3/36196>. ISBN 8483016222.
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- Gere, James M. Resistencia de materiales. 5a ed. Madrid: International Thomson, 2002. ISBN 9788497320658.

### Complementary:

- Desportes, Virginie; Espasa, Marina. Teoría King Kong. Primera edición. Barcelona: L'Altra Editorial, gener del 2018. ISBN 9788494782916.
- Vázquez Fernández, Manuel. Resistencia de materiales. 4a ed. Madrid: Noela, 1999. ISBN 8488012055.
- Miguel Canet, Juan. Resistencia de materiales y estructuras [on line]. Barcelona: CIMNE, 2012 [Consultation: 13/07/2022]. Available on: [https://portal.camins.upc.edu/materials\\_guia/250120/2012/Resistencia%20de%20materiales%20y%20estructuras.pdf](https://portal.camins.upc.edu/materials_guia/250120/2012/Resistencia%20de%20materiales%20y%20estructuras.pdf). ISBN 9788493964047.
- Spotts, M. F. Proyecto de elementos de máquinas. 4a ed. Barcelona: Reverté, 1982. ISBN 8429160863.
- Timoshenko, Stephen; Goodier, J.N. Teoría de la elasticidad. 2a ed. Bilbao: Urmo, 1975. ISBN 8431402318.
- Ortiz Berrocal, Luis. Elasticidad [on line]. 3a ed. Madrid: McGraw-Hill, 1998 [Consultation: 04/07/2022]. Available on: [https://www.ingebook-com/recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=3965](https://www.ingebook-com/recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=3965). ISBN 8448120469.

**The bibliography should include the full names of the authors, not just the initials, to increase the visibility of women's contribution to scientific knowledge.**



## RESOURCES

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### Computer material:

- Robot Structural Analysis. Robot Structural Analysis software

### Hyperlink:

- Pàgina web de la secció de mecànica del CEN. <https://www.fnb.upc.edu/mecanica/>- PRISMÀTIC 2.0 : material multimèdia docent per a l'aprenentatge de la resistència de materials. <https://www.upc.edu/prismatic/>