Course guide
280817 - 280817 - Lightweigth Structural Design

Last modified: 27/05/2025

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

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

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

LECTURER

Coordinating lecturer: FRANCESC TURON PUJOL

Primer quadrimestre:
FRANCESC TURON PUJOL - Grup: MUENO

Others: Primer quadrimestre:
FRANCESC TURON PUJOL - Grup: MUENO

PRIOR SKILLS

Advanced knowledge of strength of materials and structural analysis. Knowledge on numerical methods for structural analysis.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
ENO_CEe1-1. Knowledge of the existing regulations that regulate the project of pleasure and competition boats (specific competence of the specialty in Design of Yachts and Recreational Boats)
ENO_CEe1-4. Ability to analyze the structural behavior and optimize the structure of pleasure and competition boats (specific competence of the specialty in Yacht and Recreational Boat Design)
ENO_CEe1-7. Knowledge of the materials used in the construction of pleasure boats. Knowledge of your working conditions and maintenance requirements. Knowledge of the mechanical behavior of these materials and their failure modes (specific competence of the specialty in Design of Yachts and Pleasure Boats)

Transversal:
CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Know and understand the complexity of economic and social phenomena typical of the welfare society, being able to relate welfare to globalization and sustainability; acquire skills to use in a balanced manner compatible technology, technology, economics and sustainability.
CT3. TEAMWORK: Ability to work as a member of an interdisciplinary team, either as a member or performing management tasks, with the aim of contributing to projects pragmatically and sense of responsibility, assuming commitments considering the resources available.
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

Master Class
Class with students participation
Cooperative learning
Self learning by solving problems and exercises
Learning based on projects

LEARNING OBJECTIVES OF THE SUBJECT

Capacity to design light structures made of composite materials.
Capacity to use this knowledge for the design of naval architecture structures.

STUDY LOAD

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

Total learning time: 125 h

CONTENTS

1. Introduction to the analysis of light structures

Description:
Composite materials and components: fibers, matrices and core materials.
Existing procedures for the analysis and design of composite materials structures.
Use of composite structures in marine structures.

Full-or-part-time: 5h
Theory classes: 3h
Self study : 2h

2. Laminate micromechanics

Description:
Mechanical characteristics of composite laminae: elastic properties and failure criteria.
Calculation of the laminae mechanical properties.
Introduction to Cadec-online.

Full-or-part-time: 14h
Theory classes: 3h
Practical classes: 3h
Self study : 8h

3. Composite structures design

Description:
Rotation of the composite laminate.
Laminate stiffness based on its typology: monolitic laminates, symmetric and unsymmetric laminates, sandwich structures, etc.
Failure modes of composite laminate shells.
Numerical analysis of composite structures.

Full-or-part-time: 45h
Theory classes: 6h
Practical classes: 9h
Self study : 30h

4. Advanced procedures for the analysis of composite structures

Description:
Material non-linear analysis of structures.
Damage and plasticity models.
Classical mixing theory and serial/parallel mixing theory for the analysis of composite structures.
Non-linear analysis of a composite structure.

Full-or-part-time: 42h
Theory classes: 6h
Practical classes: 6h
Self study : 30h

5. Rules for the design of light structures

Description:
Specific rules defined by Classification Societies for the design of marine structures made of composite materials.
Rules for the design of small crafts made with composite materials.

Full-or-part-time: 19h
Theory classes: 4h 30m
Practical classes: 4h 30m
Self study : 10h

GRADING SYSTEM

The final mark of the course will be obtained with the following formula:
Nfinal = 0.3·Npp + 0.7·Nec

Nfinal: Final Mark
Npp: Mark obtained in a mid-term test
Nec: Mark obtained from course projects and assignments

EXAMINATION RULES.

The student must complete at least the 75% of the course exercises and assignments to be evaluated of the course.
The student can have notes with equations, maximum 4 pages, in the course tests.

BIBLIOGRAPHY

Basic:
- Barbero, Ever J. Introduction to composite materials design [on line]. 2nd ed. Boca Raton: Taylor & Francis, 2011 [Consultation: 11/07/2025]. Available on: https://www-taylorfrancis-com.recursos.biblioteca.upc.edu/books/mono/10.1201/9781439894132/introduction-composite-materials-design-ever-barbero. ISBN 9781420079159.
- International Organization for Standardization. UNE-EN ISO 12215-5 : Pequeñas embarcaciones. Construcción de cascos y escantillones. Parte 5: Presiones de diseño, tensiones de diseño y determinación del escantillón [on line]. Madrid: AENOR, 2019 [Consultation: 04/07/2022]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/rdgucl/alma991000617169706711.
- Martínez, Xavier; Oller, Sergio; Barbero, E. "Caracterización de la delaminación en materiales compuestos mediante la teoría de mezclas serie/paralelo". Revista internacional de métodos numéricos para cálculo y diseño en ingeniería [on line]. 2011, vol. 27, núm. 3, p. 189-199 [Consultation: 05/07/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S0213131511000022.- Oller, Sergio. Numerical simulation of mechanical behavior of composite materials [on line]. Barcelona: CIMNE : Springer, 2014 [Consultation: 04/07/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-04933-5. ISBN 9783319049328.

Complementary:
- Oller, Sergio. Nonlinear dynamics of structures [on line]. Barcelona: International Center for Numerical Methods in Engineering (CIMNE) : Springer, 2014 [Consultation: 04/07/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-05194-9. ISBN 9783319051932.
- Martínez, Xavier [i altres]. "Computationally optimized formulation for the simulation of composite materials and delamination failures". Composites Part B: Engineering [on line]. Març 2011, vol. 42, núm. 2, p. 134-144 [Consultation: 05/07/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S135983681000154X.- Car, E [i altres]. "Numerical simulation of fiber reinforced composite materials––two procedures". International Journal of Solids and Structures [on line]. Abril 2002, vol. 39, núm. 7, p. 1967-1986 [Consultation: 05/07/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S0020768301002402.- Rastellini, Fernando [i altres]. "Computers & structures". Composite materials non-linear modelling for long fibre-reinforced laminates : continuum basis, computational aspects and validations [on line]. Maig 2008, vol. 86, núm. 9, p. 879-896 [Consultation: 05/07/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S0045794907001642.