UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
280812 - 280812 - Advanced Project of the Ship

Last modified: 27/05/2024

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 742 - CEN - Department of Nautical Sciences and Engineering.

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

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: RAFAEL PACHECO BLAZQUEZ

Others: Primer quadrimestre:
RAFAEL PACHECO BLAZQUEZ - ERAS, MUENO

PRIOR SKILLS

Basic concepts referred to "Ship Design", studied in the MARINE TECNOLOGY DEGREE/ SYSTEMS ENGINEERING AND NAVAL TECNOLOGY DEGREE.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
MUENO_CG2. Ability to conceive and develop solutions that are technically, economically and environmentally appropriate to the needs of maritime or integral transportation of people and goods, of the use of oceanic resources and of the marine subsoil (fishing, energy, minerals, etc.), adequate use of the marine habitat and means of defense and maritime security)
MUENO_CG3. Ability to project ships and boats of all kinds
MUENO_CG5. Ability to design and control the construction, repair, transformation, maintenance and inspection processes of previous mills
MUENO_CG6. Ability to conduct research, development and innovation in naval and ocean products, processes and methods
MUENO_CG7. Ability to integrate complex maritime systems and translation into viable solutions
MUENO_CG8. Ability to analyze and interpret measurements, calculations, evaluations, appraisals, studies, reports, work plans and other similar works
MUENO_CG13. Ability to develop the necessary engineering in rescue and rescue operations and in the design and use of the required means
MUENO_CG14. Ability to analyze, assess and correct the social and environmental impact of technical solutions
MUENO_CG15. Ability to organize and direct multidisciplinary work groups in a multilingual environment, and to generate reports for the transmission of knowledge and results

Transversal:
CT1. ENTREPRENEURSHIP AND INNOVATION: Knowing and understanding the organization of a company and the sciences that govern the activity; be able to understand the business rules and relationships between planning, industrial and commercial strategies, quality and profit.
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

In this subject three different docent metodologies are combined:
- Presential exposition sessions of the contents of the subject, in which the professor shall introduce the theoretical basis of the subject by means of examples that easy their understanding.
- Presential practical coursework sessions by means of explaining the development of such exercices, problems and algorithms in which the professor will guide the students in the aplication of theoretical concepts.
- Autonomous study and undertaking of exercise and activities in which the students will apply the knowledge developed during the presential sessions.

LEARNING OBJECTIVES OF THE SUBJECT

Understanding of the basic concepts related to ship design.
Capability to resolve mathematic problems applied to ship deisgn.
Understanding of the algorithms, numerical methods basic tools and systems to solve such problems.

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. Organisation and mission requirements

Description:
This unit encompasses a summary of the different fundamentals of the process of ship design and actors. The classes are devoted to design itself and the treatment of data to either create reliable databases or use of existing ones. The students are introduced to more profound concepts to extend the conceptual and preliminary design of a ship structures by using reduced order modelling and generative design (machine learning).

Specific objectives:
1) Understand the different elements involving ship design.
2) Be able to identify or create suitable database from which extrapolate meaningful data in the design of ship in conceptual and preliminary design stage.
3) Understand and apply reduced order modelling (linear principal component analysis - PCA) to extend the basic interpolation techniques learnt in the bachelor degree.
4) Briefly understand the capabilities of generative design and apply different machine learning models (perceptron, neural network, dense neural network) from the MATLAB's deep learning environment.

Related activities:
An group activity that encompasses the definition of the mission requirements of two ship designs, one <24m and the second >24m. The student will be asked to provide a database and analyse the correctness of the latter by using their acquired skills. Then several optimisation and advanced techniques such as PCA or machine learning techniques (non-linear regression and classification) are required to compare with the basic analysis.

Full-or-part-time: 29h
Theory classes: 11h
Guided activities: 3h
Self study : 15h

2. Form generation and preliminary powering

Description:
This unit devotes to the analysis of hull design, propulsion power and naval architecture. First the hull is derived based on the type of mission requirements are need to be satisfied, then techniques to optimise the hull are introduced. These are: curvature optimisation, empirical or regression fitting and CFD analysis (potential and turbulent). The second section of the chapter deals with the propulsion, different methods for thrust and power estimation are introduced. The student will review basic propulsion methods and then will be introduced to advanced techniques to optimise the propeller performance by means of RPM or diameter optimisation, momentum element-blade theory or lifting-line theory. The chapter ends with a review of basic concepts of naval architecture and this section is more devoted to the use of CFD or similar tools to optimise stability.

Specific objectives:
1) To understand the different methods to use in order to optimise the hull forms (hydrodynamic-driven optimisation) by means of curvature, empirical, potential and turbulent design.
2) To review basic propulsion methodology and introduce new concepts such as momentum element-blade theory and lifting-line theory in order to analyse their advantages in early stages of the ship design spiral.
3) To review basic naval architecture concepts (arrangements, hydrostatics, intact stability, freeboard, gross tonnage and manoeuvrability) and to introduce the student to CFD tools to analyse the seakeeping of ship structures.

Related activities:
A group activity following the previous dimensioning work, the students will be asked to design a 3D hull and apply the different design optimisation techniques for both the >24m and <24m design they have proposed. The estimation of thrust and propulsion shall be assessed for both designs and a standard naval architecture calculation by the use of MAXSURF shall be performed. The student will be required to compare these empirical solutions obtained from MAXSURF with the results obtained from a equivalent computational model in order to obtain the resistance and seakeeping of the two proposed designs.

Full-or-part-time: 32h
Theory classes: 11h
Guided activities: 6h
Self study : 15h

3. Arrangements, structure, displacement and naval architecture

Description:
This chapter will review the basic concepts of arrangements and the type of typical weights found onboard. The chapter divides in two sections, first structure where the student will review the methodology to calculate the weight distribution loads and then be introduced to beam and strip theory, certain finite element analysis shall be explained to be used in different stages of the spiral of project. Once the student is familiar with the basics of structure analysis for ship structures, the introduction of other loads that conform the second part of the chapter entitled load case are explained. The student will learn to create a "load case" and perform either naval architecture or structure analysis for different load cases. The student will be introduced to the concept of damaged stability and shown different techniques. Also the syllabus will take a look on to computational methods to address manoeuvrability.

Specific objectives:
1) Review the basics of naval structure design. Then introduce the classical concept of beam strip ship theory and how this can be solved using finite element approaches.
2) Conform a load case where weight loads and hydrostatic/hydrodynamic loads are taken into account. Understand the basics of fluid-structure interaction coupling (FSI) and different techniques that can be used.
3) Introduction to other non-linear analysis both for structure and naval architecture (buckling, plasticity, damaged stability, etc.).

Related activities:
A continuation of the group task to design a >24m and <24m is asked, by performing structural design (weight estimation, distribution and proper section scantling) and use different FEM approaches and analyses. The students will be asked to perform FSI coupling and to propose different load case scenarios to re-do the naval architecture analysis done previously and extend it damaged stability. The student will be asked to apply freeboard and gross tonnage legislations in the design of their ship.

Full-or-part-time: 36h
Theory classes: 12h
Guided activities: 6h
Self study : 18h

4. Practical case review

Description:
A practical case review shall be presented, generally by a seminar of a professional ship designer that will illustrate the different aspects seen and specifics of the ship design process.

Full-or-part-time: 28h
Theory classes: 11h
Self study : 17h

GRADING SYSTEM

The final grade is the sum of the partial grades below:

G_final=0.25*G_1+0.25*G_2+0.25*G_3+0.25*G_fp

Where:
G_final: Final grade.
G_1: Block 1 grade.
G_2: Block 2 grade.
G_3: Block 3 grade.
F_p: Final presentation grade.

EXAMINATION RULES.

Rules for the fulfilment of the course activities:

Coursework Assessment:
Individual/groupal undertaking and submission of the courseworks. A report shall be submitted within the deadline. Any coursework delivered out of the deadline shall be qualified with a penalty of 10% less per day out of the deadline, meaning that a submission over 10 days would be equivalent to a 0.

Presentation:
Presentations will be in groups. It is necessary to undertake the final presentation.

BIBLIOGRAPHY

Basic:
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- Lewandowski, Edward M. The Dynamics of marine craft : maneuvering and seakeeping. Advanced Series on Ocean Engineering. Washington: World Scientific Publishing, 2004. ISBN 9789812562678.
- Okumoto, Yasuhisa; Takeda, Yu; Mano, Masaki; Okada, Tetsuo. Design of ship hull structures :practical guide for engineers [on line]. Berlin: Springer Berlin Heidelberg, 2009 [Consultation: 28/09/2020]. Available on: http://dx.doi.org/10.1007/978-3-540-88445-3. ISBN 9783540884453.
- Oliver, J.; Agelet de Saracibar, C. Continuum mechanics for engineers : theory and problems [on line]. 2nd ed. Barcelona: els autors, 2017 [Consultation: 30/05/2022]. Available on: https://upcommons.upc.edu/handle/2117/102979.
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- Molland, Anthony F; Turnock, Stephen R; Hudson, Dominic A. Ship resistance and propulsion : practical estimation of ship propulsive power. Second edition. Cambridge: Cambridge University Press, 2017. ISBN 9781107142060.
- Lamb, Thomas. Ship design and construction. Alexandria (USA): Society of Naval Architects and Marine Engineers, 2003. ISBN 9780939773411.

Complementary:
- Anderson, John David. Fundamentals of aerodynamics [on line]. 6th ed. New York: McGraw-Hill Education, 2017 [Consultation: 06/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5662650. ISBN 9781259129919.
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- Lewis, Edward V. Principles of naval architecture. 2nd revision. Jersey City: The Society of Naval Architects and Marine Engineers, 1988-1989. ISBN 0939773007.
- Papanikolaou, Apostolos. Risk-Based ship design : methods, tools and applications [on line]. Berlin: Springer Berlin Heidelberg, 2009 [Consultation: 28/09/2020]. Available on: http://dx.doi.org/10.1007/978-3-540-89042-3. ISBN 9783540890423.
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