Course guide
280832 - 280832 - Analysis and Design of Floating Offshore Wind Turbines

Last modified: 25/06/2024

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). (Optional subject).

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

LECTURER

Coordinating lecturer: PAU TRUBAT CASAL

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
ENO_CEe2-2. Knowledge of the different modes of energy extraction from the sea (specific competence of the specialty in Ocean Energies)
ENO_CEe2-4. Knowledge of the methodology for the project of a wind turbine park (specific competence of the specialty in Ocean Energy)
ENO_CEe2-5. Knowledge of the different components of a marine wind turbine, as well as its functioning and operation (specific competence of the specialty in Ocean Energies)
ENO_CEe2-6. Capacity for the design and project of platforms for offshore wind turbines (specific competence of the specialty in Ocean Energy)
MUENO_CE7. Ability to project ocean platforms and artifacts
MUENO_CE10. Knowledge of positioning systems and the dynamics of platforms and artifacts

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_CG4. Capacity for the project of platforms and artifacts for the use of ocean resources
MUENO_CG7. Ability to integrate complex maritime systems and translation into viable solutions

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.

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.
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

Expository method
Participatory exhibition class
Independent learning by solving exercises
Project-based learning

LEARNING OBJECTIVES OF THE SUBJECT

The study and design of floating platforms for offshore wind turbines focuses on the adequacy of the coupled behavior of the wind turbine, tower, hull and station keeping system regarding their motion, vibrations, loads produced by the different systems and environmental conditions, as well how to ensure the production of power energy.
The objectives are:
- Provide a basic knowledge of the different types of floating offshore wind turbines as well as the main subsystems that affect their behavior and design (wind turbine, tower, platform, anchoring system) and environmental conditions.
- Provide information on the dynamic behavior of offshore wind turbine platforms, external forces and analysis and simulation methodologies
- Become familiar with the use of key engineering design tools for floating offshore wind turbines
- Know the standards and codes of common use in the industry

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. Introduction to the technology of floating platforms for offshore wind turbines

Description:
- Type of platforms (Anchored: MonoPile, Jacket, Gravity Base; Floating: SPAR, SemiSub, TLP, Barge, Mixed).
- Wind resource (Betz's law, wind turbine capacity).
- Climatic conditions: wind, waves and currents
- Applicable regulations (DNV – ST-0119)

Full-or-part-time: 3h
Theory classes: 3h

2. Wind Turbines

Description:
- Evolution, main parts, aerodynamic forces.
- "Downwind", "Upwind" and vertical axis wind turbines.
- Campbell diagram, 1P-3P tower frequencies and wind turbine control systems.
- States of the turbine (operation and stop conditions). Aerodynamic models.

Full-or-part-time: 6h
Theory classes: 6h

3. Design of floating platforms

Description:
- Main design considerations for the different types of platforms ("SemiSubmersible", "Spar", "TLP", barge).
- Maximum tilt angles in operation and survival.
- Hydrostatic stability, specific periods of movement, damping systems.
- Displacement
- Physical properties of the platforms.

Full-or-part-time: 9h
Theory classes: 9h

4. Fluid-Structure interaction

Description:
- Theory of potential flow.
- Morison's equations.
- Effects of "Wave Stretching".
- Second order wave forces.
- CFD models.

Full-or-part-time: 4h 30m
Theory classes: 4h 30m

5. Mooring systems

Description:
- Types, materials, secondary elements.
- Calculation models
- Applicable regulations.

Full-or-part-time: 4h 30m
Theory classes: 4h 30m

6. Engineering Aero-Hydro-Servo-Elastic models

Description:
- Main parts of the software for the calculation and analysis of floating wind platforms.
- Software presentation for the analysis and design of floating wind turbines.
- Realization of simulations and analysis of the results. Comparison of simulation results withreal experiments.

Full-or-part-time: 9h
Theory classes: 9h

GRADING SYSTEM

a) NF = 0.5 EF + 0.5 AC
b) NF = EF

NF: Final Mark
EF: Final Exam
AC: Homework

EXAMINATION RULES.

The assignments required by the teacher will be handed in on the appointed day. Any work not handed in or handed in after the deadline will be graded with a 0. The student who does not appear for any exam will be counted as absent.

BIBLIOGRAPHY

Basic:

- Anaya-Lara, Olimpo; Tande, John O.; Uhlen, Kjetil; Merz, Karl. Offshore wind energy technology [on line]. Hoboken, New Jersey: Wiley, 2018 [Consultation: 02/07/2024]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781119097808. ISBN 9781119097808.
- Ng, Chong; Ran, Li. Offshore wind farms : technologies, design and operation [on line]. Amsterdam: Woodhead Publishing, 2016 [Consultation: 02/07/2024]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780081007792/offshore-wind-farms. ISBN 0081007809.
- Cruz, Joao; Atcheson, Mairead (eds.). Floating offshore wind energy : the next generation of wind energy [on line]. Cham: Springer International Publishing, 2016 [Consultation: 02/07/2024]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-29398-1. ISBN 3319293982.