Course guide
220038 - WTD - Wind Turbines Design

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering.

Degree: BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: FRANCISCO JAVIER SANZ CANO

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Understanding and mastery of basic concepts about the general laws of mechanics, thermodynamics and electromagnetism fields and waves and their application to solving problems in engineering.
2. An understanding of the basic principles of fluid mechanics and their application in solving engineering problems. The ability to calculate pipes, channels and fluid systems.
3. GrETA/GrEVA - An adequate understanding of the following, as applied to engineering: concepts and laws that govern the processes of energy transfer, the movement of fluids, the mechanisms of heat transfer and phase transition, and their role in analysis of the main aerospace propulsion systems.
4. Applied knowledge of: aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed wing and rotary wing), and theory of structures. (Specific technology module)
5. Adequate and applied knowledge in engineering: fundamentals of fluid mechanics describing flow in all regimes to determine pressure distributions and forces on aircraft. (Specific technology module: Aircraft)

TEACHING METHODOLOGY

The subject is divided in two parts:
Part 1: combines theoretical lessons plus a guided project development.
Part 2: attendance to conferences given by specialized professionals of the wind energy sector.

Lab practices
This subject does not contain laboratory practices. However, it is required to develop a project that will be guided by the professor of the subject.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of the subject is to give a general view of the wind turbine design and its operation. Additionally, some aspects related to the wind energy, such as wind farm layout, deployment, energy management and grid connection, are also considered.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	40.00
Self study	45,0	60.00

Total learning time: 75 h

CONTENTS

Module 1. Wind energy introduction

Description:
Topic 1. Wind turbine history.
Topic 2. Wind turbine types.
Topic 3. Wind energy current status.
Topic 4. Wind turbine components.

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 2. Wind turbine aerodynamics and performance

Description:
Topic 5. Airfoil aerodynamics and selection criteria for wind turbine rotors.
Topic 6. Blade Element Momentum Theory
Topic 7. Wind turbine rotor blade geometry definition.
Topic 8. Wind turbine power and noise curves.

Full-or-part-time: 33h
Theory classes: 9h
Self study : 24h

Module 3. Wind turbine design and certification process

Description:
Topic 9. Wind turbine load assumptions standards:
- aerolastic simulations
- dynamic analysis
- ultimate and fatigue load analysis
Topic 10. Loads, power and noise measurement standards.

Full-or-part-time: 6h
Theory classes: 3h
Self study : 3h

Module 4. Structural design of wind turbine rotor blades

Description:
Topic 11. Structural solutions and materials
Topic 12. Blade-hub joint
Topic 13. Manufacturing process
Topic 14. Full scale test

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 5. Wind resource

Description:
Topic 15. Wind characterisation and prediction.
Topic 16. Weibull distribution and annual energy yield calculation.
Topic 17. Micrositing.

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 6. Wind turbine conceptual design

Description:
Topic 18. Nacelle lay-out, rotor and control strategy.

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 7. Wind turbine control design

Description:
Topic 19. Closed-Loop Control.
Topic 20. Supervisory control/Real-Time Systems.

Full-or-part-time: 6h
Theory classes: 3h
Self study : 3h

Module 8. Wind turbine electrical design

Description:
Topic 22. Electrical components.
Topic 23. Constant and variable speed systems.
Topic 24. Converter types.
Topic 25. Modulation and control techniques
Topic 26. Grid integration.
Topic 27. Power quality.

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 9. Wind turbine mechanical design

Description:
Topic 28. Tools and methodologies. Power train, yaw and pitch systems. Design validation.

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 10. Structural design

Description:
Topic 29. Tower and substructures
Topic 30. Nacelle

Full-or-part-time: 6h
Theory classes: 3h
Self study : 3h

GRADING SYSTEM

The qualification of the subject is divided in two parts: guided project (40%) and written exam (60%). The guided project will be handed over at the end of the subject. The written exam will consist in a single exam that will be done at the end of the subject about part 1 as well as part 2. Attending the conferences given during part 2 is compulsory.
Mf = 0,60Me + 0,40Mp.
Mf : Final mark
Me : Exam mark
Mp : Project mark

BIBLIOGRAPHY

Basic:
- Burton, Tony [et al.]. Wind energy handbook [on line]. 2nd ed. Chichester: John Wiley & Sons, 2011 [Consultation: 07/10/2022]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781119992714. ISBN 9780470699751.
- Rodríguez, J.L.; Burgos, J.C.; Arnalte, S. Sistemas eólicos de producción de energía eléctrica. Alcorcón: Rueda, 2003. ISBN 8472071391.

Complementary:
- Creus Solé, Antonio. Aerogeneradores. [S.l.]: Cano Pina, 2008. ISBN 9788496960213.