

## Course guide

### 220038 - WTD - Wind Turbines Design

**Last modified:** 11/04/2025

**Unit in charge:** Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
**Teaching unit:** 748 - FIS - Department of Physics.

**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:** 2025    **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.

$M_f = 0,60M_e + 0,40M_p$ .

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.recurros.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.

