Course guide
220038 - 220038 - Wind Turbines Design

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: 2022  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. GrE/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. GrE - Applied knowledge of aerodynamics, mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed-wing and rotary-wing), structural theory.
5. GrEVA - An adequate understanding of the following, as applied to engineering: the fundamentals of fluid mechanics describing flow in all regimes in order to determine the distributions of pressures and forces acting on 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>45,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>40.00</td>
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</tbody>
</table>

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.

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:
- aerelastic 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 17. Micrositing.

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

Module 6. Wind turbine conceptual design

Description:

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

Module 7. Wind turbine control design

Description:

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 25. Modulation and control techniques
Topic 27. Power quality.

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

Module 9. Wind turbine mechanical design

Description:

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.

\[ M_f = 0,60M_e + 0,40M_p \]

\( M_f \): Final mark
\( M_e \): Exam mark
\( M_p \): Project mark

BIBLIOGRAPHY

Basic:

Complementary: