220038 - Wind Turbines Design

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering
Academic year: 2019
Degree: BACHELOR’S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR’S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR’S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 3
Teaching languages: English

Teaching staff
Coordinator: FRANCISCO JAVIER SANZ CANO

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. GrETA - 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>Total learning time: 75h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>40.00%</th>
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<tbody>
<tr>
<td></td>
<td>Self study:</td>
<td>45h</td>
<td>60.00%</td>
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# 220038 - Wind Turbines Design

<table>
<thead>
<tr>
<th><strong>Content</strong></th>
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</table>
| **Module 1. Wind energy introduction** | **Learning time:** 4h  
Theory classes: 2h  
Self study: 2h |
| **Description:**  
Topic 1. Wind turbine history.  
Topic 2. Wind turbine types.  
Topic 3. Wind energy current status.  
| **Module 2. Wind turbine aerodynamics and performance** | **Learning time:** 33h  
Theory classes: 9h  
Self study: 24h |
| **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. |
| **Module 3. Wind turbine design and certification process** | **Learning time:** 6h  
Theory classes: 3h  
Self study: 3h |
| **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. |
| **Module 4. Structural design of wind turbine rotor blades** | **Learning time:** 4h  
Theory classes: 2h  
Self study: 2h |
| **Description:**  
Topic 11. Structural solutions and materials  
Topic 12. Blade-hub joint  
Topic 13. Manufacturing process  
Topic 14. Full scale test |
### Module 5. Wind resource

**Learning time:** 4h  
Theory classes: 2h  
Self study: 2h

**Description:**  
Topic 15. Wind characterisation and prediction.  
Topic 17. Micrositing.

### Module 6. Wind turbine conceptual design

**Learning time:** 4h  
Theory classes: 2h  
Self study: 2h

**Description:**  

### Module 7. Wind turbine control design

**Learning time:** 6h  
Theory classes: 3h  
Self study: 3h

**Description:**  

### Module 8. Wind turbine electrical design

**Learning time:** 4h  
Theory classes: 2h  
Self study: 2h

**Description:**  
Topic 22. Electrical components.  
Topic 23. Constant and variable speed systems.  
Topic 25. Modulation and control techniques  
Topic 27. Power quality.
## Module 9. Wind turbine mechanical design

### Learning time: 4h
- Theory classes: 2h
- Self study: 2h

### Description:

## Module 10. Structural design

### Learning time: 6h
- Theory classes: 3h
- Self study: 3h

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

### Qualification 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:**