820156 - GEOEN - Wind Energy Generation

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: SERGIO RATÉS PALAU
Others: Primer quadrimestre:
SERGIO RATÉS PALAU - T11, T12

Degree competences to which the subject contributes

Specific:
1. Understand the applications of renewable energies.

Teaching methodology

- In the theory classes, will be exposed and develop the theoretical foundations of programmed materials. They consist of theoretical explanations complemented by activities to encourage participation, discussion and critical analysis by students.
- In the classes of problems will arise and solve exercises related to the matters. Students should meet individually or in groups, indicating problems. Within hours, students will conduct laboratory practices as required and submit the relevant report of the activity along with appropriate calculations and critical considerations.
- Will work in groups during the course of a specific topic related to the subject.

Learning objectives of the subject

- Understand the different technologies of wind generation of electricity.
- Know how to determine the location of wind resources.
- Understand the different possibilities of control of wind turbines.
- Understand its operation in the power system.
- Know how to model, simulate and analyze the different parts and the whole farm system.
- Learn to perform a pre-dimensioning of wind systems.
## Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
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<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td>45h</td>
<td>0h</td>
<td>15h</td>
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</table>

- **45h** (30.00%) for large group activities.
- **0h** (0.00%) for medium group activities.
- **15h** (10.00%) for small group activities.
- **0h** (0.00%) for guided activities.
- **90h** (60.00%) for self study.

Total learning time: 150h

- **30.00%** for large group activities.
- **0.00%** for medium group activities.
- **10.00%** for small group activities.
- **0.00%** for guided activities.
- **60.00%** for self study.
<table>
<thead>
<tr>
<th>Content</th>
<th>Learning time: 10h</th>
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<tbody>
<tr>
<td></td>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>1. - General Concepts</td>
<td>Theory classes: 3h</td>
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<tr>
<td></td>
<td>Laboratory classes: 1h</td>
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<tr>
<td></td>
<td>Self study : 6h</td>
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1.1 Overview of Wind Energy Conversion Systems (WECS)
1.2 Wind Energy technology
1.3 WECS configurations
1.4 Grid Code

<table>
<thead>
<tr>
<th>Learning time: 20h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>2.- The wind resource.</td>
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<tr>
<td>Theory classes: 6h</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<tr>
<td>Self study : 12h</td>
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</tbody>
</table>

2.1 General concepts.
2.2 Variation in height and space
2.3 Variability of wind in time
2.4 Determination of gross energy yield
2.5 Assessment of resources
2.6 Wind measurements
2.7 Special offshore effects

<table>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>3.- Fundamentals of wind energy conversion system control</td>
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<tr>
<td>Theory classes: 6h</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<tr>
<td>Self study : 12h</td>
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3.1 Wind turbine aerodynamics
3.2 Maximum power point tracking (MPPT) control
3.3 Wind turbine components
4.- Wind generators and modelling

**Description:**
- 4.1 Reference frame transformations
- 4.2 Induction generator models
- 4.3 Synchronous generators

**Learning time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h

5.- Power Converters in wind energy conversion systems

**Description:**
- 5.1 Two-level voltage source converters
- 5.2 Three-level neutral point clamped converters
- 5.3 Comparison 2-level and 3-level converters
- 5.4 Converter control

**Learning time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h

6.- Wind Energy Conversion System Configurations

**Description:**
- 6.1 Fixed speed WECS
- 6.2 Variable speed induction generator WECS
- 6.3 Variable speed synchronous generator WECS

**Learning time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h

7.- Wind Farm Layout

**Description:**
- 7.1 Wind Farm layout design
- 7.2 Electrical grid collector design
- 7.3 Wind farm connected to High voltage alternative current (HVAC)
- 7.4 Wind farm connected to High Voltage direct current (HVDC)

**Learning time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h
8.- Grid Integration

Learning time: 10h
- Theory classes: 3h
- Laboratory classes: 1h
- Self study: 6h

Description:
- 8.1 Power system concepts
- 8.2 Wind power variability and limited predictability
- 8.3 Grid Codes for Wind Turbines
- 8.4 Grid Code requirements

Qualification system
- Work practices done during the course (50%)
- Test done at the end (35%)
- Realization of problems individually at laboratory (15%)

Regulations for carrying out activities
- The written tests are face and individual.
- In the classes of problems and / or laboratory practices will be assessed, where appropriate, the prior work with the presentation of results of each activity.

Bibliography

Basic:

Complementary: