820750 - EPARD - Power Electronics Applied to Distributed Energy Resources

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2018
Degree: ERASMUS MUNDUS MASTER’S DEGREE IN ENVIRONMENTAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Teaching unit Optional)
MASTER’S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ERASMUS MUNDUS MASTER’S DEGREE IN ENVIRONMENTAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2010). (Teaching unit Optional)
MASTER’S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: Bergas Jane, Joan Gabriel
Others: Bergas Jane, Joan Gabriel

Opening hours
Timetable: Monday from 19:00 to 21:00
Wednesday from 10:00 to 12:00 and from 16:00 to 18:00

Prior skills
Basics on Electrical and Electronic Engineering

Degree competences to which the subject contributes

Specific:
CEMT-6. Employ technical and economic criteria to select the most appropriate electrical equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technology applications in the field of production, transport, distribution, storage and use of electric energy.
CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

Teaching methodology
The course development includes the following teaching methods:
- Master class (EXP): theory exposition and slides-based lecturing.
- Oriented individual works (TD): individual works of reduced complexity or extension. The acquired knowledge will be applied in these works, and the results will be presented. Their elaboration will start in the classroom (with the teacher’s guidance) and will end out of the classroom.
- Evaluation activities (EV). Some problems will be proposed as assignment.

Learning objectives of the subject

Objectives
The aim of this course is to deepen techniques of power electronics and control systems based on microprocessors. These
techniques focus on the torque and speed control of electric machines, as well as the flow control of the power of electrical network.

Learning outcomes

Upon completing the course, the student should:
- Model and simulate a power converter.
- Design and use a commercial converter.
- Apply a converter to DER (Distributed Energy Resources).
- Apply a converter against the network (Active Front Ends and FACTS).

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>0h</th>
<th>0.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>30h</td>
<td>24.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>10h</td>
<td>8.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>85h</td>
<td>68.00%</td>
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<tr>
<td>Content</td>
<td>Introduction to static converters</td>
<td>Sinusoidal signals generation (PWM)</td>
<td>Current control closed-loops: constant frequency, quasi-constant and variable frequency.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>To give the fundamentals of static converters comprising its modelling and sizing.</td>
<td></td>
<td>Introduction to PEBB (Power Electronic Building Blocks).</td>
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**Learning time:**
- Introduction to static converters: 44h
  - Laboratory classes: 9h
  - Guided activities: 5h
  - Self study: 30h
- Sinusoidal signals generation (PWM): 33h
  - Laboratory classes: 8h
  - Guided activities: 5h
  - Self study: 20h
- Current control closed-loops: constant frequency, quasi-constant and variable frequency: 33h
  - Laboratory classes: 8h
  - Guided activities: 5h
  - Self study: 20h
### Applications

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<th>Learning time: 15h</th>
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<tr>
<td>Laboratory classes: 5h</td>
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<tr>
<td>Self study: 10h</td>
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### Description:

1. Passive, active and hybrid filters and FACTS (Flexible AC Transmission Systems).
2. Photovoltaic and Wind Converters.

### Specific objectives:

Sizing and simulation of a series of typical applications of the power converters.
<table>
<thead>
<tr>
<th>Planning of activities</th>
<th>Hours: 9h 30m</th>
</tr>
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</table>
| **A1. Simulation of the reductor-converter** | Practical classes: 2h  
Guided activities: 2h 30m  
Self study: 5h |
| **Description:** | Simulation with PSIM of a buck converter-reducer. |
| **Support materials:** | PSIM software and activity guide. |
| **Descriptions of the assignments due and their relation to the assessment:** | Delivery of a report with the results and observations of the simulation. |
| **Specific objectives:** | To introduce students to a software simulation of power electronic components. |

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<tr>
<th><strong>A2. Simulation of the H-bridge, and the torque and speed control of a DC-Motor with Simulink</strong></th>
<th>Hours: 9h 30m</th>
</tr>
</thead>
</table>
| Practical classes: 2h  
Guided activities: 2h 30m  
Self study: 5h |
| **Description:** | Simulation of the H-bridge, and the torque and speed control of a DC-Motor with Simulink |
| **Support materials:** | Simulink software and activity guide |
| **Descriptions of the assignments due and their relation to the assessment:** | Delivery of a report with the results and observations of the simulation. |
| **Specific objectives:** | Introduce students to a software of generic simulation focused on the behaviour of a system, which allows the execution of control algorithms. |

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<tr>
<th><strong>A3. SVPWM Simulink Simulation</strong></th>
<th>Hours: 18h</th>
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| Practical classes: 3h  
Guided activities: 5h  
Self study: 10h |
| **Description:** | SVPWM Simulink Simulation |
| **Support materials:** | Simulink software and activity guide |
| **Descriptions of the assignments due and their relation to the assessment:** | Delivery of a report with the results and observations of the simulation. |
| **Specific objectives:** | Students will develop a c-mex as if it were an embedded application. |
A4. Simulation with Simulink of a current control close-loop in Park's variables. 

**Hours:** 18h  
Practical classes: 3h  
Guided activities: 5h  
Self study: 10h

**Description:**  
Simulation with Simulink of a current control close-loop in Park's variables.

**Support materials:**  
Simulink software and activity guide

**Descriptions of the assignments due and their relation to the assessment:**  
Delivery of a report with the results and observations of the simulation.

**Specific objectives:**  
Introduction to the three-phase current close-loop in simulation.

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**Qualification system**

Written test (final exam) (PE): 50 %  
Oriented individual works (TD): 40 %  
Oral presentations (PO): 10%

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**Bibliography**

**Basic:**