## 220108 - Power Converters

**Coordinating unit:** 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering  
**Academic year:** 2018  
**Degree:** BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)  
**ECTS credits:** 4,5  
**Teaching languages:** Catalan, Spanish, English

### Teaching staff

**Coordinator:** Lamich Arocas, Manuel  
**Others:** Arias Pujol, Antoni  
José Luis Romeral Martínez

### Prior skills

- Good knowledge of Circuits Theory  
- Basic knowledge of electronic devices. (Diodes, Transistors, MOS-FET).  
- Basic knowledge of Fourier analysis, (as given in Calculus Subject)

### Degree competences to which the subject contributes

**Specific:**  
1. Applied knowledge of power electronics.

### Teaching methodology

**Activities:**  
- Lectures on theoretical matters and practical exercises.  
- Laboratory Sessions. During the laboratory sessions, different applications with converters will be developed at the simulation level.

### Learning objectives of the subject

Show the students the structure and applications of different types of power converters and enable them to choose the suitable components. Study of converters used to drive electric machines, to link renewable sources to the grid, to built uninterrupted sources (UPS) and power supplies in general. Provide the basis for designing the control of these converters (related with the subjects of Automatic Control). Study of power transfer between electrical systems and electromechanical systems by means of converters. Study the performance of previous systems. Study of disturbances generated by electrical converters on the mains and electromagnetic fields in the environment.
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### Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 31h 27.56%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group: 14h 12.44%</td>
</tr>
<tr>
<td></td>
<td>Self study: 67h 30m 60.00%</td>
</tr>
</tbody>
</table>

Last update: 19-04-2018
## Content

### Power devices

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power diodes</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Thyristors</td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>MOS-FET, IGBT and MCT</td>
<td>Self study: 10h</td>
</tr>
<tr>
<td>Switching characteristics of power devices</td>
<td></td>
</tr>
<tr>
<td>Conduction and commutation loses</td>
<td></td>
</tr>
<tr>
<td>Passive components in Power Electronics</td>
<td></td>
</tr>
</tbody>
</table>

**Related activities:**
- Activity 1

**Specific objectives:**
Describe the behaviour and characteristics of the different power devices

### Simulation tools

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 7h</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORCAD PSPICE circuits simulator</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Matlab-Simulink systems simulator</td>
<td>Self study: 5h</td>
</tr>
<tr>
<td>&quot;Sim Power Systems&quot; toolbox</td>
<td></td>
</tr>
</tbody>
</table>

**Related activities:**
- Activity 2

**Specific objectives:**
Provide simulation tools to evaluate the behaviour of power devices and power systems.

### Uncontrolled rectifiers

<table>
<thead>
<tr>
<th>Learning time: 20h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study: 12h</td>
</tr>
</tbody>
</table>
### Controlled rectifiers
- **Learning time:** 20h
  - Theory classes: 6h
  - Laboratory classes: 2h
  - Self study: 12h

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

### Inverters
- **Learning time:** 26h
  - Theory classes: 9h
  - Laboratory classes: 3h
  - Self study: 14h

**Description:**
- Types and calculations of voltages and currents
- Control methods: Vector control
- Ressonant converters

**Related activities:**
- Activity 1 and 2

**Specific objectives:**
- Learn about DC-AC conversion
- Learn the calculations and sizing of DC-AC converters

### Static switches and regulators to phase control
- **Learning time:** 4h 30m
  - Theory classes: 2h
  - Self study: 2h 30m

**Description:**
- Types, Voltages and currents calculations
- Control Methods

**Related activities:**
- Activity 1

**Specific objectives:**
- Knowing the structure and control techniques of AC-AC converters by means of phase control.
- Learn the calculations and dimensioning of AC-AC converters by means of phase control.
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### Planning of activities

| ACTIVITY 1: THEORY AND PROBLEM LESSONS | Hours: 73h 30m  
Theory classes: 28h  
Self study: 45h 30m |
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Teaching of theoretical concepts and realization of numerical exercises on different topics. Proposal of new numerical exercises or design tips.</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>Classroom with audiovisual media (PC and overhead projector)</td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td>Design exercises or numerical calculations will be proposed to ensure that students take the time to learn by themselves.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Teach the necessary theoretical knowledge and solve practical exercises to link the theory, the calculation methods and the design of power converters.</td>
</tr>
</tbody>
</table>

| 2. LABORATORY PRACTICE | Hours: 20h  
Laboratory classes: 10h  
Self study: 10h |
|------------------------|------------------|

| 3. SMALL DESIGN PROJECTS | Hours: 16h  
Laboratory classes: 4h  
Self study: 12h |
|--------------------------|------------------|

| 4. MID TERM EXAM | Hours: 1h  
Theory classes: 1h |
|------------------|------------------|

| 5. FINAL EXAM | Hours: 2h  
Theory classes: 2h |
|----------------|------------------|

### Qualification system

- Partial exam 25%
- Final Exam 40%
- Practices consisting on simulation of several converters: 35%
Bibliography

Basic:

Complementary:

Others resources:
- Audiovisual material
  - Apunts

Computer material
  - Software Matlab-Simulink amb Toolbox "Sim Power Systems"

  - Software ORCAD=PSpice