320169 - VE - Electric Vehicles

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: English

Teaching staff
Coordinator: Joan Montañá Puig
Others: David Romero Duran, Luis Martínez Barrios,

Degree competences to which the subject contributes

Transversal:
1. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
3. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

Teaching methodology

1. Theoretical sessions: the professor introduces the theoretical foundations of the subject, concepts, methods, illustrating them with examples to facilitate understanding.
2. Practical work sessions: The sessions of practical work in the classroom and the laboratory.
3. Independent work and study exercises: Students will have to work and study individually and independently in order to assimilate the concepts, solving exercises.

Learning objectives of the subject

Topic 1 Introduction to the subject
Topic 2. Basics of transport: basic knowledge of mechanical transmission of power. There will be emphasis on adherence, layout and aerodynamics.
Topic 3. Motors for electric traction: This topic describes the specific application of electric motors in vehicles.
Topic 4. Energy storage: An important part of electric vehicles is the energy storage.
Topic 5. Electric Vehicle (EV): Student will learn the components of electric vehicles and functions.
Topic 6. Rail traction: One of the classic applications of electric traction is the railway. We will present different modes of traction in trains carrying special emphasis on high speed.
### 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>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td>30h</td>
<td>30h</td>
<td>0h</td>
<td>90h</td>
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<td>20.00%</td>
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## Content

<table>
<thead>
<tr>
<th>TOPIC 1: Introduction</th>
<th>Learning time: 4h</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 2h</td>
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</tbody>
</table>

**Description:**
1.1 Introduction
1.2 History of the electric propulsion and current frame

<table>
<thead>
<tr>
<th>TOPIC 2: Basic knowledge of transport</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 10h</td>
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</tbody>
</table>

**Description:**
2.1 Basic concepts of mechanical power transmission: friction and adhesion
2.2 Basics of aerodynamics
2.3 Basics of inertia and track

**Related activities:**
Activity 1: Issues and case studies in classroom.
Activity 2: Individual test.

<table>
<thead>
<tr>
<th>TOPIC 3: Motors for electric traction</th>
<th>Learning time: 38h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
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<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 4h</td>
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<tr>
<td></td>
<td>Self study: 24h</td>
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</tbody>
</table>

**Description:**
3.1 DC Motors
3.2 Induction Motors
3.3 BLDC Motors
3.4 PMSM Motors
3.5 SRM Motors

**Related activities:**
Activity 1: Case studies in classroom.
Activity 2: Individual test.
Activity 3: Work in the laboratory.
### TOPIC 4: Energy storage

**Description:**
- 4.1 Batteries
- 4.2 Fuel Cells
- 4.4 Kinetic Batteries

**Related activities:**
- Activity 1: Issues and case studies in classroom.
- Activity 2: Individual test
- Activity 3: Work in the laboratory

**Learning time:** 26h
- Theory classes: 6h
- Practical classes: 2h
- Laboratory classes: 2h
- Self study: 16h

### TOPIC 5: Electric vehicles (EV)

**Description:**
- 5.1 EV setting
- 5.2 EV operation
- 5.3 Characteristics of traction
- 5.4 Effort tractor and transmission
- 5.5 Energy Consumption
- 5.6 Regenerative Braking
- 5.7 Hybrid Vehicles

**Related activities:**
- Activity 1: Case studies in classroom.
- Activity 2: Individual test.
- Activity 3: Practice in the laboratory.

**Learning time:** 46h
- Theory classes: 12h
- Practical classes: 2h
- Laboratory classes: 6h
- Self study: 26h
**TOPIC 6: Rail traction**

**Learning time:** 18h  
Theory classes: 4h  
Practical classes: 2h  
Self study: 12h

**Description:**  
6.1 Introduction to propel rail  
6.2 Types of machines railway  
6.3 Structure of electrified tracks

**Related activities:**  
Activity 1: Case studies in classroom.  
Activity 2: Individual test.

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**Qualification system**

- Final test 35%  
- Small project: 20%  
- Practical work: 45%

Practical work includes: 40% experiments on electric vehicle drives; vehicle movement (10%), vehicle performance (20%), batteries (10%), Fuel cells (10%), visit or others (10%). It is compulsory to attend the Practical work sessions.

The Final test will be done according to the schedule of the final exams. Unsatisfying results of the Final test could be repeated in a test to be allocated during the period of the final exams. Students with a grade lower than 5 points (unsatisfactory) can retake the test. The new grade, if it is equal or higher than 5 points, will substitute with the Final test grade with 5 points.
Bibliography

Basic:


Complementary:


