320168 - CCME - Calculation and Construction of Electrical Machines

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: Catalan, Spanish

Teaching staff

Coordinator: José Ignacio Candela García
Others: José Ignacio Candela García y Joan Montaña Puig

Degree competences to which the subject contributes

Specific:
CE19. ELE: Ability to calculate and design electrical machines.

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. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
3. ENTREPRENEURSHIP AND INNOVATION - Level 2. Taking initiatives that give rise to opportunities and to new products and solutions, doing so with a vision of process implementation and market understanding, and involving others in projects that have to be carried out.
4. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
5. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Teaching methodology

- Face sessions exhibition content.
- Classroom work sessions in the classroom.
- Face sessions of laboratory work.
- Self study and exercises.

A presentation of content sessions the teacher will introduce the theoretical foundations of the subject, concepts, methods and results and illustrate them with examples appropriate to facilitate understanding. Students will have all the documentation to the Digital Campus of the subject: theoretical presentations, solved exercises, scripts and proposals for supervised practice.

Students, individually, will have to study to assimilate concepts and solve exercises.

Learning objectives of the subject

Give students an overview of the design of electrical machines (transformers, generators and motors). To know the general rules and methods of dimensioning of electric machines. Understand the limitations of used
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materials (magnetic, conductors, insulation and thermal) in order to obtain an optimized design with engineering criteria. Special emphasis is placed on design methods that rely on the use of finite element programs.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 30h</th>
<th>20.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>15h</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
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<td></td>
<td>Self study:</td>
<td>90h</td>
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<table>
<thead>
<tr>
<th>TEMA 1. Introduction</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Description of the topology of the different types of electrical machines.</td>
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<tr>
<td>Laws and methods in the design of electrical machines.</td>
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<tr>
<td>The circuits of electric machines.</td>
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<table>
<thead>
<tr>
<th>TEMA 2. Introduction to Finite Element Calculation</th>
<th>Learning time: 20h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
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<tr>
<td>Introduction to Finite Element Calculation</td>
<td></td>
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<tr>
<td>Using the FEMM program</td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>TEMA 3. The magnetic circuit</th>
<th>Learning time: 10h</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Introduction to the magnetic circuit. Magnitudes and units.</td>
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<tr>
<td>Standard magnetic materials.</td>
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<tr>
<td>B-H curves. Loss of iron.</td>
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<tr>
<td>Equation of the magnetic circuit. Magnetomotive force to be generated.</td>
<td></td>
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<tr>
<td>Electromotive forces of the different machines.</td>
<td></td>
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<tr>
<td>Permanent magnets.</td>
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</tbody>
</table>
# TEMA 4. The electric circuit

**Learning time:** 10h  
Theory classes: 2h  
Laboratory classes: 2h  
Self study: 6h

**Description:**  
Losses.  
Types of windings. Winding factors.

# TEMA 5. The dielectric circuit

**Learning time:** 10h  
Theory classes: 2h  
Practical classes: 2h  
Self study: 6h

**Description:**  
Dielectric losses. Concepts of tangent losses.  
Insulation in electric machines.  
Insulation sizing.  
Insulation in layers.

# TEMA 6. The Thermal circuit

**Learning time:** 10h  
Theory classes: 2h  
Laboratory classes: 2h  
Self study: 6h

**Description:**  
Generation and evacuation of losses.  
Thermal resistance. Equivalent thermal circuits.  
Heating curves.  
Refrigeration and ventilation systems.
### TEMA 7. Direct current electrical machines

**Learning time:** 20h  
- Theory classes: 4h  
- Practical classes: 2h  
- Laboratory classes: 2h  
- Self study: 12h

**Description:**  
Constructive forms.  
Parameters Determination, torque, speed, power.

### TEMA 8. Transformer

**Learning time:** 10h  
- Theory classes: 2h  
- Practical classes: 2h  
- Self study: 6h

**Description:**  
Constructive shapes.  
Windings. Losses.  
Determination of parameters, voltages, currents and powers.

### TEMA 9. Synchronous machines

**Learning time:** 10h  
- Theory classes: 2h  
- Laboratory classes: 2h  
- Self study: 6h

**Description:**  
Constructive shapes.  
Determination of parameters, torque, speed, power.

### TEMA 10. Asynchronous machines

**Learning time:** 10h  
- Theory classes: 2h  
- Guided activities: 2h  
- Self study: 6h

**Description:**  
Constructive shapes.  
Determination of parameters, torque, speed, power.
TEMÁ 11. Permanent magnet machines | **Learning time:** 10h

- Theory classes: 2h
- Laboratory classes: 2h
- Self study: 6h

**Description:**
Constructive shapes.
Determination of parameters, torque, speed, power.

TEMÁ 12. Variable reluctance machines | **Learning time:** 10h

- Theory classes: 2h
- Practical classes: 2h
- Self study: 6h

**Description:**
Constructive shapes.
Determination of parameters, torque, speed, power.

**Qualification system**
- First exam: 30%
- Segundo exam: 30%
- Laboratory: 25%
- Problems y activities: up to 75%

**Regulations for carrying out activities**
The practices are face-to-face and compulsory.
The subject can be approved as a continuous evaluation only with the practices, problems and activities. You can approve or supplement the note with the two official exams, up to a maximum grade of 10. The examination can take all the bibliographic information that is considered appropriate.
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Bibliography

Basic:


Complementary:


Others resources:

Finite element program for electrical applications FEMM: http://www.femm.info/wiki/Download