Course guide
820143 - EMDEE - Electrical Machines Design

Unit in charge: Barcelona East School of Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
Academic year: 2023 ECTS Credits: 6.0 Languages: Catalan

LECTURER
Coordinating lecturer: Ramon Bargalló Perpiña
Others:

PRIOR SKILLS
MAtrix analysis.
Fourier Methods.
Electromagnetics.
Electrical Machines 1 and 2.
Use of scientific calculator (HP 50G, CFX9950, other)
Use of MATLAB

REQUIREMENTS
Electrical Machines 1 and 2.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONtributes
Specific:
1. Carry out calculations for the design of electrical machines.
2. Apply regulations and standards based on sound criteria.
3. Summarise information and undertake self-directed learning activities.

Transversal:
4. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY
Expositive methodology for theory classes.
PBL for exercises classes.
Training on FE software on laboratory classes.
LEARNING OBJECTIVES OF THE SUBJECT

- To do to the student a general scope in the field of electrical machines and drives. The main treated aspects are their modelling and design.
- To put into practice the FE method to analyse and design electrical machines and apparatus.
- Explain general rules and methods for size electrical machines.
- Explain the main characteristics for materials used in the electrical machines to obtain an optimal design (technical, economical, environmental, etc. criterions are used).

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
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<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
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</tbody>
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Total learning time: 150 h

CONTENTS

Electrical machines modeling using electromagnetic equations.

**Description:**

**Related activities:**
Inductance analysis using FE software.
Actuator analysis using FE software.

**Full-or-part-time:** 13h
Theory classes: 5h
Laboratory classes: 3h
Self study: 5h

Windings for electrical machines

**Description:**
Basis: salient pole windings, slot windings, end windings. Phase windings. MMF and EMF. Fractional windings. Other windings.

**Related activities:**
Winding design for a AC machine. Analysis of MMF and EMF.

**Full-or-part-time:** 18h
Theory classes: 6h
Laboratory classes: 2h
Self study: 10h
### General concepts and limitations in the design of electrical machines.

**Description:**
General expressions for torque. Standards. Scale laws. Flux constant and weakening field work of electrical machines.

**Full-or-part-time:** 16h
Theory classes: 6h
Self study: 10h

### Optimal design methods.

**Description:**

**Related activities:**
Optimal design of an actuator.

**Full-or-part-time:** 18h
Theory classes: 6h
Laboratory classes: 2h
Self study: 10h

### Parameter and losses calculation

**Description:**
FE determination of: losses, emf, cogging torque, torque, inductance, resistance, capacitance, etc.

**Related activities:**
Transformer analysis.

**Full-or-part-time:** 15h
Theory classes: 3h
Laboratory classes: 2h
Self study: 10h

### Heat transfer

**Description:**

**Related activities:**
Thermal analysis of a transformer: steady state calculation, transient calculation.
Combined electromagnetic+thermal analysis.

**Full-or-part-time:** 18h
Theory classes: 6h
Laboratory classes: 2h
Self study: 10h
Design process

Description:
General formulation for sizing electrical machines. Application to: asynchronous, synchronous and permanent magnet machines. Every course one or more detailed process design will be developed.

Related activities:
FE analysis of:
- asynchronous machine. Steady state characteristics
- synchronous PM machine. Torque-angle characteristic, cogging torque, EMF determinations.
- Radial forces. Noise analysis.

Full-or-part-time: 33h
Theory classes: 9h
Laboratory classes: 4h
Self study: 20h

Insulation of electrical machines

Description:
Insulation materials. Monitoring insulation. Statistical analysis. Predictive analysis

Full-or-part-time: 13h
Theory classes: 3h
Self study: 10h

tile en9. Treball dels motors de corrent altern a velocitat variablename

Description:
Context: modificació de velocitat en màquines d'altern. Característiques a velocitat variable.
- Models generals per a l'estudi de la variació de velocitat en màquines de corrent altern: models amb alimentació per corrent. Variables de control. Dependència del rang de treball del flux, relació de saliència i corrent aplicat. Àmbits de treball a parell constant i a potència constant. Màquines amb velocitat màxima finita i infinita.
- Màquina síncrona de pols llios.
- Màquina síncrona de pols sortints.
- Màquina síncrona de reluctància.
- Màquina asíncrona alimentada en corrent.

Specific objectives:
Entendre les variables que intervenen en la variació de velocitat d'un motor i els límits del camp de treball.

Full-or-part-time: 6h
Theory classes: 4h
Self study: 2h

GRADING SYSTEM

Midterm test: 20%
Final test: 20%
Laboratory: 20%
Homework exercises+class exercises: 20%
Homework project (design an electrical machines): 20%
EXAMINATION RULES.

Final test with open books. NO final reexam.

BIBLIOGRAPHY

Basic:

Complementary: