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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

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours medium group:	15h	10.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

TEMA 1. Introduction

Learning time: 10h

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

Description:
Description of the topology of the different types of electrical machines.
Laws and methods in the design of electrical machines.
The circuits of electric machines.

TEMA 2. Introduction to Finite Element Calculation

Learning time: 20h

Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 12h

Description:
Introduction to Finite Element Calculation
Using the FEMM program

TEMA 3. The magnetic circuit

Learning time: 10h

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

Description:
Introduction to the magnetic circuit. Magnitudes and units. Standard magnetic materials. B-H curves. Loss of iron.
Equation of the magnetic circuit. Magnetomotive force to be generated. Electromotive forces of the different machines.
Air gap. Polos. Teeth
Permanent magnets.

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TEMA 4. The electric circuit	Learning time: 10h Theory classes: 2h Laboratory classes: 2h Self study : 6h

Description:
Introduction to the electrical circuit. Magnitudes and units. Commercial electrical materials. Influence of temperature.
Losses.
Types of windings. Winding factors.

TEMA 5. The dielectric circuit	Learning time: 10h Theory classes: 2h Practical classes: 2h Self study : 6h

Description:
Introduction to circuit dielectric. Dielectric rigidity. Dielectric constant. Materiales Aislantes malls.
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:
Introduction to the thermal circuit. Thermal characteristics of materials. Forms of heat transmission: conduction, convection and radiation.
Generation and evacuation of losses.
Thermal resistance. Equivalent thermal circuits.
Heating curves.
Refrigeration and ventilation systems.

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TEMA 7. Direct current electrical machines

Learning time: 20h

Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 12h

Description:
Constructive forms.
Magnetic field in the air gap. Polos. Windings. Losses.
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.
Magnetic field in the air gap. Poles. Coils. Losses.
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.
Magnetic field in the air gap. Poles. Coils. Losses.
Determination of parameters, torque, speed, power.

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TEMA 11. Permanent magnet machines	Learning time: 10h Theory classes: 2h Laboratory classes: 2h Self study : 6h

Description:
Constructive shapes.
Magnetic field in the air gap. Poles. Coils. Losses.
Determination of parameters, torque, speed, power.

TEMA 12. Variable reluctance machines	Learning time: 10h Theory classes: 2h Practical classes: 2h Self study : 6h

Description:
Constructive shapes.
Magnetic field in the air gap. Poles. Coils. Losses.
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:

Pyrhönen, Juha; Hrabovcová, Valéria; Jokinen, Tapani. Design of rotating electrical machines. Chichester: John Wiley & Sons, 2013. ISBN 9781118581575.

Corrales Martín, Juan. Cálculo industrial de máquinas eléctricas. Barcelona ; México D.F.: Marcombo Boixareu, DL 1982. ISBN 8426704387.

Gieras, Jacek F. Permanent magnet motor technology: design and applications. 3rd ed. Boca Raton: CRC Press, 2010. ISBN 9781420064407.

Complementary:

Kulkarni, S. V; Khaparde, S.A. Transformer engineering: design and practice [on line]. New York: Marcel Dekker, cop. 2004 [Consultation: 19/05/2014]. Available on: <http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10162455>. ISBN 0824756533.

Corrales Martín, Juan. Cálculo modular de máquinas eléctricas . Barcelona: Marcombo Boixareu, cop. 1994. ISBN 8426709850.

Hamdi, Essam S. Design of small electrical machines. Chichester [etc.]: John Wiley & Sons, cop. 1994. ISBN 0471952028.

Others resources:

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