



## Course guides

# 820128 - ME2EE - Electrical Machines II

Last modified: 21/06/2021

**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). (Compulsory subject).

**Academic year:** 2021    **ECTS Credits:** 6.0    **Languages:** Catalan

### LECTURER

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**Coordinating lecturer:** Ramon Bargalló Perpiñà

**Others:** Primer quadrimestre:  
RAMON BARGALLO PERPIÑA - M11, M12, M13, M14  
JAVIER MORALES LÓPEZ - M11, M12, M13, M14

Segon quadrimestre:  
RAMON BARGALLO PERPIÑA - T11, T12, T13, T14  
IVAN FLOTATS GIRALT - T11, T12, T13, T14

### PRIOR SKILLS

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Differential and Integral calculus  
Matrix calculus  
Numerical resolution of ODE  
Complex number algebra  
Electromagnetics  
DC and AC circuit analysis  
Transient circuit analysis (1st and 2n order)  
Scientific calculator use (HP 50G and CFX-9950)  
Some knowledge of MATLAB/OCTAVE

### REQUIREMENTS

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MÀQUINES ELÈCTRIQUES I - Prerequisite

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. Carry out calculations for the design of electrical machines.
- CEELE-20. Understand machine control and electric drives and their applications.

**Transversal:**

2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

### TEACHING METHODOLOGY

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Expositive methodology for theory classes.  
PBL for exercises classes.  
Normalized test on laboratory classes.

## LEARNING OBJECTIVES OF THE SUBJECT

Electrical machines analysis feeds with industrial grid or ideal electronic converter.  
Non conventional machines analysis  
Transient analysis of AC machines  
Introduction to design of electrical machines

## STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Self study	90,0	60.00
Hours small group	15,0	10.00

**Total learning time:** 150 h

## CONTENTS

### Tema 0: màquina asíncrona com a generador. Altres modes de funcionament.

#### Description:

Treball com a generador de la màquina asíncrona. Generador NO autònom. Generador autònom.  
Màquina asíncrona doblement alimentada. Treball com a motor i generador.  
Frenat de la màquina asíncrona.  
La màquina asíncrona en règim desequilibrat. Components simètriques.  
Motor bifàsic.  
Motor monofàsic. Motor amb condensador d'engegada i permanent.  
Motor amb espira d'ombra.

#### Specific objectives:

Estudi de la màquina asíncrona com a generador, doblement alimentada i alimentada de forma desequilibrada. Estudi del motor bifàsic i monofàsic.

#### Related activities:

Pràctica. Treball com a generador de la màquina asíncrona. Cas autònom i no autònom.  
Pràctica. Assaig del motor monofàsic.

#### Full-or-part-time: 10h

Theory classes: 5h  
Laboratory classes: 2h  
Self study : 3h

### Synchronous machines: Generator operation

#### Description:

Synchronous machine. Construction. Field excitation. Stator Winding. No load operation. Liakage. Influence of power factor on resultant field. Saturation. Equivalent circuit. Synchronous reactance. Short circuit test. Power and torque. Limits. Salient pole machine. Torque and power equation.

#### Related activities:

Test of generator. No load test. Short circuit test. Reactive characteristic. Potier's parameters. Direct and Quadrature reactances.

#### Full-or-part-time: 31h

Theory classes: 10h  
Laboratory classes: 2h  
Self study : 19h



### Synchronous machine: motor operation

**Description:**

Synchronous motor. Voltage operation. Limits. Starting. Salient pole motors. Power and torque expressions. Characteristics. Current operation. Characteristics. Synchronous reluctance motor. Self-commutated synchronous machine.

**Related activities:**

Grid Synchronization of synchronous generator. Working as a motor. Constant power characteristics.

**Full-or-part-time:** 28h

Theory classes: 10h

Laboratory classes: 2h

Self study : 16h

### Lesson 3. Variable speed analysis of electrical motors

**Description:**

- Context: modificació de velocitat en màquines d'altern. Característiques a velocitat variable.
- Variació de velocitat en la màquina asíncrona. Mètodes convencionals. Variació del nombre de pols. Variació de la tensió aplicada. Variació de la tensió i la freqüència. Màquina asíncrona doblement alimentada.
- 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 llisos.
- 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.

**Related activities:**

Laboratori. Determinació de característiques a velocitat variable d'un motor.

**Full-or-part-time:** 19h

Theory classes: 5h

Laboratory classes: 2h

Self study : 12h

### Non conventional machines

**Description:**

Electromechanical energy conversion principles. Study of lineal and rotating systems. Multiple excitation systems. Torque. Switched reluctance machines. Step motors. Linear motors. Other.

**Related activities:**

Step motor test.

Asynchronous linear motor test

**Full-or-part-time:** 36h

Theory classes: 12h

Laboratory classes: 3h

Self study : 21h



### Transients and Dynamics of electrical machines

**Description:**

3-2 transformations. Rotating references. Flux, voltage, power and torque expressions. Equivalent circuits for transient analysis. Case study.

**Related activities:**

Starting of induction machine. Simulation. Experimental test.

**Full-or-part-time:** 17h

Theory classes: 5h

Laboratory classes: 2h

Self study : 10h

### Design of electrical machines

**Description:**

General expressions for torque. Standards. Scale laws. FE applications for analysis and design of electrical machines

**Related activities:**

FE analysis of electrical machine

**Full-or-part-time:** 5h

Theory classes: 2h

Laboratory classes: 1h

Self study : 2h

### Direct current machines

**Description:**

Introduction. Constructional features. Armature voltage. Armature reaction. Commutation. Magnetization curve. Generators. Motors. Excitation methods. Mechanical characteristics. Universal motors.

**Related activities:**

DC generator test

DC motor test.

**Full-or-part-time:** 4h

Theory classes: 1h

Laboratory classes: 1h

Self study : 2h

## GRADING SYSTEM

Final test: 35%

Laboratory: 25%

Middle term exam: 30%

Homework exercises: 10%

## EXAMINATION RULES.

Scientific calculator

open book exams. No reexam.



## BIBLIOGRAPHY

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### Basic:

- Fitzgerald, A. E. (Arthur Eugene); Umans, Stephen D.. Electric machinery. 7th ed. Boston [etc.]: McGraw-Hill, 2014. ISBN 9780071326469.
- Fraile Mora, Jesús. Màquines elèctriques. 7a ed. Madrid [etc.]: Garceta, 2015. ISBN 9788416228133.
- Boldea, I.; Tutelea, Lucian. Electric machines : steady state, transients and design with MATLAB. Boca Raton [etc.]: CRC Press / Taylor & Francis Group, cop. 2010. ISBN 9781420055726.
- Pyrhönen, Juha; Jokinen, Tapani; Hrabovcová, Valéria. Design of rotating electrical machines [on line]. 2nd ed. Chichester: John Wiley & Sons, 2013 [Consultation: 03/06/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1414122>. ISBN 9780470695166.

### Complementary:

- Gieras, Jacek F.; Wing, Mitchell. Permanent magnet motor technology: design and applications. 3rd ed. Boca Raton [etc.]: CRC Press, cop. 2010. ISBN 9781420064407.