

## Course guide

### 240IEE32 - 240IEE32 - Power Electronics Systems

**Last modified:** 16/05/2023

**Unit in charge:** Barcelona School of Industrial Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering.

**Degree:** MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).

**Academic year:** 2023    **ECTS Credits:** 4.5    **Languages:** Catalan, Spanish, English

#### LECTURER

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**Coordinating lecturer:** Bordonau Farrerons, Jose

**Others:**

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

CEMEI07. Ability to design electronic systems and industrial instrumentation.

CEEENE1. Apply knowledge and valuation criteria on the design and evaluation of technological solutions for a good use of the renewable sources of energy, both in stand-alone systems as the ones connected to the network. Recognise and value the most innovative technological applications in the field of making a good use of the renewable source of energy.

CEMEI16. Ability for the research management, development and technological innovation.

CEEMAT1. Design and develop products, processes, systems and services, as well as the optimization of others already developed, taking proper account of the selection of materials for specific applications.

CEEECT2. Analyse, diagnose and maintain the electronic systems and manage the maintenance equipment of electronic systems or of systems in which the electronic subsystems have an important specific weight.

#### TEACHING METHODOLOGY

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#### LEARNING OBJECTIVES OF THE SUBJECT

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1. Design of Power Electronics Converters towards a technological professional career or combined with a later responsibility in product management, as a technical director or as an innovation director.
2. Analyze, test, design power electronics systems, managing the typical challenges in an R&D lab, as close as possible to reality.
3. Design, develop and utilize power electronics converters in industrial applications and energy management systems.

Learning-by-doing in the lab sessions:

- The student takes the role of a junior engineer in a company designing power electronics converters. The students work in teams of 2. The professor takes the role of the Technical Director.
- The professor proposes the design, simulation, assembly and test of a power electronics converter for a real application, the converter supplying energy to the microprocessor from the battery in a portable computer.
- The professor proposes starting specifications very close to the real ones in an R+D lab in a company. The students work towards the development of the converter, under the supervision of the professor.
- The design optimizes 3 challenges: cost, losses and volume/weight minimization.
- The students present their designs and the results are compared.



## STUDY LOAD

Type	Hours	Percentage
Hours small group	13,5	12.00
Hours large group	27,0	24.00
Self study	72,0	64.00

**Total learning time:** 112.5 h

## CONTENTS

### Power Electronics Systems

#### Description:

1. Introduction to Power Electronics
  - a. Block diagram of a typical system.
  - b. First approach to applications.
  - c. Common specifications.
  - d. Methodology for the analysis.
2. Power Electronics devices
  - a. Diodes
  - b. SCR, TRIAC, GTO
  - c. BJT
  - d. MOSFET
  - e. IGBT
  - f. Drivers
  - g. Snubbers
3. DC-DC converters
  - a. Buck
  - b. Boost
  - c. Buck-boost and Cuk
  - d. Topologies with isolation
  - e. Applications to power supplies
  - f. Application to Maximum Power Point Tracking (MPPT) in solar PV systems
4. DC-AC converters
  - a. Rectangular modulation, PWM
  - b. Single-phase
  - c. Three-phase
  - d. Multilevel
  - e. Application to ac drives
  - f. Grid-connected PV systems
5. AC-DC converters
  - a. Commutated by the line: single-phase, three-phase
  - b. Self-commutated
  - c. Application: Uninterruptible Power System (UPS)
6. Ac-AC converters
  - a. AC switch
  - b. Cycleconverter
  - c. Application: regulation of appliances

#### Specific objectives:

- Funcionament d'un departament d'I+D i del rol d'Enginyer/a júnior.
- Repte de disseny real, amb especificacions industrials.
- Repte de fer funcionar al laboratori el sistema electrònic de potència (?learning-by-doing?).
- Visió global de l'aplicació de convertidors electrònics de potència en la indústria i en l'aprofitament i gestió de l'energia elèctrica.
- Adquirir metodologies d'anàlisi de convertidors electrònics de potència, tant a nivell de blocs com en la seva estructura interna.
- Simulació de convertidors electrònics de potència.
- Coneixements de modulació i control de convertidors electrònics de potència.
- Coneixements de modelat de convertidors electrònics de potència, per aplicar-los en sistemes de control.
- Metodologies de disseny de convertidors electrònics de potència.
- Especificació industrial de convertidors electrònics de potència.
- Definició de prestacions de convertidors electrònics de potència, orientats a una aplicació.
- Tecnologia associada als components:
- Dispositius electrònics i circuits de "driver".
- Components reactius
- Sistemes de dissipació tèrmica.
- Tècniques de prototipat.
- Introducció al disseny industrial de convertidors.
- Modelització dels elements paràsits en Electrònica de Potència.



- Circuits d'ajuda a la commutació ("snubbers").
- Proteccions.

**Full-or-part-time:** 3h

Theory classes: 1h

Laboratory classes: 1h

Guided activities: 1h

## ACTIVITIES

### Lecture

**Description:**

16 lectures about theory and content for the lab sessions.

**Full-or-part-time:** 1h 30m

Theory classes: 1h 30m

### Samples of problems

**Description:**

8 sessions of problem samples.

**Material:**

Own resources, published in Atenea.

**Full-or-part-time:** 1h 30m

Practical classes: 1h 30m

### Lab sessions

**Description:**

6 lab sessions with the supervision of the professor for doing the design of the system proposed in the course: system to convert the battery voltage in to the microprocessor supply voltage in a laptop computer, optimizing cost, efficiency and size.

**Material:**

Own resources in Atenea.

**Full-or-part-time:** 2h

Laboratory classes: 2h

## GRADING SYSTEM

Exam 1st half of the course: 30 % (theory, laboratory and problem).

Exam 2nd half of the course: 30 % (theory, laboratory and problem).

Presentation and report of the lab sessions: 40 %

Re-evaluation of the course:

Exam of the whole course 60 % (theory, laboratory and problem).

Lab report and presentation acknowledged if pertinent: 40 %. In other cases, 4 hour lab exercise with design, assembling and experimental verification, evaluated orally: 40 %



## EXAMINATION RULES.

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The theory and lab part of the exam is done with no documentation, based in short questions. The problem is done with documentation.

The lab work is presented showing the operation of the circuit design and assembled.

## BIBLIOGRAPHY

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### Basic:

- Mohan, Ned; Undeland, Tore M; Robbins, William P. Power electronics : converters, applications, and design. 3rd ed. New York [etc.]: John Wiley & Sons, cop. 2003. ISBN 0471226939.