



Course guide

320024 - PEP - Power Electronics Processing

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Joan Rocabert

Others:

PRIOR SKILLS

Students will be expected to have passed Circuit Expansion, Electrical Systems and Electronic Systems, since the knowledge acquired in those subjects is the foundation on which an understanding of power electronic processes must be built.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

1. ELE: understanding of electrical power systems and their applications.

Transversal:

2. 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.
3. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.

TEACHING METHODOLOGY

- Face-to-face sessions in which the lecturer will present concepts, give guidance to the group and set assignments.
- Applied face-to-face sessions. In these sessions, groups of four students will be required to hand in completed assignments to the lecturer. The lecturer decides which students will participate in each of these sessions.
- Independent learning. Students will be expected to use this time to learn concepts, complete the set assignments and prepare class work.
- Group work. Working in groups of four, students will be expected to complete practicals, write up post-practical reports and prepare for defence sessions.

LEARNING OBJECTIVES OF THE SUBJECT

This subject introduces students to the analysis and design of power electronic processors. We start by reviewing the various types of power electronic devices before going on to study their basic configurations and most important industrial applications.

Students will gain an understanding of the operation and characteristics of the specific electronic and electromagnetic components used in power electronic processes.

They will become familiar with the operation and control systems of the most common power electronic processors (rectifiers, DC-DC and one-way power converters) and their use in DC and AC power systems.

Specifically, the subject is an introduction to the field traditionally known as power electronics, with the appropriate descriptive corrections.

STUDY LOAD

| Type | Hours | Percentage |
|--------------------|-------|------------|
| Hours medium group | 15,0 | 10.00 |
| Hours small group | 15,0 | 10.00 |
| Self study | 90,0 | 60.00 |
| Hours large group | 30,0 | 20.00 |

Total learning time: 150 h

CONTENTS

TOPIC 1: INTRODUCTION

Description:

- Introduction to the subject
- Introduction to power electronic processing.

Laboratory sessions

Practical P0. Laboratory safety and rules for power electronic processing.

Specific objectives:

- A better understanding of the basic concepts of electrical systems.
- An understanding of the operating principle of power electronic processors.
- Familiarity with the behaviour guidelines for a power electronic processing laboratory.

Full-or-part-time: 3h

Theory classes: 2h

Laboratory classes: 1h



TOPIC 2: POWER SEMICONDUCTOR DEVICES

Description:

- Power diodes.
- Rectifiers.
- Power switches.
- Switching losses.
- Power switch technology.
- Trigger circuits.

Laboratory sessions

Practical P1. Power switching.

Specific objectives:

- A better understanding of the basic concepts of electrical devices.
- An understanding of the operation and peculiarities of power electronic devices.
- An understanding of the state of the art in power electronic devices.
- Familiarity with a tool for stimulating power electronic systems.
- Familiarity with power switch characteristics.

Full-or-part-time: 6h

Theory classes: 4h

Laboratory classes: 2h

TOPIC 3: DIODE RECTIFIERS

Description:

- Half-wave rectifiers.
- Full-wave rectifiers.
- Parallel and series connection of rectifiers.

Laboratory sessions

Practical P2. Diode rectifier.

Specific objectives:

- A better understanding of the basic concepts of diode rectification.
- An understanding of rectifier's behaviour under different loads.
- An understanding of voltages and currents in rectifiers.
- Familiarity with various rectification topologies.

Full-or-part-time: 10h

Theory classes: 6h

Practical classes: 2h

Laboratory classes: 2h



TOPIC 4: CONTROLLED RECTIFIERS

Description:

- Full-wave rectifiers.
- Symmetrical and asymmetrical triggering.
- Switching control by means of bridge rectifiers.
- Use of controlled rectifiers in DC transmission systems.

Laboratory sessions

Practical P3. Thyristor rectifiers.

Specific objectives:

- An understanding of the operation of controlled rectifiers.
- The ability to analyse a system's voltages and currents under generic triggering conditions.
- An understanding of the operation of controlled rectifiers in rectification mode and inversion mode when used to control a motor.

Full-or-part-time: 10h

Theory classes: 6h

Practical classes: 2h

Laboratory classes: 2h

TOPIC 5: DC-DC POWER CONVERTERS

Description:

- Basic concepts of power converters.
- Buck DC-DC converters.
- Boost DC-DC converters.
- Buck-boost DC-DC converters.
- Cuk and SEPIC converters.
- Converters with galvanic isolation.
- Full-bridge DC-DC converters.
- Main applications.

Laboratory sessions

Practical P4. DC-DC converter.

Specific objectives:

- An understanding of the concept of PWM in switch-based converters.
- Familiarity with and ability to analyse the most common topologies of single-switch converters.
- An understanding of and ability to analyse certain advanced topologies.
- Familiarity with and ability to analyse the operation and performance of full-bridge power converters.
- Familiarity with the main applications of DC-DC converters.

Full-or-part-time: 15h

Theory classes: 6h

Practical classes: 5h

Laboratory classes: 4h



TOPIC 6: DC-AC POWER CONVERTERS

Description:

- Basic concepts of sinusoidal pulse-width modulation (PWM).
- Full-bridge single-phase inverters.
- Full-bridge three-phase inverters.
- Modulation schemes (ZSS-PWM, SVM, DPWM).
- Brief introduction to multi-level and resonant converters.
- Applications of DC-AC power inverters.

Laboratory sessions

Practical P5. DC-AC converter.

Specific objectives:

- An understanding of the synthesis of alternating signals using PWM.
- Familiarity with and ability to analyse single-phase and three-phase DC-AC converters.
- The ability to analyse signals generated using the most common modulation techniques.
- An understanding of and ability to design advanced modulation schemes.
- Familiarity with the operating principles of another type of DC-AC converters.
- Familiarity with the main applications of DC-AC converters.

Full-or-part-time: 16h

Theory classes: 6h

Practical classes: 6h

Laboratory classes: 4h

GRADING SYSTEM

First mid-semester examination - 35%

Second mid-semester examination - 35%

Project plus laboratory work - 30%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.

If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

BIBLIOGRAPHY

Basic:

- Mohan, Ned. Power electronics: converters, applications, and design. 3rd ed. New York: John Wiley & Sons, 2003. ISBN 0471226939.

Complementary:

- Barrado A., Lázaro A. Problemas de electrónica de potencia. Madrid: Prentice Hall, 2007. ISBN 9788420546520.

- Hart, Daniel W. Electrónica de potencia. Madrid: Prentice Hall, 2001. ISBN 8420531790.

- Holmes, D. Grahame. Pulse width modulation for power converters: principles and practice. Hoboken: IEEE Press series on power engineering, 2003. ISBN 0471208140.

- Bose, Bimal K. Power electronics and motor drives: recent advances and trends [on line]. Oxford: Academic, 2006 [Consultation: 07/10/2022]. Available on:

<https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=270068>. ISBN 0120884054.

- Blaabjerg, Frede; Kazmierkowski, Marian P.; Krishnan, Ramu. Control in power electronics: selected problems [on line]. Amsterdam: Academic Press, 2002 [Consultation: 15/06/2022]. Available on: <https://www.sciencedirect-com.recursos.biblioteca.upc.edu/book/9780124027725/control-in-power-electronics>. ISBN 0124027725.

- Erickson, Robert W. Fundamentals of power electronics. 2nd ed. Dordrecht: Kluwer Academic Publishers, 2001. ISBN 0792372700.