# Course guide
# 330107 - EP - Power Electronics

**Last modified:** 04/05/2023

**Unit in charge:** Manresa School of Engineering
**Teaching unit:** 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

**Degree:** BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Optional subject).

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

## LECTURER

**Coordinating lecturer:** INMACULADA MARTINEZ TEIXIDOR

**Others:**

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
1. Applied knowledge of power electronics.
2. Ability to design power electronic systems.
3. Knowledge to develop modeling and simulation of systems.

**Transversal:**
4. 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.
5. 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.
6. 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

The hours of directed learning that are carried out in a medium group, consist, on the one hand, in giving expository classes in which the teacher makes a brief presentation to introduce the general learning objectives related to the basic concepts of the subject, which are combined with Cooperative learning techniques, in which the resolution of practical exercises is proposed from which it is tried to motivate and involve the students so that they participate actively in their learning. Students can access all the support material via ATENEA.

The hours of directed learning that are carried out in a small group, consist of carrying out laboratory practices, which are done in groups, and allow the development of basic instrumental skills in an electronics laboratory, as well as initiating students in the application of the scientific method in problem solving.

In general, after each session, tasks are proposed outside the classroom, to be worked either individually or in groups and that are the basis of autonomous learning.Other hours of autonomous learning must also be considered, such as those dedicated to oriented reading , the resolution of the proposed problems or the self-learning questionnaires of the different contents through the virtual campus ATENEA.

## LEARNING OBJECTIVES OF THE SUBJECT

Upon completion of the Power Electronics course, the student must be able to:

- Know, understand and use the main components of power electronics.
- Know and understand the fundamental structures of power conversion.
- Know the main applications of power converters.
- Carry out measurements in electrical systems and power electronic circuits.
- Properly use modeling and simulation tools.
- Properly use electronic equipment for the experimentation of electrical and electronic circuits.

## 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

**Title content 1: FUNDAMENTALS OF POWER ELECTRONICS**

**Description:**
1.1. Introduction to Power Electronics.
1.2. Basic principles.
1.3. Power and commutation switches.

**Specific objectives:**
- Understand the fundamental principles of power electronics and its applications.
- Study in detail and systematically the circuit breakers and the switching process.

**Related activities:**
Activity 1: Explanatory session on the operation of the Power Electronics Laboratory.
Activity 2: Power Electronics laboratory practices.
Activity 3: Individual evaluation test.
Activity 4: Individual evaluation test.

**Full-or-part-time:** 60h
Theory classes: 18h
Laboratory classes: 6h
Self study : 36h

**Title content 2: STRUCTURES OF STATIC CONVERTERS**

**Description:**
2.1 Continuous-continuous converters.
2.2 DC AC converters.
2.3 AC-DC converters.

**Specific objectives:**
- Know the different structures of converters.
- Analyze and design continuous-continuous converters.
- Analyze and design DC-AC converters.
- Analyze and design AC-DC converters.

**Related activities:**
Activity 1: Explanatory session on the operation of the Power Electronics Laboratory.
Activity 2: Power Electronics laboratory practices.
Activity 3: Individual evaluation test.
Activity 4: Individual evaluation test.

**Full-or-part-time:** 67h
Theory classes: 20h
Laboratory classes: 7h
Self study : 40h

**Title content 3: THE CLOSED LOOP STATIC CONVERTER**

**Description:**
3.1 General concepts.
3.2 DC powered converters. Modulation control.
3.3 AC powered converters. Phase control.

**Specific objectives:**
- Understand and assimilate the basic concepts of closed loop control.
- Design control systems.
- Know the applications of control systems to electrical machines.

**Related activities:**
Activity 1: Explanatory session on the operation of the Power Electronics Laboratory.
Activity 2: Power Electronics laboratory practices.
Activity 4: Individual evaluation test.

**Full-or-part-time:** 23h
Theory classes: 7h
Laboratory classes: 2h
Self study : 14h

## ACTIVITIES

### TITLE OF ACTIVITY 1: EXPLANATORY SESSION

**Description:**
This session serves for the student to become aware of how the practices in this subject will be organized. It will explain the operation of the practices, the organization of the sessions, their evaluation and a brief description of the practices and the materials used in each one will be made. The group-class will be organized in groups of a maximum of 2 students (although they could also be done individually). The Atenea environment will be accessed to observe the disposition of the support materials and to specify the way in which the internship reports and other documents to be evaluated will be delivered.

**Specific objectives:**
Knowledge of the objectives set in the practices of Industrial and Power Electronics.

**Material:**
Athena Virtual Campus.
Practice guide.
Bibliography.
Web links of interest.

**Delivery:**
Oral communication student / teacher.
Control of attendance at the information session.

**Full-or-part-time:** 1h
Laboratory classes: 1h

## TITLE OF ACTIVITY 2: POWER ELECTRONICS LABORATORY PRACTICES

**Description:**
In this part the practical contents related to the Power Electronics subject are addressed. 4 practices will be developed that will cover these contents.

Practice 1. General concepts of power electronics. 2 h laboratory + 5 h autonomous.
Practice 2. PWM control of a direct current motor. 4 h laboratory + 10 h autonomous.
Practice 3. PWM modulation in AC. 4 h laboratory +10 h autonomous.
Practice 4. Control of closed loop converters. 4 h laboratory +10 h autonomous.

**Specific objectives:**
- Use general concepts of Power Electronics to solve practical cases.
- Identify and describe the behavior of power semiconductors.
- Check the operation and analyze applications of different types of power converters.
- Properly use Power Electronics modeling and simulation tools.
- Interpret data sheets of manufacturers of integrated circuits and power semiconductors.
- Carry out assemblies of power circuits.
- Prepare reports of practices in standardized format.

**Material:**
Athena Virtual Campus.
Practice script.
Bibliography.
Links of interest.

**Delivery:**
Previous and / or complementary studies.
Reports of practices.
Attendance at practice sessions.
Oral communication student / teacher.
It represents a part of the continuous evaluation (25%).

**Full-or-part-time:** 49h
Laboratory classes: 14h
Self study: 35h

## TITLE OF ACTIVITY 3: WRITTEN TEST

**Description:**
Individual test in the classroom related to the learning objectives of the subject contents.

**Specific objectives:**
Evaluate the general achievement of the objectives of contents 1 and part of the second.

**Material:**
Statement of the test delivered at the time of the test.

**Delivery:**
The resolved test is delivered to the teacher.
It represents a part of the continuous evaluation of the specific contents of the subject: 37.5%.

**Full-or-part-time:** 16h
Theory classes: 2h
Self study: 14h

**TITLE OF ACTIVITY 4: WRITTEN TEST**

**Description:**
Individual test in the classroom related to the learning objectives of the subject contents.

**Specific objectives:**
Evaluate the general achievement of the objectives of contents 1, 2 and 3.

**Material:**
Statement of the test delivered at the time of the test.

**Delivery:**
The resolved test is delivered to the teacher.
It represents a part of the continuous evaluation of the specific contents of the subject: 37.5%. If the student demonstrates sufficient knowledge of chapters 1 and part of the second, the teacher may approve activity 3. In this case, activity 4 will count for 75% of the final grade for the subject.

**Full-or-part-time:** 16h
Theory classes: 2h
Self study: 14h

## GRADING SYSTEM

- Activity 2: Electronic Systems Laboratory Practices: 25%
- Activity 3: Written test: 37.5%
- Activity 4: Written test: 37.5%

## EXAMINATION RULES.

If any of the laboratory or continuous evaluation activities is not carried out, it will be considered as not scored.

## BIBLIOGRAPHY

**Basic:**
- Ballester, Eduard; Piqué, Robert. Electrónica de potencia: principios fundamentales y estructuras básicas [on line]. Barcelona: Marcombo, 2011 [Consultation: 10/06/2022]. Available on: https://search-ebscohost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=2749464&site=ehost-live&ebv=EK&ppid=Page-__-1. ISBN 9788426716699.

**Complementary:**
- Rashid, M. H. Electrónica de potencia: circuitos, dispositivos y aplicaciones [on line]. 4ª ed. México: Prentice Hall Hispanoamericana, 2016 [Consultation: 07/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6191. ISBN 9786073233255.
- Hart, Daniel W. Electrónica de potencia. Madrid: Prentice Hall, 2001. ISBN 8420531790.
- Mohan, Ned; Undeland, Tore M.; Robbins, William P. Power electronics: converters, applications and design. 3rd ed. New York: John Wiley and Sons, 2003. ISBN 0471226939.

## RESOURCES

**Other resources:**
Specification sheets of electronic components and equipment available on the Internet.