Power Electronics

Academic Year: (2022 / 2023) **Review date: 01-02-2022**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: LAZARO BLANCO, ANTONIO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

-Fundamentals of Electrical Engineering
-Fundamentals of Electronic Engineering

OBJECTIVES

The objective of this course is that the student acquires a solid knowledge in a series of essential horizontal techniques in electronic power electronic converters. In the development of the course, special emphasis will be placed on the application of these techniques on the main converters used by the industry today. To achieve this objective, the student will acquire the following specific skills:
- Understand the operation of electrical components: inductances and capacitors, resistors and transformers. Their operation in permanent regime and capacity to store energy.
- Know and properly handle mathematical tools for the analysis of circuits in non-sinusoidal steady state: average value, RMS value, instantaneous power, average power, Fourier Series, etc.
- To understand the operation of DC-DC converters without isolation and with galvanic isolation. To analyze their applications.
- To know the operation and applications of AC-DC converters or inverters, operating with pulse width modulation (PWM), both in the single-phase and three-phase case.
- To understand the operation of AC-DC rectifiers or converters, operation in critical or boundary mode, in the case of single-phase rectifier and PWM modulation for the three-phase rectifier.

As for the general capabilities or skills, the following will be worked throughout the course:
- Ability to identify, formulate and solve engineering problems.
- Ability to use techniques and tools necessary in modern engineering to reduce equipment development times. The laboratory practices will combine simulations with the PSIM simulator and measurements in the laboratory.
- Ability to perform assemblies and measurements in the laboratory, with special emphasis on those that are typical in a power electronics environment.
Ability to combine theory and practice to solve power electronics problems.
- Have a systematic understanding of the key concepts and aspects of their branch in power electronics.
- Ability to work cooperatively in a team, knowing how to adapt the requirements and working conditions of the subsystem developed by them to work properly within an overall system not only electronic. This facet will be worked through the development of examples and case studies.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to Power Electronics
1.1. Fundamentals of Power Electronics
1.2. Typical Power Electronics Applications

2. Electrical concepts
2.1. Mean value and RMS value of a sinusoidal signal 2.2.
2.2. Fourier series decomposition of a non-sinusoidal periodic signal. Symmetries
2.3. Mean value and r.m.s. value of a non-sinusoidal signal.
Calculation of active, reactive and apparent power.
2.5. Measurement of signal quality: ripple factor, harmonic distortion, power factor.

3. Electrical and electronic components
3.1 Passive components: resistor, coil, capacitor and transformer
3.2. Introduction to electronic components: diode, MOSFETs, IGBTs

4. DC-DC conversion
4.1 Introduction to power supplies
4.2 Switching converters without galvanic isolation 4.2.1.
4.2.1 Step-down topology
4.2.2 Booster topology
4.2.3 Step-down-lifting topology. 4-switch step-up gearbox
4.3 Switched converters with galvanic isolation
4.3.1 "Flyback" topology
4.3.2 "Full-Bridge" topology

5 DC-AC conversion: Inverters
5.2 Introduction to inverters
5.3 Topologies
5.3.1 Half-bridge
5.3.2 Full-bridge
5.3.3 Three-phase bridge
5.4 Sinusoidal PWM modulation
5.4.1 Modulation basics
5.4.2 Single-phase bipolar PWM
5.4.3 Single-phase unipolar PWM
5.4.4 Three-phase single-phase PWM
5.5 Load types
5.5.1 RL load
5.5.2 LC filter and resistive load 5.5.3 Mains connection
5.5.3 Mains connection with L-filter

6 AC-DC conversion: rectifiers and PFCs
6.1 Introduction to rectifiers
6.2 Single-phase uncontrolled rectifiers. C-filter and LC-filter
6.3 Boundary Mode Boost PFCs
6.4 Three-phase elevator PFCs

LEARNING ACTIVITIES AND METHODOLOGY

-Master classes, where will be the knowledge that students need to acquire. To facilitate its development students will receive the transparencies of class and will have basic texts of reference enabling them to complete and deepen the topics in which they are most interested.

-Practical classes aimed at the resolution of exercises. These classes are complemented with the problem solving by the student who will serve as for self-assessing their knowledge and acquire the necessary capabilities.

-Laboratory practice, where the student designs, assembles and test or simulate a power electronic system. These classes allow students to manage teams of electronic instrumentation, a commercial software for circuit simulation and the main electronic components that are object of study.

-There will be sessions of group tutorials, focused on the questions of each of the educational units of the subject after the partial exams and before the final exam.

ASSESSMENT SYSTEM

The evaluation will be based on the following criteria:

- Compulsory laboratory practices (20%): the knowledge acquired by the student in the handling of electronic instrumentation equipment, the realization of simulations and measurements on the main power electronic converters under study will be evaluated.

- Partial exams (20%): the knowledge acquired by the student will be evaluated in the form of practical questions oriented to the design and analysis of circuits, and questions with a greater theoretical orientation.

- Final exam (60%, a minimum grade of 4.0 out of 10 will be required): the knowledge acquired by the student will be evaluated in the form of circuit design and analysis problems of all the contents of the course.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- A. BARRADO, A. LÁZARO Problemas de Electrónica de Potencia, Pearson Prentice Hall, 2007.
- D. W. HART Electrónica de Potencia, Prentice Hall, 2001.
- M.H. RASHID Electrónica de Potencia: Circuitos, Dispositivos y Aplicaciones, Pearson Prentice-Hall, 2004.
- N. MOHAN, T.M. UNDELAND, W.P. ROBBINS Power electronics, converters, applications and design, John Wiley & Sons, 2003.
- R.W. ERICKSON, D. MAKSIMOVIC Fundamentals of Power Electronics, Kluwer Academic Publishers, 2001.

ADDITIONAL BIBLIOGRAPHY

- F.F. MAZDA Electrónica de Potencia: Componentes, Circuitos y Aplicaciones, Paraninfo, 1995.
- S. MARTÍNEZ, J. GUALDA Electrónica de Potencia: Componentes, Topologías y Equipos, Thomson, 2006.