Power Electronics

Academic Year: (2019 / 2020) **Review date: 15-05-2020**

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

By the end of this subject, students will be able to have:
1. a systematic understanding of the key aspects and concepts of their branch of engineering in power electronics;
2. coherent knowledge of their branch of engineering including some at the forefront of the branch in power electronics;
3. the ability to apply their knowledge and understanding of power electronics to identify, formulate and solve engineering problems using established methods;
4. the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements;
5. an understanding of design methodologies, and an ability to use them.
6. workshop and laboratory skills.
7. the ability to select and use appropriate equipment, tools and methods;
8. the ability to combine theory and practice to solve problems of power electronics;
9. an understanding of applicable techniques and methods in power electronics, and of their limitations;

DESCRIPTION OF CONTENTS: PROGRAMME

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

2. Electric Concepts
   2.1. Average Value (avg) and Root Mean Square Value (rms) of a sinusoidal signal.
   2.2. Average Value (avg) and Root Mean Square Value (rms) of a non-sinusoidal signal
   2.3. Fourier Series of periodic waveforms.
   2.4. Instant power, active power, reactive power and aparent power.
   2.5. Quality factors of the electric energy conversion: Total Harmonic Distortion (THD), Ripple Factor, Power Factor.

3. Electric components and power electronic devices.
   3.1. Passive components: resistor, inductor, capacitor and transformer.
   3.2. Power Semiconductors: Diode, MOSFET, IGBT. Static characteristics and conduction power losses models.

4. DC-DC Converters.
   4.1 Introduction to power supplies.
   4.2 Basic DC-Dc converters without galvanic Isolation.
      4.2.1 Buck converter.
      4.2.2 Boost converter.
      4.2.3 Buck-Boost converter.
   4.3 DC-DC converters with galvanic Isolation.
      4.3.1 Flyback converter.
      4.3.2 Full-Bridge converter.
      4.3.3 Dual-Active-Bridge converter

5. DC-AC Inverters.
   - 5.1 Introduction to DC-AC inverters.
   - 5.2 Topologies
     - 5.2.1 Half-Bridge.
     - 5.2.2 Full-Bridge.
     - 5.2.3 Three-phase Bridge.
   - 5.3 Sinusoidal PWM Modulation.
     - 5.3.1 Basic concepts of modulation
     - 5.3.1 Single phase bipolar PWM modulation
     - 5.3.2 Single phase unipolar PWM modulation
     - 5.3.3 Three-phase bipolar PWM modulation
   - 5.4 Load types
     - 5.4.1 L filter and resistive load
     - 5.4.2 LC filter and resistive load
   - 5.4.3 Grid-tied inverter with L filter.

6. CA-CC Rectifiers and PFC
   - 6.1 Introduction to rectifiers. Current harmonics.
   - 6.2 Line commutated rectifiers: C and LC filters.
   - 6.3 Single-phase Boost PFC with Boundary Conduction Mode (BCM) operation.
   - 6.4 Three-phase Boost PFC.

7. Thermal Management of power converters
   - 7.1 Power losses and efficiency calculations.
   - 7.2 Heat-sink design.

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

Assesment will be based on the following criteria:

-Laboratory (compulsory) (20%): will assess the knowledge acquired by the student in the handling of electronic instrumentation equipment, carrying out simulations and the main electronic components object of study.

- mid-term exams (20%): will assess the knowledge acquired by the student in the form of practical issues aimed at the design and analysis of circuits , and issues with a greater theoretical orientation.

-End-of-term-exam (60%, minimum mark required): will assess the knowledge acquired by the student in the form of problems of design and analysis of circuits of the whole subject content.

% 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.