Power electronics in energetics systems

Academic Year: (2019 / 2020) **Review date: 26-09-2019**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: BARRADO BAUTISTA, ANDRES

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

OBJECTIVES

The goal of this subject is to provide the student with a multidisciplinary and solid knowledge in every aspect involved in the design, selection, and operation of power converters and power electronics systems

Along the subject, special attention will be paid to identify and justify the best converter topologies, modulation techniques, control strategies, power semiconductor devices, and magnetic components, applied to transform the electrical energy.
In order to achieve this goal, the student will acquire the following specific skills:

- Ability to identify the best power semiconductor for each type of application.
- To know which are the best converter topologies for each type of energy conversion: DC-DC, DC-AC y AC-DC.
- To know the figures of merit that drives the design and optimization of the power converters.
- To know the improvements and potential advantages of the most advanced topologies that are currently used in the electrical energy conversion systems.
- Ability to develop the dynamic modeling of a power converter, from a practical point of view.
- Ability to design in practice the current control loop of a power converter. This control technique is used in most of the control systems of power electronics converters applied to energy conversion.
- To know the basic protection techniques and thermal management techniques used in power converters.
- To know how Power Electronics is an enabling technology in most of the current energy applications

In terms of general abilities or skills, the following areas will be worked upon throughout the development of the subject:

- Ability to design and conduct experiments and to analyze and interpret the results. In particular, this capability will be dealt with during the laboratory practical sessions.
- Ability to work cooperatively in a team, knowing how to adapt the requirements and working conditions of the subsystem developed so that they operate correctly within a global system which is not only electronic. This aspect will be covered by means of the development of examples and case studies.
- Ability to identify, formulate and solve problems in Engineering.
- Ability to use the techniques and tools required in modern engineering to reduce the equipment development time.

DESCRIPTION OF CONTENTS: PROGRAMME

The subject is divided into three main blocks:

Block 1: Power Electronics applied to electrical energy production and management.
- Power supply systems in transportation. Railway, electric cars, aerospace.
- Power converters in renewable energy systems: Photovoltaics, wind power, wave energy.
- Uninterrupted Power Supplies.
- Energy recuperation systems.

Block 2: Components and topologies
- Review of basic electrical concepts and commonly used mathematical tools.
- DC-DC converters.

- Rectifiers (AC-DC).
- Inverters (DC-AC).
- Advanced topologies applied to energy conversion: multilevel converters and modular converters.
- Power losses and heat-sinks.
- Electrical protections.

Block 3: Control techniques in power converters.
- Dynamic modeling fundamental.
- Control loop design.
- Digital control techniques.
- Control of a grid-tied three-phase inverter.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include::
- Magisterial Classes (3 ECTS), where the students will be presented with the basic knowledge they must acquire. Students will be supplied with lecture notes and key reference texts that will enable them to complete and acquire a more in-depth knowledge of the subject.
- Problems Classes and Laboratory Classes (3 ECTS) these are aimed at the solving of exercises and examples within the context of real case studies. These classes will be complemented with the resolution of practical exercises on behalf of the student that in some cases may require the use of computer-based simulation programs. The Laboratory classes will be developed taking into account a double methodology. In the first session, the student will design mount and measure a real DC ¿ DC converter. In the next sessions, students will use the most convenient CAD tools applied to design and simulate power converters such as grid-tied inverters.
- Group tutorial: At least a group tutorial will be carried out the recovery week as revision and final exam preparation.
- Among all these activities, 2.4 ECTS corresponds to in-class sessions.

ASSESSMENT SYSTEM

A continuous evaluation system will be carried out where the following will be evaluated:

1. Compulsory Laboratory Sessions (20%): The knowledge acquired by the student will be evaluated by means of the experimental implementation and simulation of several of the power converters analyzed previously in the Magisterial and Problems classes. The development of the laboratory sessions will be carried out in groups.

2. Solving problems and/or test questions proposed for each thematic block (20%). The resolution will be carried out individually.

3. Final exam (60%). In addition, at the end of the course, a final exam will be carried out where the global knowledge acquired by the students will be evaluated. A minimum mark will be required in the written assessment.

Final exam Percentage: 60
Continuous evaluation Percentage: 40

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

BASIC BIBLIOGRAPHY

- BARRADO, A. LÁZARO Problemas de Electrónica de Potencia, Pearson Prentice Hall, 2007
- D.W. HART Power Electronics, McGraw-Hill Education, 2010

ADDITIONAL BIBLIOGRAPHY

- A. YAZDANI, R. IRAVANI Voltage-Sourced Converters in Power Systems, IEEE PRESS ¿ Wiley , 2010
- D.G. HOLMES, T.A. LIPO Pulse Width Modulation for Power Converters, IEEE PRESS ¿ Wiley Interscience, 2003
- 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. TEODORESCU, M. LISERRE, P. RODRIGUEZ Grid Converters for Photovoltaic and Wind Power Systems, IEEE Press - Wiley, 2011

- R.W. ERICKSON, D. MAKSIMOVIC Fundamentals of Power Electronics, Kluwer Academic Publishers, 2001