Power electronics systems

Academic Year: (2023 / 2024) **Review date: 28/01/2024 18:20:19**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: BARRADO BAUTISTA, ANDRES

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Control Engineering
Power Electronics Converters
Power Electronics

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

OBJECTIVES

By the end of this course, students will be able:

- To have a coherent knowledge of their branch of engineering including some at the forefront of the branch in power electronics
- The ability to apply their knowledge and understanding of power electronics to identify, formulate and solve engineering problems using established methods
- The ability to apply their knowledge and understanding to develop and realize designs to meet defined and specified requirements
- An understanding of design methodologies, and an ability to use them
- Workshop and laboratory skills
- The ability to select and use appropriate equipment, tools and methods
- The ability to combine theory and practice to solve problems of power electronics
- An understanding of applicable techniques and methods in power electronics, and of their limitations

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In addition, Power Electronic Systems is presented as a course eminently practical and with real application, where students will acquire the following specific technical competencies:

- Knowledge of modeling techniques that can be applied to electronic circuits and power systems.
- Modeling of equipment and systems
- Design of control loops
- Design of typical power converters and power distribution systems for different applications: Aerospace, Railway, Electrical Automotive, Solar, Lighting, etc.
- Conditioning of new energy sources.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction.
   1.1. Power electronics systems
   1.2. Applications
2. Fundamentals of power electronics
   2.1. Electrical concepts
   2.2. Electrical components
   2.3. Types of power conversion
3. Dynamics of the converters and systems.
   3.1. Steady state and transient state.
   3.2. Small signal and large signal.
   3.3. Linear and non linear elements.
4. Converters modeling.
   4.1. Types of modeling.
   4.2. Simulation-oriented modelling.
   4.3. Modelling of a Buck and Boost converters.
   4.4. Modelling of the compensator, modulator and sensing blocks.ç
   4.5. Injected and absorbed current method. Modelling of a Flyback converter in DCM.
   4.6. Current loop modeling. Feedforward technique.
5. Converter control loop design.
   5.1. Voltage-mode control.
   5.2. Current-mode control.
   5.3. Average current-mode control.
   5.4. Compensators design.
   5.5. Control of a Buck converter and a Bidirectional converter.
6. Power Factor Corrector (AC-DC).
   6.1. Power stage design.
   6.2. Inner current loop design.
   6.3. Outer voltage loop design.
   6.4. EMI Filter.
7. Inverters.
   7.1. Power stage design.
   7.2. Control stage design.
   7.3. Compensator design.

8 Modelling and control of a Three-phase rectifier.

9. Introduction to digital control of converters.
10. Laboratory practices:
    10.1. Switched-mode power supplies: DC-DC converter.

10.2. Power supply for PC: Power Factor Corrector.
10.3. CA-CC power converter for LED luminaries.
10.4. Solar plant: Grid-connected inverter.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include:
- Lectures, which will include the knowledge that students should acquire. To facilitate their development students will receive class notes and key reference books, which will allow them to complete those issues which are more interested
- Practical aimed at solving exercises. These classes are supplemented by solving exercises by students that will serve to assess their knowledge and acquire the necessary skills.
- Lab, where students simulate or design, assemble and test an electronic system aimed at solving a particular problem. In some of these practices, students will handle electronic instrumentation equipment and the main electronic components under study.

ASSESSMENT SYSTEM

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

The evaluation will be based on the following criteria:
- Resolution of problems and exercises
- Practice Laboratory will assess the knowledge acquired by students in the management of electronic instrumentation equipment and the electronics components object of study, or in the simulation of systems in computer rooms.
- Final exam will assess the knowledge acquired by students.

BASIC BIBLIOGRAPHY

- ANDRÉS BARRADO, ANTONIO LÁZARO PROBLEMAS DE ELECTRÓNICA DE POTENCIA, PEARSON EDUCACIÓN, PRENTICE HALL, , 2007

- Amirnaser Yazdani, Reza Iravani Voltage-Sourced Converters in Power Systems: Modeling, Control, and Application, WILEY, 2010

- D.G. HOLMES, T.A. LIPO. Pulse Width Modulation for Power Converters, IEEE PRESS - Wiley Interscience, 2003

- DANIEL W. HART Electrónica de Potencia, Ed. Prentice Hall, 2001

- MOHAN, N., UNDELAND, T.M., ROBBINS, W.P. Power electronics, converters, applications and design, John Wiley & Sons, 2003

- R.W. Erickson Fundamentals of power Electronics, Kluwer Academic Publishers, 2001

- RASHID, M.H. Power Electronics: circuits, devices and applications,, Prentice-Hall, 1993

- Salvador Martínez y Juan Andrés Gualda Electrónica de Potencia: Componentes, topologías y equipos, Thomson, 2006