Modelling and control of power electronic systems

Academic Year: (2019 / 2020) **Review date: 04-05-2020**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: SANZ GARCIA, CLARA MARINA

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

An introductory course on Power Electronics

OBJECTIVES

COMPETENCES

Basic Competences

Students should be able to apply their knowledge and their problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
Students should be able to integrate knowledge and handle complexity, and formulate judgments based on information that, being incomplete or limited, includes thoughts about the social and ethical responsibilities related to the application of their knowledge and judgments.

General Competences

Develop concise, clear and justified documentation, and specify the work to be done for the development, integration and implementation of complex and high added value electronic systems.
Ability to devise, design, implement and maintain an electronic system in a specific application.
Acquire teamwork skills within a multidisciplinary context
Adopt the scientific method as a fundamental working tool in both professional and research environments.

Specific Competences

Ability to design electronic systems both at the conceptual level, on the basis of concrete specifications; as system-level, using tools of modeling and simulation; as to level subsystem using, among other, hardware description languages.
Ability to use advanced tools, techniques and methodologies for the design of electronic systems or subsystems.
Ability to design a device, system or application that meets a given specification, using a systematic and multidisciplinary approach, and integrating modules and advanced tools that are specific to the field of Electronic Engineering.
Ability to solve practical problems related to the elements interaction within and outside of an electronic system. It will be considered signal interferences, electromagnetic compatibility and thermal management, during the design stages, pre-manufacturing stage and also when re-design was required.
Students should be able to identify those figures of merit and comparison techniques needed to obtain the best solutions to scientific and technological challenges in the field of Electronic Engineering and its applications.
Ability to apply optimization techniques for the development of electronic circuits and subsystems.
Ability to perform effective searches for information as well as identify the State of the art of a technological problem in the field of electronic systems and their possible application to the development of new systems.

LEARNING RESULTS

At the end of the subject, the student will achieve:

Ability to model power converters in order to obtain both small-signal and large-signal models. That includes simulation-oriented modeling to get small-signal transfer functions, as well as other types of modeling focus on multi-converters systems simulations.
Ability to apply behavioral modeling on power electronics converters as well as their identification techniques.
Ability to analyze the dynamic interactions between power converters as well as between power converters and loads in power electronics systems.
Ability to analyze the stability of muti-converters systems.
Ability to design the control loop compensator in order to stabilize single power converter and also multi-converters systems.
Ability to use CAD tools to simulate power converters and power systems, as well as to design the control loop compensator.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Modelling and control introduction for power converters and systems.
   1.1. Introduction to power electronics systems
   1.2. Review of power converters basics
2. Dynamics of power converters
   2.1 Basics of converters dynamics
   2.2 Fundamentals of modelling and control of power converters
3. Modelling and control oriented to converter-level design
   3.1. Simulation-oriented modeling
   3.2. Modelling based on injected-absorbed-current dynamic analysis method
   3.3. Control loop design
   3.4. Digital control
4. Modelling and control oriented to system-level design
   4.1. Behavioral modeling
   4.2. Identification techniques
   4.3. System stability
   4.4. Control loop design
5. Modulation, modelling and control of inverters
   5.1 Inverter concepts and inverter topologies
   5.2 Basic Output Voltage Control: Square wave operation
   5.3 Fundamentals of PWM modulation
   5.4 . Advanced Modulation Techniques
6. Real cases design.
   6.1. Buck converter with voltage mode control loop.
   6.2. Boost converter with average current mode control loop.
   6.3. Adapter for battery charge in mobile phone applications.
   6.4. Multiphase converter for high performance microprocessors.
   6.5. Power distribution system for telecommunication application.
   6.6 Modelling and control of Single-Phase Voltage Source Inverters.
   6.7. Three-phase inverter with d-q control for renewable energy applications.

LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES

Theoretical classes
Practical Classes
Lab sessions (development of simulations in computer rooms)
Tutoring hours
Teamwork
Individual work of the student

METHODOLOGY

Classroom lessons by means of presentations and simulations. In these lessons, the main concepts of the subject will be developed by teacher and complementary references will be given to students.
Practical case studies, problems resolution, etc. will be proposed by teacher to be solve individually or in groups
Project and reports development, individually or group

ASSESSMENT SYSTEM

Individual or group work done during the course, which will be valued as 60% of the final grade.
Final examination of the subject, which will be valued as 40% of the final grade. A minimum mark will be required.

In the extraordinary examination either continuous assessment or 100% final exam could be applied.

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

BASIC BIBLIOGRAPHY

- Adrian Ioinovici Power Electronics and Energy Conversion Systems, Volume 1, Fundamentals and Hard-switching Converters, John Wiley & Sons, 2013
- Amirnaser Yazdani and Reza Iravani Voltage_Sourced_Converters_in_Power_Systems: Modeling, Control, and Applications, John Wiley & Sons, 2010
- Andrés Barrado, Antonio Lázaro Problemas de Electrónica de Potencia, Pearson Educación, Prentice Hall, , 2007
- R.W. Erickson Fundamentals of Power Electronics , Kluwer Academic Publishers, 2001

ADDITIONAL BIBLIOGRAPHY

- Abraham I.Pressman Switching Power Supply Design, Mc Graw Hill, 1997
- Daniel W. Hart Electrónica de Potencia, Prentice Hall, 2001
- K. Billings Switching power supply handbook, Mc Graw Hill , 2011
- Kislovski, R. Redl, N. O. Sokal Dynamic Analysis of Switching-Mode DC/DC Converters, Van Nostrand Reinhold, 2013
- M.H. Rashid Electrónica de Potencia: Circuitos, Dispositivos y Aplicaciones, Prentice-Hall, 2004
- Salvador Martínez y Juan Andrés Gualda Electrónica de Potencia: Componentes, Topologías y Equipos, Thomson, 2006