Course guide
220108 - CONV - Power Converters

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Antoni Arias Pujol,
Manuel Lamich Arocas

Others: José Luis Romeral Martínez

PRIOR SKILLS

Knowledge of: (i) circuits theory, (ii) electronic devices (diode, transistor, MOS-FET), (iii) control (PI regulator) and (iv) Laplace (and Fourier transforms).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE27T-GETI. Applied knowledge of power electronics. (Specific Technology Module - ESEIAAT Itinerary)

TEACHING METHODOLOGY

Activities:
- Lectures on theoretical matters and practical exercises.
- Laboratory Sessions. During the laboratory sessions, different applications with converters will be developed at the simulation level.

LEARNING OBJECTIVES OF THE SUBJECT

Show the students the structure and applications of different types of power converters and enable them to choose the suitable components. Study of converters used to drive electric machines, to link renewable sources to the grid, to built uninterrupted sources (UPS) and power supplies in general. Provide the basis for designing the control of these converters. Study of power transfer between electrical systems and electromechanical systems by means of converters. Study the performance of previous systems.

STUDY LOAD

Type	Hours	Percentage
Hours small group	14,0	12.44
Hours large group	31,0	27.56
Self study	67,5	60.00

Total learning time: 112.5 h

CONTENTS

Rectifiers

Description:
Topologies of single-phase and three-phase diode and thyristors rectifiers.
Analysis and waveforms of voltages and currents at the input and output.
Analysis of medium and instantaneous powers, active and reactive at the input and active at the output.
Grid effectsi: Power factor and harmonics.
Calculation of losses and cooling.
Transformers to generate polyphase systems.

Related activities:
Activity 1 and Activity 2

Full-or-part-time: 29h
Theory classes: 8h
Laboratory classes: 4h
Self study : 17h

DC-DC Converters

Description:
Types and calculations of voltages and currents.
2 and 4 quadrant DC-DC converters.
Basic structures with and without insolation.

Specific objectives:
Know the CC-CC conversion.
Learn how to make calculations and size CC-CC converters.

Related activities:
Activity 1 i Activity 2.

Full-or-part-time: 27h
Theory classes: 8h
Laboratory classes: 2h
Self study : 17h

Single-phase and three-phase inverters

Description:
Single-phase and three-phase inverters: topologies and modulations. Space Vector Modulation (SVM).
Current and voltage loops.
Park and Clarke transforms.
Active and reactive power control.
Four quadrants operation.
Application 1: speed â□□â□□and torque control of DC machines.
Application 2: vector control of three-phase AC machines.
Application 3: grid connected inverters working as controlled rectifiers. Voltage Oriented Control (VOC).

Specific objectives:
The aim is to introduce students to the most common applications of both single-phase and three-phase inverters.
Initially, the basic topologies and their modulations to generate voltages will be studied.
The most widespread applications will then be presented and studied in their entirety, where the use of inverters as power actuators is the fundamental element.

Related activities:
Activity 1 and Activity 2

Full-or-part-time: 56h 30m
Theory classes: 15h
Laboratory classes: 8h
Self study : 33h 30m

ACTIVITIES

Activity 1. Theory and problems lectures

Description:
Teaching of theoretical concepts and realization of numerical exercises on different topics.Basic design proposal.

Specific objectives:
Teach the necessary theoretical knowledge and solve practical exercises to link the theory, the calculation methods and the design of power converters.

Material:
Classroom with blackboard and audiovisual media (PC and overhead projector)

Delivery:
Design and/or numerical calculations exercises will be proposed to ensure that students take the time to learn by themselves.

Full-or-part-time: 77h 30m
Theory classes: 31h
Self study: 46h 30m

Activity 2. Laboratory practical

Description:
Carry out computer simulated practices with a clearly practical and application-oriented aspect.

Specific objectives:
Know and use Matlab / Simulink software to evaluate the behavior of devices, power converters and applications as a whole.

Material:
Computers with Matlab / Simulink software. The lecturer will give partially completed simulation models and in any case ready for a first simulation. During the laboratory sessions the lecturer will first raise the necessary basic concepts at a more theoretical level and then the simulation models will be worked together.

Delivery:
The initial task of the student will be to understand the model and all the waveforms. Modifications and extensions of the models initially provided by the lecturer will be requested.

Full-or-part-time: 35h
Laboratory classes: 14h
Self study: 21h

GRADING SYSTEM

- First exam 34%
- Second exam 34%
- Practices consisting on simulation of several converters: 32%

Students who have failed the first theory exam (corresponding to 34% of the subject final grade) will be able to take an exam "de reconducció" that will be carried out on the same day of the final exam (just after the end of the second exam).
The final grade of the first exam (Nota_1r_Ex_Final) will be the average (50%) of the grade of the first exam (Nota_1r_EX) and the grade of the exam "de reconducció" (Nota_RECON). In the event that the grade obtained is lower, the initial grade will remain.

If [(Nota_1r_EX*0.5)+(Nota_RECON *0.5) > Nota_1r_EX]
Nota_1r_Ex_Final= (Nota_1r_EX* 0.5)+(Nota_RECON*0.5);
Else
Nota_1r_Ex_Final= Nota_1r_EX ;

BIBLIOGRAPHY

Basic:
- Rashid, Muhammad H. Power electronics : devices, circuits and applications [on line]. Fourth edition. Boston: Pearson Education Limited, 2014 [Consultation: 23/12/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=3804. ISBN 9780273769088.
- Hart, Daniel W. Power electronics. International edition. New York: McGraw-Hill, 2011. ISBN 9780071289306.

Complementary:
- Mohan, Ned; Undeland, Tore M.; Robbins, William P. Power electronics : converters, applications and design. 3rd ed. New York [etc.]: John Wiley & Sons, cop. 2003. ISBN 0471226939.

RESOURCES

Audiovisual material:
- Apunts de l'assignatura. Subject handouts and problems

Computer material:
- Programari Matlab/Simulink. Matlab/Simulink software