Universidad Zaragoza

Year : 2019/20

28826 - Power Electronics

Syllabus Information

Academic Year: 2019/20
Subject: 28826 - Power Electronics
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 424 - Bachelor's Degree in Mechatronic Engineering
ECTS: 6.0
Year: 3
Semester: Second semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

The general objective of the course is to provide the necessary knowledge to interpret and solve electronic power control circuits, especially in the areas of static switches, rectifiers, inverters, regulators and power inverters.

This requires the correct use of the most common computer applications, to obtain information on the power components and their applications, and also to correctly interpret the technical documentation of the components used; as well as computer applications for circuit simulation. The correct handling of the measuring and feeding devices commonly used in the electronics laboratory must also be achieved, as well as the proper interpretation of the measurements made.

The indicators that the objectives have been achieved will be: the ability to read plans of commercial electronic equipment and applications, and also the ability to make electronic schemes of the typical power output circuits and control elements, according to the appropriate regulations and symbols, and finally the realization of technical reports on the practical activities carried out.

1.2.Context and importance of this course in the degree

The subject of Power Electronics is part of the Degree in Mechatronic Engineering taught by EUPLA, within the Electricity and Electronics module. It is a subject of the third course located in the sixth semester and compulsory (OB), with a teaching load of 6 ECTS credits.

1.3.Recommendations to take this course

The development of the subject of Power Electronics requires putting into play knowledge and strategies, coming from subjects corresponding to the previous courses and semesters of the Mechatronic Engineering Degree, related to:

Mathematics, Physics, Chemistry, Technical Drawing, Computer Science, Electrical Engineering, Electronic Technology I and Electronic Technology II.

However, it is not a legal requirement to have passed them in order to join Power Electronics.

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

This Power Electronics course is designed as a set of contents but distributed in four blocks. The first block brings together concepts the power components performance and their protection elements. The second and third blocks make up the core that the subject must provide to the student's training: Static switches, converters and regulators, rectifiers and power inverters. The final block deals with some of the major applications of Power Electronics, without meaning to cover all the fields of application of this discipline.

The first three blocks will be dealt with under three fundamental and complementary ways: the theoretical concepts of each didactic unit, the resolution of problems or questions and practices, supported in turn by another series of activities such as tutorials and seminars and will be tested individually, regardless of the blocks.

The fourth block will have a different treatment because the students will work in groups only previously assigned sections, they will be able to express their preferences but all the subjects will have to be assigned to some group. They will prepare presentation materials and defend their work with a public presentation, which will be valued by the rest of the students and the teacher.

The teacher/student interaction is carried out in this way, through the distribution of work and responsibilities between students and teachers. However, it must be taken into account that, to a certain extent, students can set the pace of learning according to their needs and availability, following the guidelines set by the teacher.

The organization of teaching involves the active participation of the student, and will be carried out following the following guidelines:

- Lectures: Theoretical activities imparted in a fundamentally expositive way by the teacher, in such a way as to expose the theoretical supports of the subject, highlighting the fundamental, structuring the concepts and relating them to each other.

- Practical lessons: The teacher solves problems or practical cases for illustrative purposes. This type of teaching complements the theory explained in the lectures with practical aspects.

- Seminars: The total group of lectures or practical lessons may or may not be divided into smaller groups, as appropriate. They will be used to analyze cases, solve problems, etc. Unlike what happens with the practical lessons, the teacher is not a protagonist, simply listening, counselling, clarifying, evaluating, assessing. It seeks to encourage student participation, as well as making the continuous assessment of students possible and to learn about the performance of learning.

- Lab Practice: The total group of lectures will be divided into several shifts, according to the number of students enrolled, but never with more than 20 students per shift, so that smaller groups can be formed. Students will do assemblies, measurements, simulations, etc., in the laboratories in the presence of the trainee teacher.

Practical activities are carried out in groups of two students (or at the most three students) per shift, although for the reports students of two or more shifts can be grouped. For each subject block, guidelines for practical tasks will be given (compulsory and optional); In addition, the reporting rules will be specified in a guidance document, which will be handed out at the beginning of the practical activities.

- Group tutorials: Programmed activities of learning follow-up in which the teacher meets with a group of students to guide their work of autonomous learning and supervision of works directed or requiring a high degree of advice by the teacher.

- Individual tutorials: These are the ones made through the individual attention of the teacher in the department. They aim to help solve the doubts that students come across, particularly those who for various reasons cannot attend group tutorials or need more personalized attention. These tutorials can be classroom or virtual.

4.2.Learning tasks

The course includes the following learning tasks:

Generic on-site activities:

? Lectures: The theoretical concepts of the subject will be explained and illustrative practical examples will be developed as a support for the theory when it is deemed necessary.

? Practical lessons: Problems and practical cases will be made as a complement to the theoretical concepts studied.

? Practical tasks: Students will be divided into several groups of no more than 20 students, being guided by the tutorial action of the teacher.

? Defence and presentation of topics: on the particular contents that are assigned to each group of students, corresponding to Block 4**.**

Generic off-site activities:

? Study and assimilation of the theory explained in the lectures.

? Understanding and assimilation of solved cases in practical lessons.

? Preparation of seminars, solving suggested problems, etc.

? Participation in Forums of the subject via Moodle, to provide links of information on the Internet.

? Preparation and development of scripts and corresponding reports.

? Preparation of written continuous assessment tests, and global assessment tests.

Autonomous tutored activities:

Although they will be done on-site, they have been taken into account separately because of their particular features, they will be focused mainly on seminars and tutorials under the supervision of the teacher.

Reinforcement activities: Off-site activities preferably, via the virtual portal of teaching (Moodle), will be designed to reinforce the basic contents of the subject. These activities can be personalized or not.

4.3.Syllabus

The theoretical contents are divided into four sections (numbers 1 to 4) preceded by a Section 0 of introduction to Maintenance. The choice of the content of the blocks has been made looking for the express clarification of the final objective, so that with the union of incidental knowledge, the student obtains a structured knowledge, easily assimilated for the Mechatronics Engineers.

Each of the blocks is composed of subjects, with a temporary assignment of one or two weeks of the course, these topics collect the contents necessary for the acquisition of predetermined learning outcomes.

Theoretical contents:

Section 0: INTRODUCTION

Section 1: POWER SEMICONDUCTORS

1-. Power Diodes and Transistors

? Types of power diodes. Reverse Recovery

? Power bipolar transistors. Safe Operating Area

? Power unipolar transistors. FET, MOS, IGBT

2-. Thyristor, TRIAC and other active components

? Thyristor (SCR). Building. Lock and Drive States

? Thyristor. Shooting and blocking times and forms

? TRIAC. Building. Driving and triggering modes

? Other components: Diac, GTO, SCS, ...

3-. Protection, Association and Refrigeration

? Protection against overvoltages and overcurrents

? Serial and parallel connections

? Thermal protection. Calculation of radiators

? Passive power components

Section 2: STATIC SWITCHES, CONVERTERS, REGULATORS

4-. A.C. and D.C. static switches.

? D.C. switches with thyristors and transistors

? A.C. switches with thyristors, TRIACs and transistors

? Single and three-phase A.C. switches

5-. Power Converters

? All-nothing controls. Synchronous control. Proportional variation

? Phase control. Shooting and driving angles. Electrical noise

? Open and closed chain control

6-. A.C. Regulators.

? With power dissipation, by Ferro-resonance and by slicing

? With Thyristors in the natural block. Integral and phase control

? With switching loads with TRIAC

7-. D.C. Regulators.

? Reducing regulators with thyristors

? Reducing regulators with transistors. Buck and Forward

? Lift controllers with transistors. Boost, Forward and Flyback

Section 3: RECTIFIERS, POWER INVERTERS, AND MOTOR CONTROL

8-. Uncontrolled and controlled rectifiers

? Half-wave three-phase Assemblies

? Full-wave with star secondary Assemblies

? Half-wave with polygon secondary Assemblies

9-. Topologies and Inverter and Converter circuits

? Configuration of the inverter power circuit

? Regulation of the output voltage in an inverter

? Four-quadrant converter.

? Cycle-converters

? Inverters with self-excited transistors

? Inverters with transistors and independent excitation

? Inverters with natural and forced blocking thyristors

10-. Speed drives for electric motors

? Static starters for AC motors

? Frequency inverters for A.C. asynchronous motors

? DC Motor Control. Brushless

Section 4: APPLICATIONS OF POWER ELECTRONICS

11-. Temperature controls and heating

? Temperature control methods

? Power regulation in industrial ovens

? Resistance welding

? Ultrasound Welding

? Inductive heating

12-. Uninterrupted power supply systems (U.P.S.)

? A.C. and D.C. output Systems

? Line conditioners and active filters

? Storage and by-pass devices

? Battery chargers

13-. Control Systems in Alternative Energies

? Inverters for an autonomous photovoltaic power plant in A.C.

? Inverters for network injection photovoltaic power plant

? The photovoltaic solar power plant for power supply in D.C.

? Electronic controls in wind farms

14-. Other fields of application of Power Electronics

? Railway Electronic controls

? Automobile Electronic controls

? Electroplating and Electro-Filters Rectifiers

? Synchronous and timed lighting controls

? Dimmer and sensor lighting controls

Practical contents:

Each Section exposed in the previous section has associated practices in this regard, either through practical assumptions and/or physical or simulated assembly work leading to obtaining results and their analysis and interpretation. As the topics are developed, these Practices will be proposed, preferably in the classroom and also through the Moodle platform.

Practices to be developed in the Laboratory are given below. They will be carried out by the students in one-hour sessions, except in the final practice, in which the three hours corresponding to Section 4 are accumulated.

PRACTICE 1: ASSOCIATED WITH Section 1

Exercise 1: Power Diodes and Transistors

Power diode recovery time Analysis. Switching of resistive loads using transistors. Inductive load switching using transistors. Manufacturer and wave data Queries.

Exercise 2: Thyristor, TRIAC and others

Switching of resistive and inductive loads with thyristors. Switching of resistive and inductive loads with TRIAC (optocoupled control). Wave Analysis and Capture.

Exercise 3: Protection, Semiconductor Association, Refrigeration

Protective elements. Data manufacturer query. Radiator calculation and assembly of in power components.

PRACTICE 2: ASSOCIATED WITH Section 2

Exercise 1: Static switches

Connection of switches with thyristors and transistors in D.C. Switching on A.C. Single phase with thyristors and TRIAC. Three-phase A.C. Switching switches with thyristors and TRIAC. Multisim Simulation controls using Digilent Basys-2.

Exercise 2: Power shifters

Phase control connection with TRIAC and diac. Wave Analysis. Control connection per cycle packet. Synchronous control. Wave Analysis. Measurements with network quality analyzer.

Exercise 3: A.C. Regulators

Simulation of Ferro-resonant regulators. Regulation Simulation/assembly using transformer socket change. Manufacturer data Query.

Exercise 4: D.C. Regulators

Simulation of Buck and Forward reducers. Boost, Forward and Flyback elevator Simulation. PWM controller Assembly and analysis. Wave Capturing.

PRACTICE 3: ASSOCIATED WITH Section 3

Exercise 1: non-controlled Rectifiers

Half-wave three-phase rectifier assembly. Full-wave three-phase rectifier assembly. Wave capture and analysis.

Exercise 2: Controlled rectifiers

Total Control half-wave three-phase rectifier Assembly. Semi-controlled full-wave three-phase rectifier Assembly. Waves capture and analysis. Network quality analyzer measurements.

Exercise 3: Inverters and Power Converters

Simulation and Analysis of Output Topologies. Simulation and Analysis of Cycle-Converters.

Exercise 4: Variable speed drives in electric motors

DC motor control, independent excitation using rectifiers. Connection of the IR frequency variable drive. Waves Capture and analysis. Network quality analyzer measurements.

PRACTICE 4: ASSOCIATED WITH Section 4

Assembly, adjustment and documentation of one of the applications related to topics 10 to 12, depending on what is assigned for theoretical defence and the availability of suitable components.

4.4.Course planning and calendar

Temporary distribution of a teaching week:

The subject is defined in the Verification Report of the Degree with a low experimental grade so that the 10 hours a week are distributed as follows:

? Theory-practical classes: 3 hours a week (blocks 1, 2 and 3) / 5 hours per week (block 4).

? Practice tasks: 1 hour per week.

? Other activities: 6 hours per week (blocks 1, 2 and 3) / 4 hours per week (block 4).

Test schedule:

For the assessment tests, described in the continuous assessment process, the following schedule is suggested:

? Week 3: Test 1 (Topics 1, 2 and 3).

? Week 7: Test 2 (Topics 4, 5, 6 and 7).

? Week 12: Test 3 (Topics 8, 9 and 10).

Speech-Presentation of Works:

The ones belonging to Block 4 (Digital devices of the high scale of integration), will be tested orally during the three final weeks of the course, depending on the number of students and the specific development of the preparatory tasks.

4.5.Bibliography and recommended resources

Resources:

Theory Notes, PWP presentations, typical problems and Web links, all related to the syllabus, will be provided through the Moodle page of the subject.

Electronic circuit simulation software (Multisim) and manuals for their use, will be installed in the computer room or Laboratory PCs. Download and installation in the personal computers of students will be allowed.

PCs, Multimeters, 2 and 4 channel Oscilloscopes, Network Quality Meters, Tachometers, Function Generators, Power Supplies, discrete and integrated electronic components, must be part of the Electronics Lab equipment.

The teacher wants to emphasize that the text: ***Electrónica de Potencia. Componentes, topologías y equipos***, authors: *MARTINEZ S., GUALDA J.A.,* included in the bibliography as a base text, is an essential resource to follow the subject in

theory sessions.
http://biblos.unizar.es/br/br_citas.php?codigo=28826&year=2019