820124 - EPEE - Power Electronics

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
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ECTS credits: 6 Teaching languages: Catalan

Teaching staff

Coordinator: PIQUÉ LÓPEZ, ROBERT

Others: FRANCISCO JOSÉ CASELLAS BENEYTO - PEDRO GAYA SUÑER - ROBERT PIQUÉ LOPEZ - XAVIER ROSET JUAN

Opening hours

Timetable: Check in each case the particular information

Prior skills

Those of the obligatory subjects of preceding levels (semesters).

Requirements

Having completed the course ELECTRONIC SYSTEMS (STI)

Degree competences to which the subject contributes

Specific:

1. Understand the applications of power electronics.

Transversal:

2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
4. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
5. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

Teaching methodology

The course uses in the classroom the expositive methodology by 60%, individual work by 10% and peer to peer work (twos students) by 30% under PBL (Problem-Based Learning) approach.

Outside the classroom individual work is weighted by 60%, while the small group work, for the deliverables of theory and practice, occupies 40%.

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Learning objectives of the subject

Upon successful completion of this course, students will be able to:

- Describe the essential contents of the syllabus for the course and its justification (Knowledge).
- Describe the scope across the course in Engineering (Understanding).
- Describe the state of the art, trends and limitations of the components used in power electronics (Knowledge-Understanding).
- Describe justifiably the various types of switches and the switching process (Comprehension).
- Describe the main structures of static conversion and its functional principle (Understanding).
- Determine analytically the response of the basic steady static converters (Application-Analysis).
- Synthesizing a basic structure of conversion from the requirements of the sources to be linked (Application-Synthesis).
- Describe the main methods of closed loop control for static converters (Understanding-Application).
- Properly use the PSIM simulator as aid in the analysis of static converters (Understanding-Application).
- Evaluate the increase of knowledge that has brought up the subject (Evaluation).

Study load

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

1. Introduction to Power Electronics.	Learning time: 10h Theory classes: 3h Self study : 7h

Description:
1.1. Some definitions. 1.2. Classification of static converters. 1.3. Static converters in steady-state. 1.4. Components for power electronics: current status and trends.

2. Switches and Switching.	Learning time: 15h Theory classes: 4h 30m Laboratory classes: 2h Self study : 8h 30m

Description:
2.1. Dipoles. Current-voltage characterization. Static characteristic. Power dissipation. Sources. Resistors. 2.2. Switches. Static characteristics. Switching. Dynamic (or control) characteristic. Market switches and synthesis switches. State transition diagrams. 2.3. Switching process. Soft switching. Approaches to the soft switching. 2.4. Synthesis of elementary converters.

Related activities:
Practice 1: Introduction to Power Electronics Laboratory.
Week number 4 of the course: Completing the written test ET1 (chapters 1 and 2).

3. Components and protections; practical considerations.	Learning time: 10h Theory classes: 3h Self study : 7h

Description:
3.1 Diodes. 3.2. Transistors. 3.3. Thyristors. 3.4. Other switches. 3.5. Some considerations about the association of switches. 3.6. Electrical protections. 3.7. Termal protections.

4. DC to DC Converters.	Learning time: 35h Theory classes: 9h 30m Laboratory classes: 4h Self study : 21h 30m

Description:
4.1. Basic principle of DC-DC converters. 4.2. Rules for sources interconnection. 4.3. Basic one-quadrant DC-DC converters. 4.4. Buck converter. 4.5. Boost converter. 4.6. Buck-Boost converter. 4.7. Two and four quadrants operation. 4.8. Isolated DC-DC converters. 4.9. PWM control of DC-DC converters.

Related activities:
Practices 2 and 3: DC-DC converters.

5. DC to AC Converters.	Learning time: 20h Theory classes: 6h Laboratory classes: 2h Self study : 12h

Description:
5.1. DC-AC conversion concept: time and frequency. 5.2. Inverter structures. 5.3. Half-bridge and full-bridge inverters. 5.4. Basic commutation techniques: square and quasi-square waves. 5.5. PWM techniques. Bipolar and unipolar SSPWM. 5.6. Three-phase inverters. Unmodulated control and PWM control. 5.7. Harmonic control. Harmonic elimination techniques.

Related activities:
Practice 4: DC-AC converters.
Week number 8 of the course: Completing the written test ET2 (chapters 3 and 4).

6. AC to DC Converter.	Learning time: 30h Theory classes: 9h Laboratory classes: 2h Self study : 19h

Description:
6.1. Rectifier concept. 6.2. Basic operation under different load conditions. 6.3. Commutation groups. 6.4. Uncontrolled, controlled and semi-controlled rectifiers. 6.5. P-type rectifiers 6.6. PD-type rectifiers. 6.7. S-type rectifiers. 6.8. Voltage drops. 6.9. Rectifiers association. 6.10. Comparative characteristics.

Related activities:
Practice 5: AC-DC converters.

7. AC to AC Converters.	Learning time: 10h Theory classes: 3h Laboratory classes: 2h Self study : 5h

Description:
7.1. AC to AC conversion concept. 7.2. One-phase regulator with phase control. 7.3. Three-phase regulator with phase control. 7.4. Regulator with integral cycle control. 7.5. Cycloconverters. 7.6. Matrix converters.

Related activities:
Practice 6: AC-AC converters.
Week number 12 of the course: Completing the written test ET3 (chapters 5 and 6).

8. Introduction to the conventional closed-loop control of static converters.	Learning time: 10h Theory classes: 3h Self study : 7h

Description:
8.1. Concepts of modeling and simulation. 8.2. General structure and functional blocks of a conventional control scheme of static converters in closed loop. 8.3. Closed loop control of PWM converters. Control electronics and driving. Voltage-mode control. Cascade control. Current-mode control. Reference-wave control. 8.4. Closed loop control of the converter with phase control. Control electronics and driving. Voltage-mode control.

9. Applications of Power Electronics.	Learning time: 10h Theory classes: 3h Self study : 7h

Description:
9.1. Energy and sustainability. The electrical energy chain. Overview and main fields of application. 9.2. Conversion to renewable energy. 9.3. High DC-voltage electricity transmission. 9.4. Traction. 9.5. Static reactive power compensation. Harmonic control. 9.6. Power systems. 9.7. Electric drives. 9.8. Uninterruptible power systems. 9.9. Domestic applications. 9.10. Smart Grid. 9.11. Other applications.

Related activities:
Week number 14 of the course: Completing the written test ET4 (chapters 7, 8 and 9).
Week number 15: Preparation and public presentations of theory delivery made in collaborative group.

Qualification system

Curse evaluation is based on continuous assessment tests, PAC, and practices. In addition to the traditional summative assessments, formative assessments are also used as a feedback.

The set of PACS consists of 3 written exercises (ET) on specific knowledge and one deliverable oriented to PBL (Problem-Based Learning). Evaluates each practice preparation, laboratory work and report writing. The assessment tests, except the ET's, including generic and specific goals. The weights assigned to each part are as follows:

PACS: 70%
Practices: 30%

With the above tests, the qualification of the subject, Ncurs, is obtained.

There isn't a last test in the classical sense of a final exam.

In Power Electronics there are four assessment blocks, three of theory and problems (PAC1, PAC2 and PAC3) with 23.3% weight each PAC, and practices, weight 30%. According to the specific academic regulations of the EEBE, sections 2.2.b and 2.2.c, is considered marked continuous assessment methodology and, therefore, is exempt from reassesment.

If Ncurs> = 5.0 is achieved suitable for the subject, obtaining a rating given by NOTA = Ncurs. Otherwise should return to complete the course in its entirety. For more details, see the "Power Electronics student guide" available in Atenea.

Regulations for carrying out activities

See details in the "Guia de l'Estudiant d'Electrònica de Potencia" at Atenea virtual campus.

Remember that by regulations it's mandatory to hav a valid ID (identity card, Passport or estudent card).

Bibliography

Basic:

Ballester Portillo, Eduard; Piqué, Robert. Electrónica de potencia : principios fundamentales y estructuras básicas. Barcelona: Marcombo, 2011. ISBN 9788426716699.

Ballester, Eduard; Piqué, Robert. Exercicis d'electrònica de potència. 2a ed. Barcelona: UPC, 2005.

Ballester, Eduard; Piqué, Robert; Román, Manuel. Pràctiques d'electrònica de potència. 3a ed. Barcelona: UPC, 2011.

Complementary:

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

Erickson, Robert W.; Maksimovic, Dragan. Fundamentals of power electronics [on line]. 2nd ed. Dordrecht: Kluwer Academic Publishers, cop. 2001Available on: <http://link.springer.com/book/10.1007/b100747/page/1>. ISBN 0792372700.

Krein, Philip T. Elements of power electronics. New York: Oxford University Press, 1998. ISBN 0195117018.

Others resources:

All documentation and course resources (slides, guided exercises, templates, assessment rubrics, feedbacks, surveys, Programme Groups, etc.) is available on the digital campus Athena.