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820750 - EPARD - Power Electronics Applied to Distributed Energy Resources

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN RENEWABLE ENERGIES (Syllabus 2011). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONOMICAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONOMICAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2010). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONOMICAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Bergas Jane, Joan Gabriel

Others: Bergas Jane, Joan Gabriel

Opening hours

Timetable: Monday from 19:00 to 21:00
Wednesday from 10:00 to 12:00 and from 16:00 to 18:00

Prior skills

Basics on Electrical and Electronic Engineering

Degree competences to which the subject contributes

Specific:

CEMT-6. Employ technical and economic criteria to select the most appropriate electrical equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technology applications in the field of production, transport, distribution, storage and use of electric energy.

CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

Teaching methodology

The course development includes the following teaching methods:
- Master class (EXP): theory exposition and slides-based lecturing.
- Oriented individual works (TD): individual works of reduced complexity or extension. The acquired knowledge will be applied in these works, and the results will be presented. Their elaboration will start in the classroom (with the teacher's guidance) and will end out of the classroom.
- Evaluation activities (EV). Some problems will be proposed as assignment.

Learning objectives of the subject

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Objectives

The aim of this course is to deepen techniques of power electronics and control systems based on microprocessors. These techniques focus on the torque and speed control of electric machines, as well as the flow control of the power of electrical network.

Learning outcomes

Upon completing the course, the student should:
- Model and simulate a power converter.
- Design and use a commercial converter.
- Apply a converter to DER (Distributed Energy Resources).
- Apply a converter against the network (Active Front Ends and FACTS).

Study load

Total learning time: 125h	Hours small group:	30h	24.00%
	Guided activities:	10h	8.00%
	Self study:	85h	68.00%

Content

Introduction to static converters

Learning time: 44h
Laboratory classes: 9h
Guided activities: 5h
Self study : 30h

Description:
1.- Duality theory of static converters.
2.- Modelling and simulation of static converters.

Related activities:
A1. Simulation of the reductor converter ("buck converter") with PSIM.
A2. Simulation of the H-bridge, and the torque and speed control of a DC-Motor with Simulink.

Specific objectives:
To give the fundamentals of static converters comprising its modelling and sizing.

Sinusoidal signals generation (PWM)

Learning time: 33h
Laboratory classes: 8h
Guided activities: 5h
Self study : 20h

Description:
1. Single-phase sinusoidal voltage generation: Pulse Width Modulation (PWM)
2. Three-phase sinusoidal voltage generation: homopolar harmonic injection.
3. Space Vector PWM (SVPWM).

Related activities:
A3. SVPWM Simulink Simulation.

Specific objectives:
To establish the knowledge for the power converter digital control

Current control closed-loops: constant frequency, quasi-constant and variable frequency.

Learning time: 33h
Laboratory classes: 8h
Guided activities: 5h
Self study : 20h

Description:
1. Torque control of induction and brushless motors.
2. Unity power-factor rectifiers. PWM Rectifiers.
3. Phase-Lock-Loop (PLL).

Related activities:
A4. Simulation with Simulink of a current control close-loop in Park's variables.

Specific objectives:
Introduction to PEBB (Power Electronic Building Blocks).

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Applications	Learning time: 15h Laboratory classes: 5h Self study : 10h

Description:

1. Passive, active and hybrid filters and FACTS (Flexible AC Transmission Systems).
2. Photovoltaic and Wind Converters.

Specific objectives:

Sizing and simulation of a series of typical applications of the power converters.

Planning of activities

A1. Simulation of the reductor-converter

Hours: 9h 30m
Practical classes: 2h
Guided activities: 2h 30m
Self study: 5h

Description:
Simulation with PSIM of a buck converter-reducer.

Support materials:
PSIM software and activity guide.

Descriptions of the assignments due and their relation to the assessment:
Delivery of a report with the results and observations of the simulation.

Specific objectives:
To introduce students to a software simulation of power electronic components.

A2. Simulation of the H-bridge, and the torque and speed control of a DC-Motor with Simulink

Hours: 9h 30m
Practical classes: 2h
Guided activities: 2h 30m
Self study: 5h

Description:
Simulation of the H-bridge, and the torque and speed control of a DC-Motor with Simulink

Support materials:
Simulink software and activity guide

Descriptions of the assignments due and their relation to the assessment:
Delivery of a report with the results and observations of the simulation.

Specific objectives:
Introduce students to a software of generic simulation focused on the behaviour of a system, which allows the execution of control algorithms.

A3. SVPWM Simulink Simulation

Hours: 18h
Practical classes: 3h
Guided activities: 5h
Self study: 10h

Description:
SVPWM Simulink Simulation

Support materials:
Simulink software and activity guide

Descriptions of the assignments due and their relation to the assessment:
Delivery of a report with the results and observations of the simulation.

Specific objectives:
Students will develop a c-mex as if it were an embedded application.

A4. Simulation with Simulink of a current control close-loop in Park's variables.	Hours: 18h Practical classes: 3h Guided activities: 5h Self study: 10h

Description:
Simulation with Simulink of a current control close-loop in Park's variables.

Support materials:
Simulink software and activity guide

Descriptions of the assignments due and their relation to the assessment:
Delivery of a report with the results and observations of the simulation.

Specific objectives:
Introduction to the three-phase current close-loop in simulation.

Qualification system

Written test (final exam) (PE): 50 %
Oriented individual works (TD): 40 %
Oral presentations (PO): 10%

Bibliography

Basic:

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

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 978-0-471-22693-2.