UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
820750 - EPARD - Power Electronics Applied to Distributed Energy Resources

Last modified: 16/04/2024

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONOMICAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Optional subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Bergas Jane, Joan Gabriel

Others: Bergas Jane, Joan Gabriel

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

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

Type	Hours	Percentage
Hours small group	30,0	23.08
Guided activities	15,0	11.54
Self study	85,0	65.38

Total learning time: 130 h

CONTENTS

Introduction to static converters

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

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

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.

Related competencies :
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.

Full-or-part-time: 44h
Laboratory classes: 9h
Guided activities: 5h
Self study : 30h

Sinusoidal signals generation (PWM)

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).

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

Related activities:
A3. SVPWM Simulink Simulation.

Full-or-part-time: 33h
Laboratory classes: 8h
Guided activities: 5h
Self study : 20h

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

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

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

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

Full-or-part-time: 33h
Laboratory classes: 8h
Guided activities: 5h
Self study : 20h

Applications

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.

Full-or-part-time: 15h
Laboratory classes: 5h
Self study : 10h

ACTIVITIES

A1. Simulation of the reductor-converter

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

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

Material:
PSIM software and activity guide.

Delivery:
Delivery of a report with the results and observations of the simulation.

Full-or-part-time: 9h 30m
Practical classes: 2h
Guided activities: 2h 30m
Self study: 5h

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

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

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

Material:
Simulink software and activity guide

Delivery:
Delivery of a report with the results and observations of the simulation.

Full-or-part-time: 9h 30m
Practical classes: 2h
Guided activities: 2h 30m
Self study: 5h

A3. SVPWM Simulink Simulation

Description:
SVPWM Simulink Simulation

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

Material:
Simulink software and activity guide

Delivery:
Delivery of a report with the results and observations of the simulation.

Full-or-part-time: 18h
Practical classes: 3h
Guided activities: 5h
Self study: 10h

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

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

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

Material:
Simulink software and activity guide

Delivery:
Delivery of a report with the results and observations of the simulation.

Full-or-part-time: 18h
Practical classes: 3h
Guided activities: 5h
Self study: 10h

GRADING 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.