Course guide
820752 - GEPFR - Application of Power Electronics for Renewable Generation

Last modified: 16/05/2023

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

Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN ELECTRIC POWER SYSTEMS AND DRIVES (Syllabus 2021). (Optional subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: Cheah Mañé, Marc

Others: Cheah Mañé, Marc

PRIOR SKILLS

Electrical and Electronic systems, Electric Machines

REQUIREMENTS

Models and control implementation

TEACHING METHODOLOGY

Teaching methodology:
The course teaching methodologies are as follows:
- Lectures and conferences: presentation of main concepts by lecturers or guest speakers.
- Participatory sessions: collective resolution of exercises with the lecturer and other students in the classroom
- Theoretical/practical supervised work (TD): classroom activity carried out individually or in small groups, with the advice and supervision of the teacher.
- Homework assignment of reduced extension (PR): carry out homework of reduced extension, individually or in groups.
- Homework assignment of broad extension (PA): model implementations and writing a report that should include the approach, results and conclusions.
- Evaluation activities (EV).

Training activities:
The course training activities are as follows:
- Face to face activities
o Lectures and conferences: learning based on understanding and synthesizing the knowledge presented by the teacher or by invited speakers.
o Participatory sessions: learning based on participating in the collective resolution of exercises with the lecturer and other students in the classroom.
o Theoretical/practical supervised work (TD): practical exercises and assignments, individually or in small groups, with the advice of the teacher.
- Study activities
o Homework assignment of reduced extension (PR): Optional activities related to review of concepts that students should know to develop the course without difficulties.
o Homework assignment of broad extension (PA): Assignments that involve implementation of simulation models and writing of related reports
o Self-study (EA): learning based on studying or expanding the contents of the learning material, individually or in groups, understanding, assimilating, analysing and synthesizing knowledge.

LEARNING OBJECTIVES OF THE SUBJECT

Electrical aspects of renewable energy will be addressed, from the modelling and control of the required electrical machines to electrical grid integration issues.
1. Introduce the generation principles of the different renewable sources.
2. Introduce the different renewable energy sources focusing on photovoltaic solar and wind systems.
3. Delve into the the electrical aspects of the treated energy sources: induction and synchronous generators, PV panels, etc.
4. Work with energy conversion technologies to integrate renewable energies into the electrical grid or microgrid.
5. Focus on control techniques to maximise generation and control optimally the grid interconnection.
6. Analyse issues related to grid integration: voltage and frequency stability, effect of perturbations into the renewable source generation, etc.
7. Development of simulation-based exercises.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	66.39
Hours small group	40,5	33.61

Total learning time: 120.5 h

CONTENTS

Introduction to renewable generation systems

Description:
A global introduction to the course will be given covering all the main aspects related to renewable energy generation, specifically photovoltaic and wind systems. Modelling and analysis techniques will be described.

Specific objectives:
Introduction and context of the course. Basic modelling aspects.

Related activities:
Review basic knowledge in converter and electrical machine modelling

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

Photovoltaic generation systems

Description:
Review of solar resource and description of main operation and control principles of photovoltaic inverters.

Specific objectives:
Understanding of photovotaic inverters and model implementation.

Related activities:
Steady state and dynamic models of PV system

Full-or-part-time: 9h
Theory classes: 2h 30m
Self study : 6h 30m

Wind generation systems

Description:
Review of wind resource and description of operation and control of Type 1,2 3 and 4 wind turbines.

Specific objectives:
Understanding of wind turbine converters and model implementation.

Related activities:
Steady state and dynamic models of wind systems

Full-or-part-time: 18h 30m
Theory classes: 4h 30m
Self study : 14h

Grid integration of renewable generation

Description:
Description of power plant controls and grid integration compliance.

Specific objectives:
Understand the need of a power plant control and grid requirements.

Related activities:
Activity 2

Full-or-part-time: 1h 30m
Theory classes: 1h 30m

GRADING SYSTEM

Written test (PE): 50%
Work performed individually or in groups (TR): 50%

BIBLIOGRAPHY

Complementary:
- Ackermann, Thomas. Wind power in power systems [on line]. 2nd ed. Chichester ; Hoboken, N.J.: Wiley, 2012 [Consultation: 05/02/2021]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781119941842. ISBN 978-0470974162.
- Manwell, J. F. [et al.]. Wind energy explained : theory, design and application [on line]. 2nd ed. [Chichester]: John Wiley & Sons, 2010 [Consultation: 29/03/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5892699910037277797067 11. ISBN 9780470686287.
- Infield, D. G ; Freris L.L. Renewable energy in power systems. Chichester, U.K.: John Wiley & Sons, 2008. ISBN 9780470017494.
- Anaya-Lara, Olimpo [et al.]. Wind energy generation : modelling and control [on line]. Chichester, U.K.: John Wiley & Sons, 2009 [Consultation: 05/02/2021]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=454292. ISBN 9780470714331.
- Quaschning, Volker. Understanding renewable energy systems. 2nd ed. London: Earthscan, 2016. ISBN 9781317669425.