820153 - IRXPE - Renewable Integration in Electrical Grids

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering

Teaching unit: 709 - EE - Department of Electrical Engineering

Academic year: 2016

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: Heredero Peris, Daniel

Others: Heredero Peris, Daniel
Prieto Araujo, Eduardo

Opening hours

Timetable: Preferably, an appointment by email.

Prior skills

Basic knowledge on electrical systems, power generation, energy resources, control theory and energy transport.

Requirements

Electrical Machines and Power Generation
Electric power system or power transmission and distribution II
Energy Control Systems

Degree competences to which the subject contributes

Specific:

1. Understand the applications of power electronics.

2. Understand the applications of renewable energies.

3. Understand electrical power systems and their applications.

4. Explain the operating principles of power conversion systems and their application to transport and distribution systems.
5. Explain the operating principles of fluid, gas and vapour, and electricity transport and distribution systems and understand their respective models.
6. Assess and compare the energy capacitance and potential of the energy resources available.

7. Analyse and simulate specific energy systems.

Transversal:

8. 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

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suitable information sources.
9. 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.
10. 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 subject is based on the theoretical explanation of a different renewable technologies and their integration to the utility from the point of view of the system control. The theoretical part is complemented with basically a series of practices with MATLAB.
The course uses approximately methodology exhibition / participation 30%, individual 60
% and group working in 10%. The practical implementation is basic to better understand the concepts worked.

Learning objectives of the subject

The main of the course is to study the various methodologies for integration of photovoltaic and wind power into the utility, considering their behavior from small to large powers. Also will be explained the implications in the electrical system of the electrical vehicle and will be announced the problematics to take care in micro-grids, both AC and DC.

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

Integration of PV at the utility

Learning time: 60h

Theory classes: 18h
Laboratory classes: 6h
Self study : 36h

Description:
Introduction to Photovoltaic Systems, Solar Radiation, Photovoltaic modules, Solar plants, Introduction to photovoltaic converters, Power semiconductors, Pulse Width Modulation (PWM), filters, Grid connected inverter, Introduction to system dynamics and control of discrete and continuous systems, Clarke and Park Transforms, Synchronism, Current loop network side, Loop voltage, Algorithms maximum power point tracking
Island Detection Systems, Efficiency of inverter equipment

Related activities:
Classroom theoretical sessions. Practical examples and MATLAB in classroom and autonomously

Specific objectives:
At the end of the activity students will be able to:
- Understand the scope and content of the course and details of teachers, dedication weekly practices, evaluation and bibliography.
- Understand the implications of a control system AC grid side to manage renewable resources

Grid integration of wind power

Learning time: 40h

Theory classes: 12h
Laboratory classes: 4h
Self study : 24h

Description:
Wind energy. Principles and basic elements: wind turbine, pitch, stall, gearbox. Electrical machines used in wind generation: induction generator, doubly fed induction generators, synchronous generators. Converters used for power generation. Control of wind turbines. Grid integration . Modeling and simulation of wind power.

Related activities:
Classroom theoretical sessions. Practical examples and MATLAB in classroom and autonomously

Specific objectives:
At the end of the activity students will be able to:
- Understand the scope and content of the course and details of teachers, dedication weekly regimen practices, evaluation and bibliography.
- Understand the implications of a control system for AC machine side to manage a wind generator

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Electric vehicle in the utility	Learning time: 32h Theory classes: 9h 36m Laboratory classes: 3h 12m Guided activities: 19h 12m

Description:
EV market forecast. Generation of CO2 in different scenarios. Charging methods. Charging end detection. BMS (Battery Management System). The electric vehicle charging. Configurations of electric vehicles. Electric vehicles and the operation of the system. Mechanisms of demand management. Standardization of EV charging. Charging infrastructure. Location of charging points.

Related activities:
Classroom theoretical sessions. Practical examples and MATLAB in classroom and autonomously

Specific objectives:
At the end of the activity students will be able to:
- Understand the scope and content of the course and details of teachers, dedication weekly regimen practices, evaluation and bibliography.
- Understand the implications of the EV integration to the grid.

Basic concepts of micro-grids	Learning time: 18h Theory classes: 10h 48m Guided activities: 5h 24m Self study : 1h 48m

Description:
The microgrid. Elements of the microgrid. Sources of energy. Paralelization of AC / DC systems

Related activities:
Classroom theoretical sessions. Practical examples and MATLAB in classroom and autonomously

Specific objectives:
At the end of the activity students will be able to:
- Understand the scope and content of the course and details of teachers, dedication weekly regimen practices, evaluation and bibliography.
- Understand the implications of the EV integration to the grid.At the end of the activity students will be able to:
- Understand the scope and content of the course and details of teachers, dedication weekly regimen practices, evaluation and bibliography.
- Understand the microgrid concept

Qualification system

The evaluation will be conducted by the assessment of the teacher. Partial checks account for 30%, exercises-problems and practical 30% and 40% a final control.

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Regulations for carrying out activities

The use of scientific calculators are allowed on exams.
You can not make use of any notes in the controls.

Bibliography

Basic:

Alonso Abella, Miguel; Escudero Díaz, Urbano J; Lozano Polo, Sinuhé. Sistemas fotovoltaicos : introducción al diseño y dimensionado de instalaciones de energía solar fotovoltaica. Madrid: Publicaciones Técnicas, cop. 2001. ISBN 9788486913090.

Bianchi, Fernando D; De Battista, Hernán; Mantz, Ricardo J. Wind turbine control systems : principles, modelling and gain scheduling design. London: Springer, 2007. ISBN 9781846284922.

Hatziargyriou, Nikos. Microgrids : architectures and control. Wiley-IEEE Press, 2014. ISBN 9781118720684.

Ogata, Katsuhiko. Ingeniería de control moderna. 5ª ed. Madrid [etc.]: Pearson Educación, cop. 2010. ISBN 9788483226605.