REM master basic syllabus

Title:
502150 Integration of renewable energy into the electricity system

Credit value:
3 ECTS

Mandatory/Optional:
Mandatory

Semester:
2

Lecturer/s:
Dr. Pablo Eguia Lopez

University:
Universidad del País Vasco UPV/EHU

Department:
Department of Electrical Engineering

Rationale:
The integration of distributed renewable generation into the electricity system poses technical, economic and regulatory problems in current systems since they are designed for bulk energy generation and transmission. In this regard, these problems are discussed along with the proposed solutions, making use of the knowledge acquired by students in previous subjects of the curriculum.

Objectives:
The main objective of the course is to provide students with the knowledge of the impacts caused by the integration of distributed renewable generation in the power system.
A supplementary objective is to provide student with the ability to use modern simulation tools to evaluate the performance of electric power systems with high penetration of renewable energy.

Skills: *(according to the list of skills provided)*

Subject skills	REM Master Skills						
	L2.1	**L2.2**	**L2.3**	**L2.4**	**L2.5**	**L2.6**	**L2.7**
L3.1. To explain and to demonstrate knowledge and understanding of the main technical and economic impacts of distributed renewable generation, as well as the solutions proposed to limit them	X						
L3.2. To explain and to demonstrate knowledge and understanding of the regulatory framework for distributed renewable generation and its relation to the technical, economic and social issues	X				X		
L3.3. To have knowledge and to become skilled with simulation tools to analyze the impacts of distributed renewable generation in the electrical system		X	X				
L3.4. To acquire new skills, organize information and make effective reports						X	X
L3.5. To use communication skills in various formats: group discussion, debate and exhibition					X		

Teaching and learning methods:

The course methodology includes various techniques as individualized and group learning methodology, combining both throughout the whole learning process. Lectures, workshop, computer classes and tutorials will be used:

1. Lecture format with oral and audiovisual presentations

2. Together with the lectures, classroom practices in small groups and a workshop will be developed.

3. Computer practices in a computer room.

4. Individual monitoring of the learning process is done through mentoring

Allocation of student time:

	Attendance (classroom, lab,…)	**Non attendance (lecture preparation, self study…)**
Lectures	16 hours	20 hours
Classroom practice	4 hours	8 hours
Workshop	2 hours	1 hours
Computer lab	8 hours	16 hours

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Assessment:

Procedures for assessment of the course are:

1. Through the assistance and active participation in class.

2. By conducting group work and housework.

3. By conducting a final exam.

There will be a final exam and three laboratory and housework exercises to be developed in group.

After each lecture students can assess the knowledge gained through the realization of a true / false test with feedback on failed responses. These tests are intended to assess the individual progress of each student to the final exam.

The reports of the exercises will be returned reviewed a week before the final deadline.

Assessment Matrix:

Subject skills	**Assessment method**					
	Exam	**Presentation**	**Homework**	**Report**	**…**	**…**
L3.1.	50%	25%	25%			
L3.2.	50%		25%	25%		
L3.3.				100%		
L3.4.				100%		
L3.5.		100%				

Programme:

Lesson 1	***Introduction to renewable distributed generation and system impacts*** *General introduction to the concept of distributed generation and its technical, economic and social impacts in the electrical system* *Distribution (2 h theory)*
Lesson 2	***Network topologies with distributed renewable generation*** *Description of the different network topologies where distributed renewable generation can be connected. Principles of design, operation and protection* *Distribution (1 h theory)*
Lesson 3	***Types of generators and system studies*** *Description of the types of generators used in distributed renewable generation, their modeling and use in system studies* *Distribution (2 h theory + 1 h practical classroom + 1 h computer)*
Lesson 4	***Technical Impact: Voltage control, stability and power quality*** *Study of the technical impact of distributed renewable generation focusing the study on voltage control, power quality and system stability* *Distribution (4 h theory + 2 h practical classroom + 3 h computer)*
Lesson 5	***Technical impact: Protection*** *Study of protection practice for distributed renewable generators and their impact on the network protection system, both transmission and distribution* *Distribution (2 h theory + 1 h practical classroom + 2 h computer)*
Lesson 6	***Regulatory framework. Connecting criteria*** *Analysis of the regulatory framework of renewable generation in the European and Spanish systems. Grid codes.* *Distribution (1 h theory)*
Lesson 7	***Economic impact*** *Economic impact analysis of distributed renewable generation in the planning and operation of the electric energy system. Integration of distributed renewable generation in the electricity market* *Distribution (2 h theory)*
Lesson 8	***Integration of distributed renewable generation into the electricity system*** *Current status, challenges and prospects. Case Studies* *Distribution (2 h theory + 2 h computer)*

Resources:

Classrooms, Blackboard, laptop, projector, audio, computer room, laboratory, security issues,…

All the material necessary to follow the course is facilitated by teacher of the subject during the course development, through eGELA platform (https://egela.ehu.es/).

The resources used include: A suitable classroom for small group activities; blackboard; laptop with projector; photocopies; library; a computer room.

Bibliography:

Basic textbooks:

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[2] Jenkins N., Ekanayake J.B., Strbac G., Distributed generation. IET Renewable Energy Series 1. London 2010.
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Deepening bibliography:

[1] CIGRE W.G. A3.13. Changing network conditions and system requirements. Part 1: the impact of distributed generation on equipment rated above 1 kV.
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[3] Microgrids Task A1, Digital models for micro sources. February 2004.
[4] WECC Modeling and Validation Workgroup, WECC Wind Power Plant Power Flow Modeling Guide. May 2008.
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[15] R. Piwco, P. Meibom, H. Holttinen, B. Shi, N. Miller, Y. Chi, W. Wang, Lessons learned from large-scale wind power integration, IEEE Power & Energy Magazine, Vol.10 No. 2, March/April 2012

Further comments: