UNIVERSITAT POLITÈCNICA DE CATALUNYA

ESCOLA UNIVERSITÀRIA D'ENGINYERIA TÈCNICA INDUSTRIAL DE BARCELONA

Degree in ENGINEERING (All degrees)

Escola Universitària d'Enginyeria Tècnica Industrial de Barcelona
Consorci Escola Industrial de Barcelona
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Guide of the course (English)

Subject:	Sustainable electric energy systems				
Acronym:		**Type:**	**Optional**		
Code:		**Semester:**	**SPRING**		
Year:	**2011**	**Level:**			
Credits:	**Total Credits ECTS:**	6	**Total number of hours:**	6	
	In Classroom Credits (Theory):	1	In Classroom Hours (Theory):	1	
	In Classroom Credits (Problems):	1	In Classroom Hours(Problems):	1	
	Laboratory Credits:	0	Laboratory Hours:	0	
	Guided Activities Credits:	2	Guided Activities Hours:	2	
	Out of the Classroom Credits:	2	Out of the Classroom Hours:	2	
Coordinator:	Oriol Gomis Bellmunt				
Teaching staff:	Xavier Soler Pedemonte, Oriol Gomis Bellmunt				
Consulting Timetable:	To be determined				
Prerequisites:	Knowledge on electrical circuits is highly recommended.				
Co-requisites:					
General Objectives:	Electrical aspects of renewable energy and systems efficiency will be addressed, from technology description, modeling and control of the required electrical energy converters to sound related economics analysis.				
Specific Objectives by topic:	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 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 maximize generation and control optimally the grid interconnection. 6. Analyze issues related to grid integration: voltage and frequency stability, effect of perturbations into the renewable source generation, etc… 7. Analyze efficient electrical technology options and its economics. 8. Development of simulation based exercises				
Cross competences:	Work on system efficiency of renewable energies focusing on electrical solutions.				

Topics of the course:

1. Generation introduction
    a. Renewable and non-renewable energy sources
    b. General considerations
2. Wind Power
    a. Basic elements and principles
    b. Wind park configurations.
    c. Electrical machines employed.
    d. Power converters.
    e. Wind parks and wind turbine control.
    f. Modeling and simulation.
    g. Wind energy generation economics
3. Photovoltaic Power
    a. Basic elements and principles.
    b. PV converters.
    c. Power converters.
    d. PV systems control.
    e. Modeling and simulation.
    f. Photovoltaic energy generation economics
4. Grid integration
    a. Effects of perturbations
    b. Power systems stability
    c. Islanding detection
    d. Islanded operation of renewable based grids.
5. Electrical systems efficiency
    a. Transformers
    b. Electricity distribution
    c. Electrical energy storage
    d. Quality at the end customer
    e. Motors and loads efficiency
    f. Standards and regulations about quality and efficiency
    g. Economic analysis

Laboratory:

Lab synchronous generator characterization:

1. Generator working at no load and load testing. Electrical Model Parametrers calculation
2. Synchronous generator coupling to the mains

Guided Activities:

Students will develop practical exercises focusing on modeling and simulation of wind and PV systems. Different groups will select different schemes. The work undertaken will be presented to the other students along with a report with the obtained results.

Student's Weekly work expressed in hours:

Activity type/weekly	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Theory																					30
Practice																					20
Problems																					
Out of the classroom																					70
Practice work delivery																					25
Oral/Written tests																					5
Other activities																					
TOTAL	6	6	8	8	10	10	10	8	8	10	8	10	8	9	6	4	4	4	6	7	150

[1] The laboratory sessions are two hours biweekly, starting the first week. The odd groups attend the 7 sessions on weeks 3, 5, 7, 9, 11 and 13, while even groups attend to them on weeks 6, 8, 10, 12 and 14.

[2] This includes the individual out of the classroom activity (learning time)

[3] The practice reports entail the work of reduced groups during the whole semester. Each report delivery requires three hours of work (previous preparation of the practice and of the report afterwards)

Teaching/Learning method:

Theory / Problems / Lab presential classes + non-presential exercises

Main bibliographic resources:

Complementary bibliographic resources:

Wind Turbine Operation in Electric Power Systems: Advanced Modeling
Zbigniew Lubosny
Springer Verlag, 2003

Wind Power in Power Systems
Thomas Ackermann (Editor)
Wiley, 2005

Embedded Generation
N. Jenkins, R. Allan, P. Crossley, D. Kirschen and G. Strbac.
The Institution of Electrical Engineers, 2000

Assessment and qualification:

Final exam 50 %
Non-presential activities 40 %
Lab practices 10 %