Last update:

820739 - EO - Wind Power (DRAFT VERSION)

Coordinating unit: 820 - EUETIB - Barcelona College of Industrial Engineering

Teaching unit: 709 - EE - Department of Electrical Engineering

Academic year: 2014

Degree: MASTER IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ERASMUS MUNDUS MASTER IN ENVIRONOMICAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Gomis Bellmunt, Oriol

Others: Oriol Gomis, Agustí Egea, Eduardo Prieto, Mònica Aragüés, Oriol Lemhkul

Prior skills

Basic electrical and mechanical engineering
Electrical circuits analysis

Requirements

Basic electrical and mechanical engineering
Electrical circuits analysis

Degree competences to which the subject contributes

Transversal:

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Learning objectives of the subject

Last update:

820739 - EO - Wind Power (DRAFT VERSION)

The course will focus on providing the knowledge and the tools needed to understand and analyze wind power generation systems. Steady-state and dynamic analysis of wind turbines and wind power plants will be conducted.

At the end of the course the students will be able to:
- Understand the principles of electrical generation with wind turbines
- Determine the steady state conditions of a given wind power generation system
- Analyze the dynamic behavior of wind turbines
- Understand how wind turbines can be aggregated in wind power plants
- Size and pre-design wind turbines and wind power plants

Study load

Total learning time: 125h	Hours large group:	0h	0.00%
	Hours medium group:	0h	0.00%
	Hours small group:	30h	24.00%
	Guided activities:	15h	12.00%
	Self study:	80h	64.00%

Last update:

820739 - EO - Wind Power (DRAFT VERSION)

Content

Introduction to wind energy

Learning time: 7h

Small group/Laboratory: 2h
Self study : 5h

Description:
Wind power generation systems will be introduced, covering the following topics:
- Electrical power systems
- Renewable energy prospects and trends
- Onshore and offshore wind power
- The wind industry
- Relevant organizations

The topics will be introduced in the class and materials for further study will be proposed to students.

Specific objectives:
Understanding on where wind power is compared to other renewal and non-renewable energy sources and what can be expected in the coming years.

The wind resource

Learning time: 12h

Small group/Laboratory: 2h
Self study : 10h

Degree competences to which the content contributes:
CT1a (Transversal)
CT2 (Transversal)
CT3 (Transversal)
CT4 (Transversal)
CT5 (Transversal)

Description:
The module will introduce the analysis and characterization of the wind resource both in onshore and offshore conditions. Exercises will be performed to exemplify the analysis of variability of wind speed depending on key parameters. Activity 1 will be proposed and started in this module.

Related activities:
Activity 1

Specific objectives:
Wind resource analysis and characterization.

820739 - EO - Wind Power (DRAFT VERSION)

Principles and components of wind turbines	Learning time: 12h Small group/Laboratory: 2h Self study : 10h

Degree competences to which the content contributes:
CT1a (Transversal)
CT2 (Transversal)
CT3 (Transversal)
CT4 (Transversal)
CT5 (Transversal)

Description:
The module will describe how wind turbines work and the basic related fluid-dynamics principles. The power coefficient will be introduced. The different components of wind turbines will be introduced. Related exercises and guidance on activity 1 will be provided.

Related activities:
Activity 1

Specific objectives:
Wind turbine operation principles, Wind turbine configurations, Wind turbine components

Fix-speed wind turbines	Learning time: 12h Small group/Laboratory: 2h Guided activities: 10h

Degree competences to which the content contributes:
CT1a (Transversal)
CT2 (Transversal)
CT3 (Transversal)
CT4 (Transversal)
CT5 (Transversal)

Description:
The different concepts of wind turbines will be introduced. Fix speed wind turbines will be analyzed including the key elements description, steay-state analysis, and operation and control issues. The module will introduce the modeling and analysis of wind turbines both for steady-state and dynamic analysis which will be the basis for Activity 2.

Related activities:
Activity 2

Specific objectives:
Fix speed wind turbine

820739 - EO - Wind Power (DRAFT VERSION)

Variable speed wind turbines

Learning time: 24h

Small group/Laboratory: 4h
Self study : 20h

Degree competences to which the content contributes:
CT1a (Transversal)
CT2 (Transversal)
CT3 (Transversal)
CT4 (Transversal)
CT5 (Transversal)

Description:
Variable speed wind turbines will be analyzed including the key elements description, steay-state analysis, and operation and control issues. Doubly fed induction generator based and full power converter based variable speed wind turbines will be considered. The module will include the modeling and analysis of variable-speed wind turbines both for steady-state and dynamic analysis which will be the basis for Activity 3.

Related activities:
Activity 3

Specific objectives:
Variable speed wind turbines

Wind power plants

Learning time: 12h

Small group/Laboratory: 2h
Self study : 10h

Description:
The key issues related to wind power plants will be presented, including electrical configuration analysis and sizing and the effect of wakes between wind turbines.

Specific objectives:
Offshore and onshore wind power plants

820739 - EO - Wind Power (DRAFT VERSION)

Planning of activities

Power curve and energy extraction	Hours: 7h Guided study: 1h Self study: 5h Laboratory classes: 1h

Degree competences to which the activity contributes:

CT1a (ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
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CT2 (SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
)

CT3 (TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
)

CT4 (EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
)

CT5 (FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

)

Description:

For a given location and known wind resource information, and considering a given wind turbine with a known power curve, the activity will develop an energy extraction analysis also considering the influence of different parameters.

Support materials:

Wind resource data, Wind turbine parameters.

Descriptions of the assignments due and their relation to the assessment:

An activity report will be submitted. Part of the groups will also defend their work in an oral presentation.

Steady-state and dynamic analysis of a fix-speed wind turbine	Hours: 7h Guided study: 1h Self study: 5h Laboratory classes: 1h

820739 - EO - Wind Power (DRAFT VERSION)

Degree competences to which the activity contributes:

CT1a (ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
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CT5 (FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

)

Description:

A given fix-speed wind turbine will be analyzed in steady-state and with dynamic simulations.

Support materials:

Wind turbine parameters.

Descriptions of the assignments due and their relation to the assessment:

An activity report will be submitted. Part of the groups will also defend their work in an oral presentation.

Steady-state and dynamic analysis of a variable speed wind turbine	Hours: 7h Guided study: 1h Self study: 5h Laboratory classes: 1h

820739 - EO - Wind Power (DRAFT VERSION)

Degree competences to which the activity contributes:

CT1a (ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
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CT2 (SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
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CT5 (FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

)

Description:

A given variable speed wind turbine will be analyzed in steady-state and with dynamic simulations.

Support materials:

Wind turbine parameters.

Descriptions of the assignments due and their relation to the assessment:

An activity report will be submitted. Part of the groups will also defend their work in an oral presentation.

Bibliography

Basic:

Heier, Siegfried. Grid Integration of Wind Energy. ISBN 9781119962946.

Hau, Erich. Wind turbines : fundamentals, technologies, application and economics. ISBN 9783540242406.

Ackermann, Thomas. Wind Power in Power Systems. ISBN 9780470974162.

Lubosny, Zbigniew. Wind turbine operation in electric power systems : advanced modeling. ISBN 354040340X.