Course guide
820739 - EO - Wind Power

Last modified: 16/04/2024

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: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Gomis Bellmunt, Oriol

Others: Oriol Gomis, Eduardo Prieto

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

Specific:
CEEN4. (ENG) Realitzar de manera eficient l'obtenció de dades de recursos renovables d'energia i el seu tractament estadístic, així com aplicar coneixements i criteris de valoración en el diseny i avaluació de solucions tecnològiques per a l'aprofitament de recursos renovables d'energia, tant per a sistemes aïllats com connectats a xarxa. Reconéixer i valorar les aplicacions tecnològiques més novedoses dels recursos renovables d'energia.
CEEN6. (ENG) Aplicar criteris tècnics i econòmics en la selecció de l'equip elèctric més adequat per a una determinada apliació. Dimensionar equips e instal.lacions elèctriques. Reconeixer i valorar les aplicacions tecnològiques més novedoses en l'àmbit de la producció, transport, distribució, emmagatzematge i us de l'energia elèctrica.

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.

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

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

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	45,0	36.00

Total learning time: 125 h

CONTENTS

Introduction to wind energy

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.

Full-or-part-time: 7h
Laboratory classes: 2h
Self study : 5h

The wind resource

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.

Specific objectives:
Wind resource analysis and characterization.

Related activities:
Activity 1

Related competencies :
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.

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Full-or-part-time: 12h
Laboratory classes: 2h
Self study : 10h

Principles and components of wind turbines

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.

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

Related activities:
Activity 1

Related competencies :
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Full-or-part-time: 12h
Laboratory classes: 2h
Self study : 10h

Fix-speed wind turbines

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.

Specific objectives:
Fix speed wind turbine

Related activities:
Activity 2

Related competencies :
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Full-or-part-time: 12h
Laboratory classes: 2h
Guided activities: 10h

Variable speed wind turbines

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 some example case studies developed in the class.

Specific objectives:
Variable speed wind turbines

Related competencies :
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.

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Full-or-part-time: 24h
Laboratory classes: 4h
Self study : 20h

Wind power plants

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

Full-or-part-time: 12h
Laboratory classes: 2h
Self study : 10h

ACTIVITIES

Power curve and energy extraction

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.

Material:
Wind resource data, Wind turbine parameters.

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

Related competencies :
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Full-or-part-time: 7h
Self study: 5h
Guided activities: 1h
Laboratory classes: 1h

Steady-state and dynamic analysis of a fix-speed wind turbine

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

Material:
Wind turbine parameters.

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

Related competencies :
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.

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Self study: 5h
Guided activities: 1h
Laboratory classes: 1h

GRADING SYSTEM

The final mark will be calculated as follows:
Final Mark = 0.5 EF + 0.25 ACT1 + 0.25 ACT2
where
EF is the final exam
ACT1 Activity 1
ACT2 Activity 2

EXAMINATION RULES.

The final exam will have two parts:
- Multiple choice test (50 %)
- Conceptual questions (50 %)
No calculator or material is allowed to do the exam.

BIBLIOGRAPHY

Basic:
- Heier, Siegfried. Grid integration of wind energy conversion systems [on line]. 3rd ed. Chichester [etc.]: Wiley, 2014 [Consultation: 05/10/2017]. Available on: http://onlinelibrary.wiley.com/book/10.1002/9781118703274. ISBN 9781118703304.
- Hau, E. Wind turbines : fundamentals, technologies, application and economics [on line]. 3rd ed. Berlin, Heidelberg: Springer Berlin Heidelberg, 2013 [Consultation: 10/10/2016]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-642-27151-9. ISBN 9783642271519.
- Ackermann, Thomas (ed.). Wind power in power systems. 2nd ed. Chichester: Hoboken, N.J, 2012. ISBN 9780470974162.
- Lubosny, Zbigniew. Wind turbine operation in electric power systems : advanced modeling [on line]. Berlin [etc.]: Springer, cop. 2003 [Consultation: 16/11/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6300737. ISBN 354040340X.