Wind power generation systems

Academic Year: (2022 / 2023) **Review date: 26/05/2022 11:59:13**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: ARNALTES GOMEZ, SANTIAGO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Circuit analysis
Electrical machines
Electrical drives
Control systems

OBJECTIVES

The general objectives are summarized in:
- Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context
- That students know how to apply the acquired knowledge and their ability to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study
- That students are capable of integrating knowledge and facing the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments
- That students know how to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way
- That students possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

The specific objectives are summarized in:

1- Acquire adequate knowledge of renewable energies: resources and technology. They should know in more detail the most frequent energies in our environment: wind energy.
2- Acquire adequate knowledge of electrical engineering applied to wind.
3- Acquire adequate knowledge of industrial management of projects and renewable energy companies: wind
4- Project, calculate and design products, processes, facilities and renewable energy plants: wind.
5- Direct, plan and supervise multidisciplinary teams that design or execute renewable energy projects: wind.
6- Carry out research, development and innovation in products, processes and methods related to renewable energies: wind
7- Perform strategic planning and apply it to renewable energy systems: wind.
8- Technically and economically manage projects, facilities, plants, companies and technology centers related to renewable energy: wind.
9- Follow the technological evolution of renewable energies (wind) and have prospective knowledge of this evolution.

Students who successfully complete this course will be able to:

1- Summarize the history of modern wind turbines justifying the development of current technology. On the other hand, students must use the exact terminology of the components for the most common applications, including offshore wind and offshore, as well as small wind turbines.
2- Understand and use the fundamental physical equations that allow converting wind energy into mechanical and electrical energy.

3- Understand the technology, as well as the main systems design criteria of modern wind turbines.
4-Describe all types of wind turbines and justify their main characteristics. On the other hand, students must understand the main mathematical models for the most relevant types, with special emphasis on different control strategies.
5-Identify the main wind turbine manufacturers, as well as to adequately analyze and compare the technical specifications of their products.
6-Understand the impact of wind energy, and the main aspects of the network codes developed to mitigate them.
7- Be able to understand the results of software packages that use wind turbine models for economic evaluation or analysis of power systems.
8- Develop the ability to work as a team and promote team interaction in a creative way to encourage the contribution of all members in order to deliver specific engineering projects and tasks
9- Know the social and energy needs of wind energy, as well as its advantages and disadvantages
10- Sizing capacity / design of electricity producing plants from wind power.
11- Understand each of the constituent parts of the elements that can form a wind turbine.
12- Having the ability to select the most appropriate components within the commercially available.
13- Know the requirements required for the integration of wind power in the electricity grid, and in the electricity markets.
14- Have the ability to apply the concepts of control and regulation in wind power plants.
15- Have the capacity to evaluate the feasibility and manage projects and wind energy companies.
16- Having the ability to develop original works on a subject of the degree, under supervision, in which the competences acquired in the teachings are synthesized.
17- Have the ability to exhibit and defend projects and their conclusions.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
- History of the development of wind energy
- Statistics of the development of wind energy
- Current manufacturers and models of wind turbines

2- Wind resource and power generation
- Wind resource monitoring
- Analysis of the wind resource
- Annual energy production of a wind farm

3- Aerodynamics of wind systems
- Introduction to lift and thrust forces
- Triangle of speeds and relative speed
- Aerodynamic models in wind energy conversion systems.
- Power efficiency coefficient: Cp
- Calculation of the power and torque developed by the blade

4- Description of the main components and types of terretre wind energy conversion systems
- Classification of wind turbines
- Main components
- Mechanical components
- Electric components
- Control systems
- Types of wind systems

5- Electrical components of wind energy conversion systems
- Power transformers
- Electric generators
- Power electronics
- Settings

6- Control systems in wind turbines
- Blade pitch control
- Torque control
- Speed control
- Simulation model of a fixed speed system
- Simulation model of a variable speed system

7- Type 1 wind energy conversion system
- General description
- Aerodynamic and mechanical components
- Electrical components
- Control systems
- Simulation models

8- Type 2 wind energy conversion system
- General description
- Aerodynamic and mechanical components
- Electrical components
- Control systems
- Simulation models

9- Type 3 wind energy conversion system
- General description
- Aerodynamic and mechanical components
- Electrical components
- Control systems
- Simulation models

10- Type 4 wind energy conversion system
- General description
- Aerodynamic and mechanical components
- Electrical components
- Control systems
- Simulation models

LEARNING ACTIVITIES AND METHODOLOGY

The teaching method will consist of lectures and the development of a project chosen by the student team ("project based learning").

The last classes will be presented by the students with projects that develop along the whole course.

Problems will be solved with the use of specific software packages.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

In the ordinary call the students will have to deliver a report of the chosen project, present the results and take an oral final exam, which will compute 100% of the mark of the continuous evaluation.
In the extraordinary call students will have to take a written exam, and the percentage weight of this exam in the final grade will be 100%.

BASIC BIBLIOGRAPHY

- James F. Manwell, Jon G. McGowan, Anthony L. Roger Wind Energy Explained: Theory, Design and Application, 2nd Edition, Wiley, 2009

- John Dalsgaard Sørensen, Jens N Sørensen Wind Energy Systems: Optimising Design and Construction for Safe and Reliable Operation, Elsevier, 2010

- José Luis Rodriguez Amenedo, Juan Carlos Burgos, Santiago Arnalte Sistemas Eólicos de Producción de Energía Eléctrica, Rueda, 2003

- Mohamed A. El-Sharkawi Wind Energy: An Introduction, CRC Press, 2015

- Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright, Michael Hughes Wind Energy Generation: Modelling and Control, Wiley, 2009

- Thomas Ackermann (Editor) Wind Power in Power Systems, 2nd Edition, Wiley, 2012

ADDITIONAL BIBLIOGRAPHY

- Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro Power Conversion and Control of Wind Energy Systems, Wiley, 2011

- Gonzalo Abad, Jesus Lopez, Miguel Rodriguez, Luis Marroyo, Grzegorz Iwanski Doubly Fed Induction Machine: Modeling and Control for Wind Energy Generation, Wiley-IEEE Press, 2011

- Olimpo Anaya-Lara, David Campos-Gaona, Edgar Moreno-Goytia, Grain Adam Offshore Wind Energy Generation: Control, Protection, and Integration to Electrical Systems, Wiley, 2014

- R Clark Small Wind, 1st Edition Planning and Building Successful Installation, Elsevier, 2013

- Tony Burton, Nick Jenkins, David Sharpe, Ervin Bossanyi Wind Energy Handbook, 2nd Edition, Wiley, 2011