Wind power generation systems

Academic Year: (2024 / 2025) **Review date: 24-04-2024**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: CASTRO MARTÍNEZ, JESÚS

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 specific objectives are summarized in:
- Acquire adequate knowledge of wind energy technology and use the exact terminology of the components for the most common applications, including offshore wind and offshore, as well as small wind turbines.
- Follow the technological evolution of wind energy and have prospective knowledge of this evolution.
- Understand and use the fundamental physical equations that allow converting wind energy into mechanical and electrical energy.
- Understand and apply the main systems design criteria of modern wind turbines.
- Describe all types of wind turbines and understand the main mathematical models for the most relevant types, with special emphasis on different control strategies.
- Identify the main wind turbine manufacturers, and adequately analyze and compare the technical specifications of their products.
- Understand the results of software packages that use wind turbine models for economic evaluation or analysis of power systems.

DESCRIPTION OF CONTENTS: PROGRAMME

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

2. Aerodynamics, wind resource and wind farm production
- Introduction to lift and thrust forces
- Velocity triangle and relative velocity
- Aerodynamic models in wind energy conversion systems.
- Coefficient of power efficiency: Cp
- Calculation of power and torque developed by the blade.
- Wind resource monitoring
- Wind resource analysis
- Annual energy production of a wind farm

3. Description of the main components and general classification
- Classification of wind turbines
- Main components
- Mechanical components
- Electrical components

4. Modeling of a wind turbine and classification by regulation systems
- Types of wind turbines according to their speed regulation system
- Aerodynamic model
- Mechanical model
- Blade pitch model

5. Fixed speed wind energy conversion system
- General Description
- Aerodynamic and mechanical components
- Electrical components
- Control systems

6. Electronic converters
- Topologies of electronic converters
- Principle of operation
- Modulation techniques
- Control techniques
- Operating limits

7. Type 3 Wind Energy Conversion System
- General Description
- Aerodynamic and mechanical components
- Electrical components
- Control systems

8. Type 4 Wind Energy Conversion System
- General Description
- Aerodynamic and mechanical components
- Electrical components
- Control systems

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:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

In the ordinary call, the grade will be given by the following elements:

- Qualification of a computer practice that will be carried out throughout the course in which the student will be taught to use simulation software dedicated to the modelling of electrical systems, focused on the field of wind energy. 20 %.
- Qualification of the report submitted by each working group on the project carried out in the course. 60%.
- Qualification of the presentation of the results of the subject's project in an oral presentation session. 20 %.

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