

Module PRE700

Wind Energy Fundamentals and Wind Farm Design

This module is associated to the following degrees

Master > Renewable Energy Online > Mandatory Module

Abstract:

In this module, the students will learn the fundamentals of wind power generation and utilization. The course starts with the explanation of the physics behind the generation of the wind, its occurrence and how wind measurements are carried out. Concepts about the energy and power available in the wind, as well as the types of wind energy converters will be described. The aeromechanical energy conversion is explained thoroughly, including the basic blade aerodynamic design. The main components of the wind turbine are also characterized, along with the main drive train, generator concepts and power control strategies. Insights on the mechanical design of the wind turbine components will be given, based on the generation and occurrence of loads. Environmental effects, political and social aspects of wind energy utilisation will be discussed as well.

In the practical part of the module, calculation exercises will be given to complement the theoretical knowledge. Additionally, students will get insights on how wind farm planning is done in the industry. They will perform tasks related with the assessment of the wind resource, energy yield, wind farm efficiency, shadow casting and noise emission of a wind farm. In a self-contained work they will select types of wind turbines and establish a wind farm layout for a given site. They will also optimize the wind farm design, in regard of energy yield and environmental impacts. Tasks to learn about basic economic calculations will be also provided.

Duration:	1 semester	Teaching form:	Theoretical – practical seminar: e-learning.
Cycle:	Summer Semester	Language:	English
Type of module:	Mandatory	Credit points:	6 ECTS
Level:	MM (master module)	Workload:	180 hours
Max. No. of students:	30	Pre-requisites:	none
Weblink:	n/a	Associated with the module(s):	n/a

Lecturer(s):
David Bastine, Hans Holtorf

Mentor(s):
Mónica Gutiérrez, Adnan Shihab

Designer(s) of the module:
Mónica Gutiérrez

Examiner(s):
David Bastine, Hans Holtorf

Objective of the module / learning outcomes:

After successful completion of the module students should be able to:

- describe a wind resource by means of physical and statistical parameters
- explain the aeromechanical concepts of wind power generation
- characterise the main components of a wind turbine
- perform basic aerodynamic blade design calculations
- perform a basic design of a wind farm layout, based on energy yield, turbine characteristics and environmental impacts applying widely used software tools
- discuss limitations and critical factors of design processes and calculations
- describe the environmental effects, political and social aspects of wind energy utilisation

Forms of learning:

The learning process will be predominantly based on reading material (self-learning) and applying new knowledge in practical exercises, which are designed to complement the content of each chapter of the module. The students will be supported by lecturers and mentors using forums, messages and video conferences for active discussions and constant contact to address questions and any type of difficulties.

Helpful previous knowledge:

- Basic knowledge of mechanics (statics and dynamics)
- Mathematics for physics and engineering

Content of the module:

- The wind: generation, occurrence and measurements.
- Aerodynamic concepts of wind turbines.
- Aero-mechanical wind turbine design.
- Wind turbine components.
- Wind turbine characteristics and control.
- Grid connection and integration.
- Wind farm aerodynamics and planning.
- Economics of wind energy utilization.

Useful literature:

- T. Burton, D. Sharpe, N. Jenkins, and E. Bossanyi. Wind energy handbook. Ed. by John Wiley & sons Ltd. Chichester, 2001. ISBN: 0-471-48997-2.
- R. Gash and J. Twele, eds. Wind power plants - Fundamentals, design, construction and operation. Second. Berlin: Springer, 2012. ISBN: 978-3-642-22937-4. DOI: 10.1007/978-3-642-22938-1.
- J. Manwell, J. McGowan, and A. Rogers. Wind Energy Explained - Theory, Design and Application. Ed. by John Wiley & Sons Ltd. Second Edi. Chichester, 2009. ISBN: 978-0-470-01500-1.
- S. Mathew. Wind energy - fundamentals. resource analysis and economics. Netherlands: Springer-Verlag Berlin Heidelberg, 2016. ISBN: 9783540309055.
- E. Hau. Wind turbines - Fundamentals, technologies, application, economics. Third. Springer-Verlag Berlin Heidelberg, 2013.

Requirements for awarding the credit points

Practical exercises: Submission of the solutions of the calculation exercises and tasks in due time. Each set of tasks will be graded. The average of the grades obtained during its duration will be calculated, giving the final grade.

Examination periods:

Tasks corresponding to each chapter will be given to the students. The tasks are designed to be solved in 2 weeks' time frame. Deadlines to deliver the tasks will be at the end of each month.

Comments:

none

Registration procedure:

C3LLO

Last update:

29.03.2019