SG2226 Wind Energy Aerodynamics 6.0 credits

Strömningsmekanik för vindenergi

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Technology

Specific prerequisites

Knowledge of fluid dynamics corresponding to at least SG1215, SG1217 or SG1220 or equivalent. Basic knowledge of Matlab.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

Once the course will be completed, the student should be able to:

- explain main concepts of wind energy conversation and how wind turbines work from an aerodynamic perspective.
- explain the momentum theory and derive Betz' and Glauert's rules.
- design an optimum blade using blade element momentum theory.
- describe available fluid mechanics measurement methods related to wind energy and under which conditions they are applicable.
- what are wind turbine real operating conditions inside the atmospheric boundary layer and the consequent effects on the wind turbine loads.
- explain basic meteorological forces and how the affect global and local winds.
- describe the daily and seasonal variations of the atmospheric boundary layer both on land and for offshore conditions.
- use different simulation methods for wind energy production estimations and when they are applicable and what limitations they have during different terrain conditions.

Course contents

For wind energy applications the student should be able to:

- explain general wind turbine functions and main turbine concepts.
- derive the momentum theory including Betz' and Glauert's optimum performance.
- derive general wind turbine aerodynamic equations.
- explain and use blade element momentum theory.
- use the blade element momentum method to design an optimal blade design.
- exemplify and describe experimental methods, used both for field measurements and in wind tunnels.
- derive equations for wind tunnel corrections.
- explain and describe fundamental wake dynamics.
- describe parameters that affect the wind farm power production.
- describe how icing affects the production.
- explain general wind meteorology (Forces, geostrophical balance, etc.).
- describe how the atmospheric boundary layer depends on stability and ground conditions.
- account for different wind energy utilization simulation methods and their limitations and when they are applicable.

Disposition

The course consists of 16 two hour lectures, including two external lecturers, one home assignment and one laboratory work.

The laboratory work and home assignment are essential and central part of the course:

- The laboratory work aims to give the students an understanding of how some fundamental parameters affect the aerodynamic behaviour of a wind turbine.
- The home assignment consists of a project where a wind turbine blade should be designed numerically using Matlab.

Course literature

Hansen, Martin O. L., 2007, Aerodynamics of Wind Turbines,Earthscan Ltd, ISBN 9781844074389.

Ivanell, S., and Sørensen, J. N., 2010, Wind Turbine Aerodynamics, 30 pages course compendium.

Additional course material, about 200 pages.

Examination

- INL1 - Home Assignment, 1.5 credits, grading scale: P, F
- TEN1 - Examination, 3.5 credits, grading scale: A, B, C, D, E, FX, F
- LAB1 - Lab Exercise, 1.0 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

Homework assignment (INL1; 1.5 university credits), Laboratory work (LAB1; 1.0 university credits), Final exam, (TEN1; 3.5 university credits). Completed laboration and approved laboration report.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.