FSG3226 Wind Energy Aerodynamics 7.5 credits

Strömningsmekanik för vindenergi

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

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

Establishment

Course syllabus for FSG3226 valid from Spring 2019

Grading scale

P, F

Education cycle

Third cycle

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 and how wind turbines work from an aerodynamic perspective.
- Explain the momentum theory and derive Betz and Glauert 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

The course describes the aerodynamic phenomena involved in wind energy, an energy source that is strategic in the transition from a reliance on fossil fuels to renewable energy to address the challenges of energy security and climate change. The performance of wind turbines are first described according to momentum-based theories providing a detailed characterisation of the wind-turbine blade aerodynamics and guidelines about its optimisation. Elements of meteorology and wind-resource assessment are introduced to learn what is causing the wind and how it is affected by large-scale dynamics down to the local terrain conditions. Current measurements techniques and corrections are presented for both wind-tunnel and atmospheric measurements. Elements of flow modelling and wind-resource assessment are provided together with guidelines about the design of wind farms both in classrooms and by means of dedicated software suites used in the wind-energy community.

Disposition

The course consists of 16 two-hours lectures, including four external lecturers, one home assignment and one laboratory work. In details:

- Laboratory exercise. Measurement of wind-turbine performance of a wind turbine model in a wind-tunnel experiment. Use of wind-tunnel blockage corrections. Measurement of the total pressure downstream of a wind turbine model.
- Home assignment. Use of the software of WindSim/WindFarmer in specific test cases to assess how conflicting requirements are accounted (such as optimal land use, noise production, shadow flickering, etc.).
- Additional home assignment (for graduate students only): Analysis and optimization of wind turbines and wind farms
- Written exam with open-ended questions

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 - Assignment, 1.5 credits, grading scale: P, F
- INL2 - Assignment, 1.5 credits, grading scale: P, F
- LAB1 - Lab exercise, 1.5 credits, grading scale: P, F
- TEN1 - Examination, 3.0 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.

INL1 Assignment 1,5 hp (P, F)

INL2 Assignment 1,5 hp (P, F)

LAB1 Laboration 1,5 hp (P, F)

TEN1 Exam 3,0 hp (P, F)

Other requirements for final grade

- INL1 - Home Assignment
- INL2 – Additional Home Assignment
- LAB1 - Lab Exercise
- TEN1 - Examination

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.