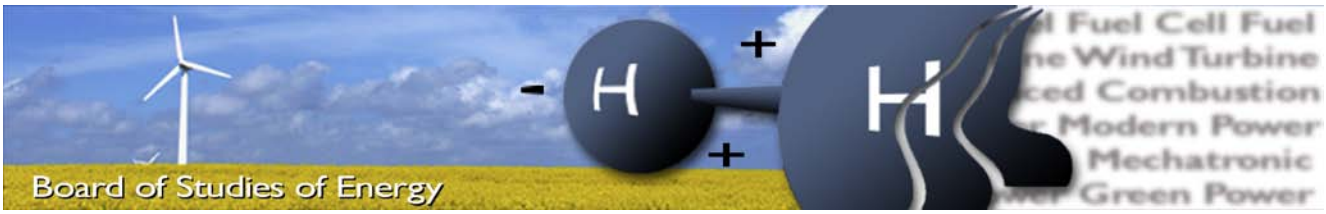


Wind Power Systems (WPS)

Introduction

The wind industry is developing rapidly, and many new technologies are applied and new problems arise due to the large penetration of wind power systems into the network grid. This gives many new challenges for wind power engineers in the future, and the MSc specialisation in Wind Power Systems tries to assess many of the topics related to this area.

Wind Power System (WPS) is focusing on mainly the electrical aspects in wind power systems and ensures a high education in subjects concerning generators, power electronics, control engineering and power system technology in relation to wind power applications and ensures an excellent background for job possibilities in the wind industry.

Programme description

Through the MSc specialisation in WPS the students get experience with project work in connection with problems in the areas of Electrical Engineering and Wind Generation Technology and the students work with the dynamics of wind generators under normal and abnormal conditions of duty. The dynamic behaviour of wind turbine systems, when connecting them to a power system with time varying loads, are analysed and the stability in such a system is examined. Different types of wind turbines are analysed together with their control principles and use of power electronics interface between the wind turbines and the grid. The specialisation should enable the students to analyze the power electronic applications in power systems with wind turbines and to look at the performance during power system faults and dynamics. Based on this they should evaluate the operation and control of wind power system to realize good power stability.

The MSc specialisation in WPS is taught in an innovative, dynamic and challenging environment through a combination of research-based courses and team-based project work. There is a high degree of interaction with the wind

industry, who takes an active part by providing project proposals for the problem-oriented project work and new laboratory set ups.

The main objectives of the syllabus may be summarized as follows:

- To provide the students with experience of project work solving real problems associated with the Electrical Engineering of Wind Generation Technology.
- That the student should understand the dynamics of wind power generation under normal and abnormal conditions of duty.
- To enable the students to analyze the dynamic behaviour of wind turbine systems when they are connected to a power system with time varying loads.
- To enable the students to analyze the load flow in a WPS, including reactive power flow and to analyze the stability in a WPS.
- To enable students to analyze the power quality of the system and to determine the need for power compensation.
- To enable the student to synthesise control systems for different types of wind turbine systems.
- To enable students to analyze the power electronics interface between the wind turbines and the grid.
- To enable the students to synthesise power electronic applications in power systems using wind turbines and to evaluate the performance during power system faults and during dynamic events.
- To enable the student to evaluate the operation and control of wind power system to ensure acceptable power stability.

1st Semester (see profile description for 1st semester of the specialisations in Energy Engineering)

2nd Semester

Project theme: Interaction of wind generator and load

Students will complete a project in which a wind turbine system has to be controlled under time varying loads, either as a stand alone system or coupled to a power network. The system should be modelled, simulated, and evaluated with respect to power quality and system stability. It should be determined whether any power compensation units/systems are necessary. This semester offers a variety of advanced courses in control theory, power systems, high voltage engineering and several specialised courses in wind power technology. These courses form the background for the project.

The courses offered on the 2nd semester are:

- Finite Element Method
- State Space Control
- Innovation and Entrepreneurship
- Optimisation Theory
- Non-Destructive Test Methods in High Voltage Engineering
- EMC regulations and apparatus design
- Advanced Control of AC-drives
- Harmonics in Power Systems
- Load Flow Methods for Power System Analysis
- Power System Protection
- Wind Turbine System Technology

Project examples:

- Grid connection of large off-shore wind turbine parks.
- Operation Of Wind Turbines in Isolated Power Systems.
- Power Quality of Grid Connected Wind Turbines.

3rd Semester

Project theme: Control of Wind Generator Systems

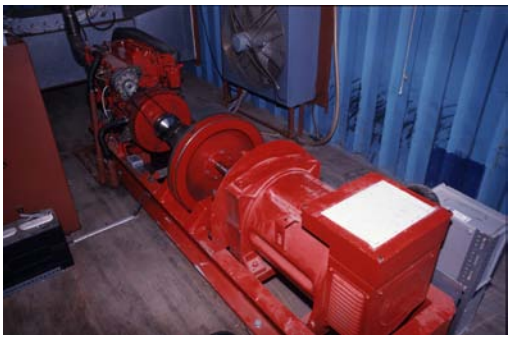
The student will complete a project studying the operation and control of wind turbine systems during power system transients and dynamic events. The system studied must include a controlled power electronic converter. The effect on power system stability conditions should be studied. A model of the system should be constructed and simulated. To continue the development of scientific communication skills, the project result or parts of it should be published in an article written in English to be presented at an internal seminar. Courses are offered introducing the operation and control of wind power systems, power electronics, and power system stability to support the project.

The courses offered on the 3rd semester:
At this semester all the courses are PE courses, and the students must follow a course load corresponding to at least 8 ECTS, of which 2 ECTS are mandatory for all students under the Board of Studies of Energy, the rest is elective and can for instance be courses offered at other specialisations or research intensive packages either within the specialisation or multidisciplinary packages. The elective courses will/or can be changed from year to year.

Mandatory courses:
- Stiff systems and differential algebraic equations
- Linear optimal control theory

Courses of which at least 6 ECTS must be chosen could for instance be in the area of:
- Control engineering
- Power electronics in power systems
- Electrical machines
- Mechatronic control engineering
- Thermal energy engineering
- Energy planning
- Nonlinear control
- Grid-connected power converters
- Finite element analysis in electromagnetism
- Power system stability
- Dielectric breakdown and insulation coordination
- Operation and control of wind power systems

Project examples:
- Frequency control of wind farms.
- Dynamic model of active stall wind turbines.
- Control of Variable Pitch or Speed Wind Turbines with Doubly-Fed Induction Generators



4th Semester

Project theme: Master's thesis

The final master project may study a known problem in the wind power system area. It may be an extension to project work from previous semesters or a completely new topic, possibly in collaboration with the wind industry, energy supply companies or the responsible power system utility. As courses are not normally offered on this semester, the entire semester is dedicated to the project work.

Examples of master thesis projects:

- Design of Power Electronic Grid Interface System for Large Scale Wind Turbines
- Optimization of an Energy Conversion System in a Power System with Large Scale Wind Energy
- Performance of the synchronous generator as wind generator
- Assessment of the reliability of wind power systems

Specific admission requirements

Successful completion of the 1st semester of the M.Sc specialisation in Electrical Energy Engineering or Introductory Semester under the Board of Studies of Energy, or equivalent.

For further information:

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Study Advisory

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