Master in Wind Energy

A two-year master programme on part time basis : 26 single subject courses

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AALBORG UNIVERSITY
Continuing Education

Master in *Wind Energy*

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· 26 single subject courses

Content

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Master in Wind Energy

Wind turbine technology has become an important industry. Many new technologies have been applied to ensure that the global wind energy sector develops rapidly. The wind industry is very important in Denmark, internationally well known and widely respected. The technology used is very advanced.

New developments must be made continuously to ensure that the wind industry can compete in future. A major challenge could be to halve the price per produced kWh by reducing the cost of wind turbine itself. Improving reliability is a key-issue for the future. Connection to the network grid is a new challenge, since more and more energy is supplied by dispersed generation. This demands new control functions to ensure a reliable and stable electric energy supply.

Target group

- Engineers with a Bachelor of Science in Engineering who wish to proceed to a master's degree
- Engineers with a Master of Science in Engineering who wish to supplement the degree with a specialization in another field of study, i.e. electrical engineers who wish to continue their education in the mechanical area or vice versa.

The programme

To ensure a supply of qualified engineers in the wind industry area an international master programme is offered for mechanical or electrical engineers working with wind turbines. Aalborg University, Denmark, offers a two-year part-time study programme that you can complete simultaneously with working in industry. The programme is modularized allowing courses and projects to be completed individually.

There is no obligation to complete the full programme. After having completed the programme you receive the title 'Master in Wind Energy'.
The programme is taught in English.

Purpose of the Study Programme

The purpose of the master programme in wind energy is to enable the student to:

- acquire research based competence in the wind energy area
- acquire knowledge of fundamental theories and methods used in the area
- attain theoretical and practical skills required for wind turbine planning and design
- develop technical skills relating to the design, analysis, specification and evaluation of complex wind turbine projects.

Two specializations

Each semester of the part-time study corresponds to a workload of 15 ECTS. This includes three to five 3-5 day seminars, distance learning, self study, and project group work. The programme has an electrical and a mechanical specialization and the structure of the programme is given in the table at page 5:

Single Subject Courses

The single subject courses are not described in this leaflet. You will find detailed descriptions of the 26 single subject courses on the homepage of the study programme: www.windmaster.aau.dk.

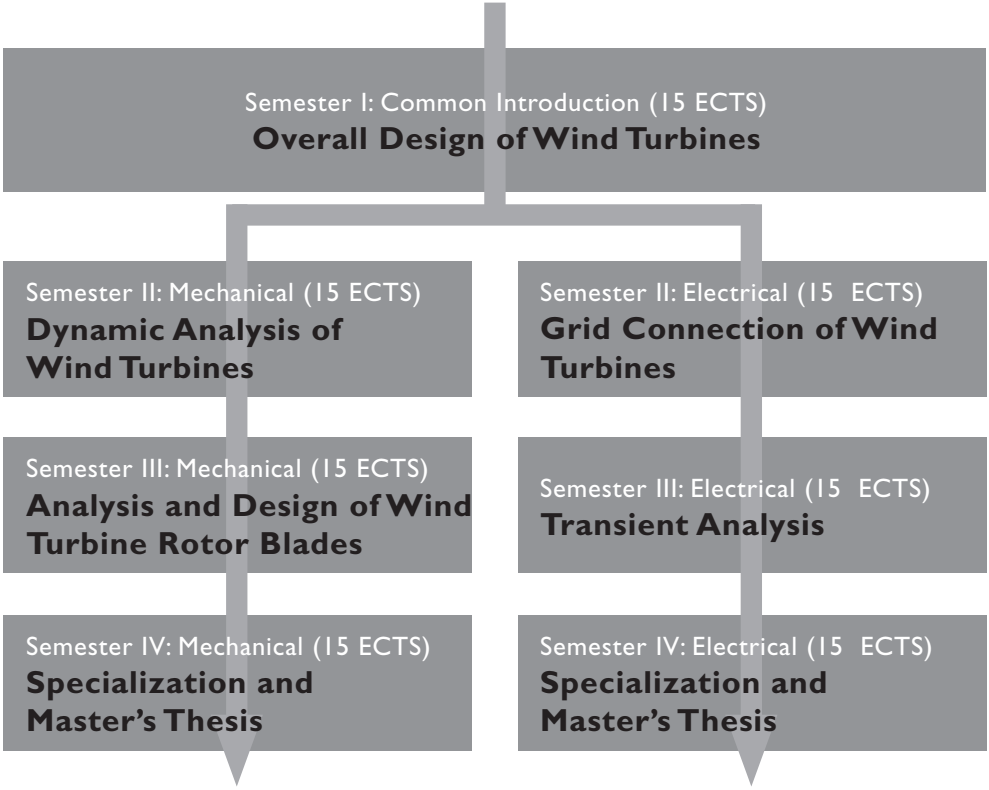
The first semester of the programme introduces important problems arising in wind energy systems. Following this, you can choose either the Mechanical or the Electrical Specialization. The participants have to make this choice before study start.

The technical content of the Mechanical Specialization is focused on the determination of aerodynamic loads on wind turbines, dynamic structural analysis and the optimization of wind turbine blades. This will enable participants to analyse and design wind turbine structures, taking into account structural dynamics, aerodynamics and material properties.

The technical content of the Electrical Specialization is focused on electrical and control aspects within the wind turbine technology. This includes the study of electrical machines, power electronics, control theory, and analysis of the effect of connecting of wind turbine generators to the power network. Stability and protection issues are also studied, enabling participants to analyse, design and evaluate the electrical components in a wind generator system and to predict the dynamic interaction of the wind turbine and the network grid.

Some common core courses are shared by the two specializations, whereas others are individual to the two specializations.

Structure of the Programme



Study form and examination

Master students

The study form is problem based and project oriented, which is the normal study form at Aalborg University. This means that the students are supposed to work in a project group. The group works on a project in the area which is the focus of the semester. In order to help the students with the project work, project unit courses are offered (denoted (PE) in the following). These are evaluated at project examinations, which take place at the end of the semesters and are based on both the written project report and the project unit courses. Furthermore, study unit courses are offered (denoted (SE) in the following). They are typically of a more general nature, and are used at later semesters. The study unit courses are evaluated individually, independently of the project.

The courses in one semester are given in three to five 3-5 day seminars, typically with one course a day. The projects are generally made in groups of two-six students. Communication within the group and with the supervisors is carried out in the seminars, and through e-mail, www etc.

Single subject students

The courses offered can, as mentioned, be taken as single subject courses if the student only wants to take some of the courses instead of the full study programme. In this case the normal project unit courses (PE) will be evaluated separately by an oral or written examination.

Single subject courses are generally given in two one-day seminars with a 2-4 weeks interval. Before the first seminar the student will receive detailed information about the course. The seminars will contain lectures, time for discussions and problems to be solved. In between the seminars texts have to be studied and problems have to be solved. Finally, problems after the last seminar also have to be solved.

Teachers

The lecturers and the supervisors are highly qualified professors, associate professors and researchers from the following departments at Aalborg University:

- Department of Civil Engineering
- Department of Energy Technology
- Department of Mechanical Engineering
- Department of Development and Planning

Some of the teachers at the master programme are:

- Professor, Søren R. K. Nielsen, Department of Civil Engineering, Aalborg University
- Professor MSO, Niels N. Sørensen, Department of Wind Energy, Risø National Laboratory
- Professor MSO, John Dalsgaard Sørensen, Department of Civil Engineering, Aalborg University
- Professor MSO, Erik Lund, Department of Mechanical Engineering, Aalborg University
- Associate Professor, Poul A. Østergaard, Department of Development and Planning, Aalborg University
- Professor Zhe Chen, Department of Energy Technology, Aalborg University
- Associate Professor, Ewen Ritchie, Department of Energy Technology, Aalborg University.

Seminars

Plan for the semester can be found at www.windmaster.aau.dk. The seminars take place on weekdays. The seminars take place at Aalborg University.

Work load

The Wind Energy programme has been planned in order to allow the participants to combine the study with a full time job. As a general guideline a half-time study will require approximately 15 – 20 hours per week throughout the duration of the programme. There will be offered several single subject courses. Normally 1 ECTS will require a work load of 25-30 hours in total.

Semester 1: Common Introduction

The intention of the common core courses in the first semester is to provide an introduction to important problems arising in wind energy engineering. The semester includes electrical, mechanical, structural and aerodynamic subjects.

Project: Overall Design of Wind Turbines

Objectives: The purpose is to enable the student to:

- understand central problems and methods for their solution in the design of wind energy plants
- use the correct specialist terminology in the design of wind energy plants
- analyse aerodynamic loads on a wind turbine
- analyse structural strengths of tower and blades
- analyse the drive train and generator
- evaluate different methods for analysis and dimensioning of wind turbine

Activities: Wind turbine analysis will be based on an actual site where the wind conditions are known and where the power output from the wind turbine is defined. Knowing these parameters, the students will be required to specify and dimension the wind turbine.

The aerodynamic loads on the blades and the needed strength of the wings and tower should be determined and the output power calculated.

Based on these data and the selected control strategy (pitch or active stall) the generator and drive train should be designed.

Courses on the 1st semester

Aerodynamics I (PE)	1 ECTS
Control of Wind Turbines (PE)	1 ECTS
Structural Mechanics (PE)	1 ECTS
Load Modelling (PE)	1 ECTS
Generators I (SE)	1 ECTS
Electricity, Magnetism, and Circuit Theory (SE)	1 ECTS
Planning of Wind Power Projects (SE)	1 ECTS

Mechanical Specialization

Semester 2

The aim of the project unit is to provide the student with the knowledge needed to analyse the structural behaviour of a wind turbine due to time varying loads caused by turbulence, the motion of the rotor in an inhomogeneous wind field, or load changes caused by yaw or pitch motions. Further, to analyse aeroelastic load variations on the blade due to the influence of the elastic deformation of the blade on the surrounding air flow.

Project: Dynamic Analysis of Wind Turbines

Objectives: The purpose is to enable the student to:

- analyse and understand fundamental aerodynamic concepts as stall and dynamic stall
- understand aerodynamic damping, including aeroelastic vibrations caused by these phenomena
- use CFD calculation and profile theory to perform a global dynamic modelling of a wind turbine with coupling to time-varying aerodynamic and vibration control loads

Activities: Based on data for a given wind turbine the dynamic analysis of the entire structure is performed, where the dynamic effect of turbulence or control forces are taken into consideration.

Courses on the 2nd semester

Rotor Dynamics I (PE)	1 ECTS
Rotor Dynamics II (PE)	1 ECTS
Aerodynamics II (PE)	1 ECTS
Aerodynamics III (PE)	1 ECTS
Finite Element Method I (SE)	1 ECTS
Generators II (SE)	1 ECTS
Turbulence Theory (SE)	1 ECTS

Semester 3

The project unit should enable the student to apply principles for design and analysis of selected parts of a wind turbine rotor blade, including design aspects related to weight critical structures with maximum strength and stiffness.

Project: Analysis and Design of Wind Turbine Rotor Blades

Objectives: The purpose is to enable the student to:

- use correct professional terminology
- perform analysis using mechanics of composite materials
- analyse the interaction between composite materials and adjacent structural elements
- design and analyse structures made of composite materials, including problems related to local effects
- apply standard dimension rules for wind turbine rotor blades
- apply advanced strength and stiffness analysis using finite element modelling of selected parts of a wind turbine rotor blade

Activities: The starting point is selected parts of an existing wind turbine blade and based on this the structural problem is stated and its solution is sought using systematic design work.

Courses on the 3rd semester

Composite Materials for Wind Turbine Rotor Blades (PE)	2 ECTS
Optimization Methods (PE)	1 ECTS
Control Theory (SE)	1 ECTS
Power Electronics and Control (SE)	1 ECTS
Energy System Analysis and Socio-economics (SE)	2 ECTS

Semester 4

The aim of the project unit is to demonstrate that the student is capable of working out an unaided project at a high technical level, which encompasses advanced methods and theories from structural and control engineering with relevance to wind turbines.

Master's Thesis: The theme can be any specialization in the field of wind energy engineering. Typically, the final thesis will be a further elaboration of some of the work carried out in the previous semesters. However, it is also possible to work on an entirely different subject.

Objectives: The purpose is to enable the student to:

- evaluate the benefit of wind turbine technology within the mechanical and power electronic areas
- evaluate alternative control strategies and optimization methods
- use economical constraints in combination to code provisions in wind turbine design
- independently make and explain choice of scientific theoretical and/or experimental methods
- during the project and when finalizing it make an independent and critical estimation of the chosen theories and methods as well as the analyses, results and conclusions
- communicate relevant technical and professional aspects of project work in a clear and systematic way

Activities: The final project will be a natural continuation of the projects carried out at the previous semesters, usually the project work at the 3rd semester. Additionally, the project may be based on a project proposed by the wind turbine industry, or be a part of a larger ongoing research project at the university.

If the project is carried out in cooperation with the industry, this partner will usually be willing to provide sufficient specification and equipment. Alternatively, the project may be based on completely new ideas suggested by the student or the supervisor, where relation to previous projects or courses is not as pronounced.

Courses on the 4th semester

Fatigue (PE)	1 ECTS
Finite Element Method II (PE)	1 ECTS
Reliability and Codes (SE)	1 ECTS

Semester 2
The intention is to enable the student to analyse the conditions and problems when wind turbines are connected to the power supply network. The problem is partly due to the irregular dynamic behaviour of wind turbines, due to wind fluctuation.

Project: Grid Connections of Wind Turbines

Objectives: The purpose is to enable the student to:
- analyse the load flow in the power supply network including the reactive power flow
- analyse power electronics in relation to wind generators
- comprehend aerodynamic loads on the rotor
- analyse the wind turbine generator
- analyse the dynamic interaction of the blades, tower and drive train on the delivered power from the wind turbine

Activities: The idea is to enable the student to calculate the power delivered to the power supply network from the wind generator, based on known wind conditions, and the mechanical and electrical construction of the wind generator and the power supply network.

Courses on the 2nd semester

Electrical Power Transmission (PE)	1 ECTS
Power Electronics (PE)	2 ECTS
Generators II (PE)	1 ECTS
Rotor Dynamics I (SE)	1 ECTS
Aerodynamics II (SE)	1 ECTS
Turbulence Theory (SE)	1 ECTS

Semester 3
The intention of this semester is to enable the student to analyse the transient behaviour of the wind generators when they are connected to the power supply network. This includes analyses of wind generator behaviour when fault conditions arise in the power supply network, and how different control strategies can result in different transient behaviours for various transient occurrences on the power supply network and at the wind turbine.

Project: Transient Analysis

Objectives: The purpose is to enable the student to:
- analyse various stability conditions on the power supply network
- comprehend the effect of applying different protection equipment
- analyse the effect of applying various wind turbine control strategies, optimization methods, and energy system analysis methods
- comprehend the economic aspects of wind turbine operation

Activities: The idea is to enable the student to make simulations of transient occurrences with wind turbines connected to the power supply network, at start and stop and under a number of fault conditions on the power supply network and the wind turbine. In the simulations the effect of applying various control strategies will be analysed, to find the best solution. The effect of applying different protection equipment on the stability of the system will be studied.

Courses on the 3rd semester

Network Stability and Protection (PE)	2 ECTS
Power Electronics and Controllers (PE)	1 ECTS
Control Theory (PE)	1 ECTS
Optimization Methods (SE)	1 ECTS
Energy System Analysis and Socio-economics (SE)	2 ECTS

Semester 4

The aim of the project unit is to demonstrate that the student is capable of working out an unaided project at a high technical level, which encompasses advanced methods and theories from structural and control engineering with relevance to wind turbines.

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.

Objectives: The purpose is to enable the student to:

- analyse the features of wind turbine technology in the electrical, electro-mechanical and power electronic areas
- analyse alternative control strategies and optimization methods
- apply economic constraints combined with the constraints, provisions and specifications of Standards in wind turbine design
- independently make and explain choice of scientific theoretical and/or experimental methods
- during the project and when finalizing it make an independent and critical estimation of the chosen theories and methods as well as the analyses, results and conclusions
- communicate relevant technical and professional aspects of project work in a clear and systematic way

Activities: The final project will be a natural continuation of the projects carried out at the previous semesters, usually the project work at the 3rd semester. Additionally, the project may be based on a project proposed by the wind turbine industry, or be a part of a larger ongoing research project at the university.

If the project is carried out in cooperation with the industry, this partner will usually be willing to provide sufficient specification and equipment. Alternatively, the project may be based on completely new ideas suggested by the student or the supervisor, where relation to previous projects or courses is not so as pronounced.

Courses on the 4th semester

Advanced Generators and Controllers (PE)	2 ECTS
Reliability and Codes (SE)	1 ECTS

Admission Requirements

Please note, that the entry requirements for a Master's degree is both a particular educational background and relevant professional experience.

Prior Education
Applicants must have a relevant bachelor degree (180 ECTS points), a relevant Bachelor of Science degree (180 ECTS points), a relevant medium duration engineering qualification or diploma. An education may be relevant if it falls in the technical area of electrical, mechanical, or structural engineering.

Working Experience
As a minimum, applicants must possess at least two years relevant professional experience after having completed their relevant study. I.e. an applicant must have worked professionally in electrical or mechanical engineering at a theoretical and a practical level and have performed calculations on or designed relevant apparatus or systems.

Exemption
Applicants who do not live up to the educational admission requirement, but who have similar qualifications can apply for admission. However, the programme cannot grant exemption from the requirement of two years of working experience.

Language skills
You must have written and oral mastery of English. This requirement is important due to the fact that courses are taught in English and the majority of the literature is in English.

Restricted Intake and Admission Requirements
Although applicants meet with the admission requirements this does not ensure enrolment, since there may be more qualified applicants than the programme can accommodate. If this is the case, selection will take place based upon an overall assessment of the individual student's qualifications. The selection among those applicants qualified will take place upon an assessment of the applicants' current employment, working experience and overall level of education. When putting together the course groups the aim is to ensure some diversity among the students' educational backgrounds and working experiences.

Practical information

Application for admission
To apply for admission to the Master in Wind Energy you have to fill in the application form. You can download an application form at Aalborg University's website:
www.evu.aau.dk/uddannelser/vindenergi or at www.windmaster.aau.dk.

The application must include documentation of sufficient academic level e.g. diploma, in copy, as well as relevant work experience, a written motivation for applying and a curriculum vitae.

Semester start
The full master's programme starts February.
Single courses start February (odd semesters) and September (even semesters), respectively.

Application deadline
For the full master please send the application form with enclosures before15 December.
For single courses please send the application form with enclosures before 15 December (odd semesters) and 15 July (even semesters), respectively.

Tuition fee and other expenses
The tuition fee depends on your citizenship. Please see the webpage www.windmaster.aau.dk for the tuition fee.

The amount will be collected biannually prior to the beginning of the semester. Beyond the 1st semester expenses may be subject to change. The fee covers expenses for tuition and up to three attempts at passing the exam, per exam. In addition, one must expect expenses for various written material, lunch, and coffee breaks approximately 2,000 – 3,000 DKK per semester as well as expenses, if necessary, for board and lodging as well as travel in connection with seminars.

You commit yourself to one semester at a time. If you regret your application and wish to resign, your tuition fee will not be refunded after 1 September and 1 February, respectively.

Study regulations
The programme is offered in accordance with the Curriculum for the Master Programme in Wind Energy.

For further information please contact:
Professor MSO, John D. Sørensen
Phone: +45 9940 8581
E-mail: jds@civil.aau.dk

Or visit our homepage: www.windmaster.aau.dk

Please note that **The Secretariat for Continuing Education** at Aalborg University handles all applications and therefore questions regarding admission requirements should be directed to the secretariat.

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Upon the closing day for applications, Aalborg University may abstain from establishing the offered programme / single subject courses due to an insufficient number of applicants or due to other special circumstances.

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