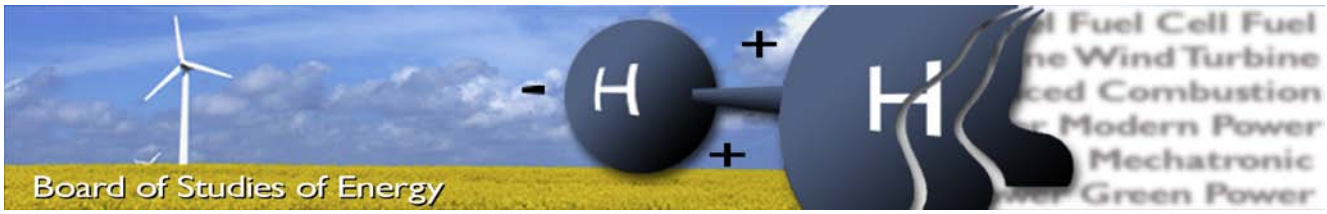


Power Electronics and Drives (PED)

Introduction

Spurred on by technological progress and a steadily increasing concern about the efficient use of depleting energy resources, static power electronic converters employing advanced semi-conductor devices are currently used in an increasing number of applications. Applications range from low-power converters, for milli-watt applications, to converters for high-voltage dc transmission systems handling hundreds of mega-watts. Other classical applications include adjustable-speed ac and dc drives for use in industry, switch-mode power supplies, audio amplifiers, uninterruptible power supplies, and welding machines. In the last decade Power Electronics and Electrical Drives have penetrated deeply the renewable energy sector. Today, power electronic converters provide vital functionality in a diversity of new technologies including large wind turbine systems, fuel-cells systems and photo-voltaic power generation.

Motor drives comprising power electronic converters and advanced electric machines play a key role in the transportation sector, where new technologies are exploited in order to electrify many kinds of vehicle.

Programme description:

The MSc specialization in Power Electronics and Drives concentrates on studying efficient and intelligent energy conversion employing power electronic technology and electrical machines. These topics are studied analytically, numerically and experimentally in an innovative research environment. The specialization combines state-of-the-art technologies with conventional technologies, for example power semiconductor devices, electronics, electro-magnetic, digital signal processors, control theory, EMC, and energy technology.

Principally, the themes for the three semesters study in Power Electronics and Drives provides an in-depth understanding of the technologies and scientific disciplines involved in electric energy conversion by means of power electronic converters and electric machines.

The PED specialisation offers core competences in power electronic converters, electrical machines, and control engineering. The objective is to provide graduates with the ability to model, analyze, synthesize, and develop PED systems. Attention is paid to how PED interact with externally connected components or systems.

The objectives of the Power Electronics and Drives programme are:

- To provide the student with a detailed understanding of the operation, function and interaction between various components and sub-systems used in power electronic converters, electric machines and adjustable-speed drives
- To provide the student with knowledge enabling design, modelling, simulation and synthesis of power converter-based systems used for conversion of electric energy
- To provide the student with experience of the design of controllers for PED systems using classical and modern control theory
- To provide the student with experience of the practical implementation of controllers using, for example, digital signal processors
- To enable the student to develop, construct, operate and test power electronic converters and drives in the laboratory

Experimental work plays a key role in the syllabus. A large, well-equipped laboratory is available, offering excellent opportunities for the construction and testing of prototype of electronic systems and electric machines. Facilities for testing power electronic components, converters and high power systems are also available.

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

2nd Semester

Project theme: Control in converter-fed AC drives

2nd semester projects will study modelling, analysis, simulation and control of an electric power system, which must include a power electronic converter and an electric machine. The system being studied will be described using a dynamic model and analysed in order to design a suitable controller for the whole or part of the system. Dynamic interaction between the different parts of the system will be studied. All or part of the system will be built and tested in the laboratory, including real-time implementation of controllers in e.g. digital signal processors, to provide verification of the models used.

The courses offered on the 2nd semester are:

- Finite element methods
- State-space control
- Innovation and entrepreneurship
- Optimization theory
- Non-destructive test methods in High Voltage Engineering
- EMC regulations and apparatus design
- Advanced control of AC-drives
- Applied digital signal processors
- Harmonics in Power Systems
- Control of brushless machines
- Modelling and control of robot manipulators
- Resonance and switch-mode power supplies

Project examples:

- Wide-bandwidth current control of PWM inverter-fed induction motor drive with LC filter
- Sensorless control of a brushless motor drive system
- Energy efficient control of permanent-magnet motor for electric vehicle
- Control of wide-bandwidth actuator for application in robotics

3rd Semester

Project theme: Design of power electronic converters and systems

The objective with this semester is to strengthen skills related to design of power electronic converters and systems. 3rd semester projects will perform a systematic analysis and synthesis of a system or a part of a system. A detailed description of the system is required and a model taking all relevant phenomena into account will be formulated. A systematic design procedure will be devised, which guarantees best possible fulfilment of one or more selected performance indices. For example, the project objective may be to minimize power losses in a converter with given performance constraints or to design a controller that is robust to parameter value uncertainty. Another relevant area of study could be the optimal sizing of electric machines. Building a real prototype power electronic converter or electric machine, and testing it thoroughly in the laboratory is a highlight of 3rd Semester. To continue practising scientific communication, the project result or parts of it should be published in an article written in English which is to be presented at an internal seminar.

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.

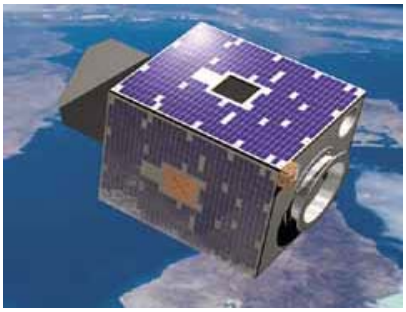
Mandatory courses:

- 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

Sports cycle computer-controlled by students.



Cubesat sattelite made by students

4th Semester

Project theme: Master project

The final project may study new subjects or be an extension of the project work of previous semesters. The project will be carried out in collaboration with an industrial partner, energy supply company or transmission system operator assuming the character of industrial research or development work. Alternatively it may be support one or more research projects at the Institute of Energy Technology, or another research facility assuming the character of research. Often, students write scientific papers reporting the work of their final project.

Examples of master's thesis projects:

- Single-stage three-phase solar cell power electronic converter

- o High-efficiency magnetic gear box with a high gearing ratio
- o Design of power electronic grid interface system for large-scale wind turbines
- o Sensor-less control of a permanent magnet motor drive using signal injection techniques

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:

General information:	**Technical information:**
Board of Studies of Energy Head of Studies Birgitte Bak-Jensen Aalborg University Pontoppidanstræde 101 9220 Aalborg East Denmark Phone: +45 9940 9274 Fax: +45 9815 1411 bbj@iet.aau.dk www.nsn.aau.dk	Board of Studies of Energy Technical Coordinator Ewen Ritchie Aalborg University Pontoppidanstræde 101 9220 Aalborg East Denmark Phone: +45 9940 9241 Fax: +45 9815 1411 aer@iet.aau.dk www.nsn.aau.dk

Study Advisory
nsv@iet.aau.dk