MS ISEE Study Track: System Integration of Wind Power
Study Plan and Course Table: 2018/2019

Year 1 at NTNU: Department of Electric Power Engineering, Associate Professor Trond Toftevaag
Year 2 at DTU: Management Engineering – Associate Professor Lise-Lotte Pade

Study track focus and goals

In the study track System Integration of Wind Power the participants will achieve a general understanding of wind energy as seen as a part of the total energy system. They will gain specific knowledge on wind turbines but also on the various technologies related to wind energy in a system context. The study track enables the participants to analyse, design, develop and operate wind energy systems. The study track combines socio-economic aspects of sustainable energy with relevant technical disciplines, such as measurement techniques, design of wind turbines, planning and development of wind farms, grid integration of wind energy systems and a relation to smart grid development.

Learning outcome

Candidates with a degree from the System Integration of Wind power study line are qualified for jobs not only in the rapidly expanding wind energy sector, but also in Engineering companies and public bodies carrying out planning and development in relation to wind power and energy systems.

Course table:

1. Semester	2. Semester	3. Semester	4. Semester
Norwegian University of Science and Technology (NTNU) Search for courses		**Technical University of Denmark (DTU)** Search the course number	
TET4115 - Power System Analysis 7.5 ECTS	TEP4220 – Understanding and Quantifying Environmental Impacts on Ecosystems 7.5 ECTS	Wind Turbine Measurement Technique, 46400, 10 ECTS	Thesis , 30 ECTS
TET4190 - Power Electronics 7.5 ECTS	TET4185 - Power Markets, Resources and Environment 7.5 ECTS or TET4215 Protect and control in power systems 7.5 ECTS (new course from Spring 2018)	Integration of Wind Power in Power Systems, 31783, 5 ECTS	
TEP4175 – Design of a wind turbine 7.5 ECTS	TET4175 – Design and Operation of Smart Grid Power Systems 7.5 ECTS or TET4180 Electric Power System Stability 7.5 ECTS	Elective courses from list 3, 15 ECTS	
Elective course from list 1	Elective course from list 2		
= 30 ECTC	**= 30 ECTS**	**= 30 ECTS**	**= 30 ECTS**

Elective course list 1 at NTNU

- TPK4120 Safety and Reliability Analysis 7.5 ECTS
- TEP4240 System Simulation 7.5 ECTS
- TEP4223 Life cycle Assessment 7.5 ECTS

Elective course list 2 at NTNU

- TET4180 Electric Power System Stability 7.5 ECTS
- TET4175 Design and Operation of Smart Grid Power Systems 7.5 ECTS
- TET4135 Energy Systems Planning and Operation 7.5 ECTS
- TET4200 Marine and Offshore Power Systems 7.5 ECTS
- Experts in teamwork 7.5 ECTS (Course code depends on choice of project)

Elective course list 3 at DTU

- 42004 Feasibility studies of energy technologies 5 ECTS, Fall
- 46100 Introduction to micrometeorology for wind power 5 ECTS, Fall
- 46200 Planning and development of wind farms 5 ECTS, January 3 week
- 46211 Offshore wind energy 10 ECTS, (blocked if Marine and Offshore Power Systems taken), Fall
- 46230 Power system balancing with large scale wind power 5 ECTS, Spring
- 46320 Loads, Aerodynamics and Control of wind turbines 10 ECTS, Fall

Degree requirements for admission process

A BSc degree corresponding to a minimum of 180 ECTS credits in the following fields: Mechanical Engineering, Electrical Engineering or other relevant BSc. Applicants must document that they have fulfilled the following minimum requirements:

- Mathematics: 25 ECTS including linear algebra, calculus and differential equations
- Statistics and probability theory: 5 ECTS
- Electric circuits/Circuit analyses: 5 ECTS
- Basics in control systems
- Basics in electrical machines
- Basics in fluid mechanics

Moreover, the applicant must have sufficient qualifications within numerical methods and elementary programming using e.g. MATLAB or a similar programming language.

Research areas for projects / master thesis

Responsible professor at DTU, 2. year University:

Name	Research area
Poul Erik Morthorst, Management Engineering, DTU	System Integration of wind power, Energy Markets, Energy Policies
Jens Nørkær Sørensen Wind Energy, DTU	Wind turbine technology, wind turbine design, Aerodynamics and Aero-acoustics, Non-linear Fluid Dynamics
Henrik Klinge Jacobsen Management Engineering, DTU	Power markets and wind, support instruments for wind Systems integration of wind power,
Lise-Lotte Pade, DTU	Integration of renewable energy, support schemes, policy instruments, power market regulation
Klaus Skytte, DTU	Integration of renewable energy, support schemes, policy instruments, power market regulation
Marie Münster, DTU	Energy planning and renewable energy technologies. national energy modeling (Balmorel, EnergyPLAN, STREAM) with focus on Waste-to-Energy technologies producing heat, power and transport fuels and on analyses of the role of district heating in future energy systems
Pierre Pinson Electrical Engineering, DTU	Mathematical modeling and decision-making methods in the energy sector, large scale integration of renewable energies into power systems and electricity markets, stochastic process modeling, forecasting, optimization and decision-making subject to uncertainty
Gregor Giebel Wind Energy, DTU	Short-term forecasting of wind power, large-scale integration of wind power into electricity grids, and condition monitoring for wind turbines including standardisation within the IEC.
Niels Erik Clausen Wind Energy, DTU	Public acceptance of wind energy, System integration of wind power, wind power in cold climate
Joakim Holbøll Electrical engineering, DTU	Electrical components, lightning prevention, superconducting electrical machines, measurement techniques, generator technology
Anca D. Hansen Wind Energy, DTU	Grid integration, ancillary services, IEC standards, Integration of renewable energy
Nicolaos Antonio Cutululis Wind Energy, DTU	Control of wind power plants, HVDC systems, ancillary services, integration of large scale wind power

Co-supervisor at NTNU, 1st Year University

Electric power systems

Name	Research area
Prof. Kjetil Uhlen	Research within the fields of power system dynamics, operation and control. Interests are especially focused towards development of applications based on phasor measurements (PMUs) for monitoring and control purposes, and challenges related to large scale integration of RES in interconnected and isolated systems. Head of the Power Systems group at the department.
Prof. Magnus Korpås	Research within the fields of Energy Planning and Power Markets. Interests are especially focused towards integration of renewable energy in the energy system
Prof. Elisabetta Tedeschi	Power electronics for HVDC and HVAC transmission systems (including MMCs), offshore grids and isolated systems, wave energy converters, large scale (offshore) wind integration, control systems, etc

Prof. Lars Einar Norum	Control of Power Electronics converters and Microgrids. Renewable Energy Systems and PV applications. Topology and internal Control of Multilevel Converters.
Prof. Olav Bjarte Fosso	Hydro power scheduling, Power system analysis – methods and algorithms, Integration and coordination of intermittent energy sources
Associate professor Vijay Vadlamudi	Reliability and Risk – based Power System Operation and Planning Practices, Probabilistic Methods Applied to Power System Analysis, Reliability – based Appraisal of Smart Grid Challenges and Realisation.
Associate professor Hossein Farahmand	Power system stability and control, Offshore wind energy integration, power system dynamic modeling and analysis, etc.
Associate professor Trond Toftevaag	Power system analysis, interconnected systems, isolated systems, electrical machines, offshore power systems, wind power integration, laboratory work. Most of the time used in teaching
Adjunct professor Gerard Doorman	Power market design, European network codes, power system scheduling, cross-border balancing of electricity, effect of large scale wind power on system balancing, pumped hydropower storage, etc.
Adjunct professor Olimpo Anaya-Lara	Power system stability and control, Offshore wind energy integration, power system dynamic modeling and analysis, etc.
Adjunct prof. Kjell Sand	Transmission and distribution system analysis, quality of supply in power systems (reliability, power quality), Smart-grids, microgrids, technical- economical planning of power system, power system standardization, economical regulation and benchmarking of grid monopolies, powert system ICT. Project manager National Smart Grid lab, Scientfic manager The Norwegian Smartgrid Centre, Scientific Manager Centre for Intelligent Electricity Distribution - CINELDI
Adjunct prof. Gerd Kjølle	Power system reliability analysis, security of electricity supply, distribution system planning, fault statistics, interruption costs. Centre Director at Centre for Intelligent Electricity Distribution - CINELDI.

Electric power technology

Name	Research area
Prof. Hans Kristian Høidalen	Power system transients, stress analysis, power system protection. Project leader of ProSmart. Group leader of Power Technology
Prof. Erling Ildstad	High voltage insulation, cable technology, diagnostic testing and condition assessment
Prof. Ole-Morten Midtgård	Smart Grid, especially photovoltaic power systems and microgrids, and power electronics. Also interested in electromagnetics and field calculations.
Prof. Kaveh Niayesh	Current interruption and limitation in power grids, circuit breaker and switchgear technology, power system transients, condition assessment of high voltage apparatus, gaseous and vacuum discharges, high current and high voltage testing methods, pulsed power technology.
Prof. Robert Nilssen	Field calculation, design of electrical machines and other power components. Design optimization. Numerical modelling of electromagnetic fields using FEM.
Prof. Arne Nysveen	Analysis and design om electromagnetic power equipment and installations. Numerical analysis using finite elements. Applications focused on hydropower equipment and subsea installations. Responsible for research on generators and turbines in FME HydroCen
Associate professor Eilif Hugo Hansen	Light and lighting, Low voltage installations, Intelligent Building Installations, Intelligent Street Lighting, Lighting in Fish Farming
Associate professor Frank Mauseth	High voltage insulation technique for energy efficient and environmental friendly electric power transfer and distribution. Important topics are modelling and experimental testing of design criteria associated with ageing mechanisms and electric withstand strength of different high voltage insulation materials.
Associate professor Dimosthenis Peftitsis	Power electronics, design of power electronic converters, wide bandgap power semiconductors (e.g. SiC and GaN), gate and base drivers design, hybrid and solid-state DC breakers, high-efficiency design of power electronics, high-temperature design, reliability of power electronics.
Adjunct associate prof. Eivind Solvang	Risk based asset management, cost-benefit analysis of maintenance and reinvestments, methods and tools for estimation of remaining useful life, failure probability and technical-economic risk based on the technical condition of components, distribution system planning