Powergrid and Technology for Renewable Production

Programme course

6 credits

Elkraftnät och teknik för förnyelsebar elproduktion

TSTE26

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study
Electrical Engineering

Course level
Second cycle

Advancement level
A1X

Course offered for
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Electronics Engineering, Master's programme
- Engineering Electronics
- Mechanical Engineering, M Sc in Engineering
- Computer Science and Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Information Technology, M Sc in Engineering

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Basic knowledge in electric circuit theory, control theory and physics. Knowledge in MATLAB.

Intended learning outcomes

The aim of the course is to give the student knowledge about the functionality of a powergrid and the control of its main circuit components.
After completion of the course the student shall be able to:

- describe the main principles of the powergrid and how to control the voltage and frequency through connected generation units and power converters
- describe the functional blocks of a wind turbine system and the associated properties for control
- describe the properties of a pv-system and how to connect to the powergrid
- describe how energy storage is integrated in a pv-system
- describe the function and control of power converters for integration of a generation unit to the power grid
- understand and use models for the main components of a powergrid in system simulation of a power system for energy production.

Course content

The course will give knowledge in applications of power electronics, how a power converter operates in a system for energy production as well as the control of the powergrid. Focus is on renewable energy production and its connection and control in a powergrid.
The course has three main blocks:

1. Technology for energy production based on pv, wind and hydro sources.
2. The properties of the powergrid related to stability and availability.
3. Power converter functionality for connection of renewable energy production and control of the powergrid.

In detail, the first block will go through the technology for pv-, wind and hydro power. The properties of pv-cells and how a pv-system is controlled to obtain high efficiency and economy of energy production. Wind power system is described to give basic understanding of different turbine and generator types, including the mechanical and electrical control systems. Difference between sea- and land based wind power systems. Basics for wave, tidal and dam based hydro power systems.
In the second block the power balance between generation and consumption is studied, emphasizing the functions for voltage and frequency control. Needs for energy storage related to day- and seasonal variations in production and consumption.
The functionality and control of power converters for connection of energy production units to the power grid is studied in the third block. Principles for connection of energy storage or supply of isolated loads are presented.

Teaching and working methods

The course consists of lectures with integrated exercises, laboratory exercises and computer simulation exercises.

Examination

LAB1	Laboratory Work	2 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

Grades

Four-grade scale, LiU, U, 3, 4, 5

Department

Institutionen för systemteknik

Director of Studies or equivalent

Tomas Svensson

Examiner

Tomas Uno Jonsson

Course website and other links

http://www.isy.liu.se/edu/kurs/TSTE26/

Education components

Preliminary scheduled hours: 44 h
Recommended self-study hours: 116 h

Course literature

Additional literature

Books

Brendan Fox et al, (2007) *Wind Power Integration: Connection and System Operational Aspects* IET
ISBN: 9780863414497
Mertens, Konrad, Hanser, Karl Friedrich, (2013) *Photovoltaics: Fundamentals, Technology and Practice* Wiley
N. Mohan, (2012) *Elecric Power Systems, A first course* Wiley

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.