FEN3250 Communication and Control in Electric Power Systems, graduate course 9.0 credits

Kommunikation och styrning i elkraftsystem, doktorandkurs

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

Admitted to PhD program at KTH.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After completing the course the student should be able to:

· Model and simulate substation level control systems for simple power systems in terms of reliability protection, automation and control.

· Analyse the impact of characteristics, e.g. delay's and bandwidth, of communication systems used in power system control.

· Develop models of power systems and simple control strategies needed for system-wide control from control rooms, e.g. SCADA, WAMC and EMS applications.

· Analyse the impacts of threats and risks associated with the use of information & control system for controlling the electric power system, known as Cyber Security.

· Identify a suitable area for advanced study and within this area conduct individual work with the purpose to either:

o Describe related work within the field, perform a minor pre-study and propose suitable next steps for research in the domain, or

o Develop learning activities that consider new developments, such as for instance grid models for application in real-time simulators

Course contents

The course consists of two parts. The first part consists of four study blocks with lectures and seminars; the second part consists of an individual project. The first part of the course is essentially a continuation and extension of topics covered in course EH2741, the topics covered in the first part include:

Study Block 1: Local and distributed control and automation

The topic includes modeling and analysis of local computer control, implications of real-time computing platform constraints on measurements and control. Methods for distributed control and methods for information sharing among autonomous units.

Study Block 2: Communication systems for Wide Area control

The topic includes analysis and modeling of communication networks for wide area control with an emphasis on investigating key characteristics that affect the performance of wide area control. This includes also development of generalized communication system models useful for combined cyber-physical studies of power system control.

Study Block 3: Centralized control of wide area systems

The topic includes analysis and design of centralized control for power system phenomena, such as for instance sub-synchronous resonance, optimal power flow and wide area protection. The topic also includes methods for distributed solution of power flow and state estimation as well as topology estimation.

Study Block 4: Cyber security in power system control

The topic includes study on threats and countermeasures, application of standards to the area of cyber security as well as review of some existing technologies for protection such as key management for authentication and encryption.

The exact scope of the individual project is agreed beforehand with the course examiner and the PhD supervisor. Examples of projects are: Literature studies within a field of application, such as communication and control for microgrids, distributed control of small scale generation and authoring of a literature survey paper of 6-8 pages suitable for entry level conference publication. Alternately from a more application-oriented perspective, the project can consist of implementation of power grid model and communication models in simulation platforms, either for educational purposes or to form a basis for coming research work by the PhD candidate.

Disposition

The course is conducted as a sequence of four study blocks, followed by an individual project. For each study block there is one introductory lecture to start the study block, thereafter 1-2 lectures for presentation of content of the literature for the study block. Thereafter, the students work in groups on problems in the domain. As a conclusion to each study block, there is an individual presentation by each participating student on one or two key concepts from the course literature. Each study block represents 1 week of full time work, 1,5 ECTS credits. The Study blocks normally cover one full study period, and require attendance by participating students.

The course is concluded with a individual project representing 3 ECTS credits. The individual project need not be coordinated with other students of the course. However, all students of a course round must participate in presentation of other student' projects however.

In total, the course contains 8-10 lectures and an approximate number of 12-14 seminars.

Course literature

Course literature for the initial four study-blocks includes (but is not limited to).

SB1: Wittenmark, Åström, Årzen "Computer Control. An Overview"

SB1: Rehtanz "Autonomous Systems and Intelligent Agents in Power System Control and Operation", selected chapters.

SB2: Berger, Iniewski "Smartgrid – Appications, Communications, Security" – Part II

SB2: Nordström, Babazadeh "Cyber Physical Approach to control of HVDC grids"

SB3: Shahidepour Wang "Communications and Control of Electric Power Systems" (parts)

SB4:Berger, Iniewski "Smartgrid – Appications, Communications, Security" – Part III

Equipment

None.

Examination

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

Pass all Study Blocks by completing the individual project, including an individual presentation and a final report, both of which are to be approved by the examiner.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.