Version 1.3 18 October 2011

EH2750 Computer application in Power Systems, Advanced Course

Course Memo

Overview

Development of future power systems requires careful analysis design of interoperable, secure, robust and high-performing ICT systems that implement the advanced power system control applications needed. Furthermore these systems must conform to international standards such as IEC 61850 and 61970 related to utility automation and information exchange for power system control.

The course consists of a large project assignment in which the course participants are required to implement a specific ”Smart” power system function. The project involves analyzing requirements, designing a solution and finally implementing the solution. The implementation is based on the components available in the course lab. The course also consists of a series of seminars in which present and future challenges in development of ICT based systems for power system control and automation are discussed.

Course Objectives

The purpose of the course is that the students shall be able to independently analyze the needs of advanced ICT based systems for power system control, automation and protection, and also design such systems. The course also provides an overview to the challenges of building so called Smart power systems. After completing the course, the student shall be able to:

- Analyze the needs of advanced functions for power system control and automation
- Document requirements s for power system control and automation in a structured manner, e.g. in the form of use cases.
- Independently perform design of advanced functions for power system control and automation based on a set of requirements
- Independently plan and execute a project including requirements analysis and documentation, and design advanced ICT based functions for power system control and automation.
- Implement functions for power system automation and control using predefined components using standardized interfaces.
- Design and configure automation systems in accordance with the IEC 61850 standard for utility automation.
- Design and configure information exchange using the IEC 61970 standard for information exchange.
- Describe the developments in the fields of ICT reliability, security and performance with a specific focus on power system control and operation.

Prerequisites

The following courses are pre-requisites for this course.

- EH 2740 IT applications in Power System

Course limitations

The course is open to a maximum of 8 students; selection will be based on (in order of priority):

Number of ECTS credits achieved, Grade on course EH2740, Average grade.

N.B. During 2011, this limitation has not been implemented due to an administrative error. This means that the course will have more than 8 participants, which in turn affects the layout of project assignments etc.

Course Structure

The course consists of three parts, *Lectures & exercises*, a *Use Case Assignment* and a *Project Assignment*. The Lectures & exercises as well as the Use Case assignment are all intended to provide input for the Project Assignment. The Project Assignment is the core of the course, and the grading of the course depends on the grades of the Project Assignment. However, it is most likely not possible to complete the Project Assignment successfully without active participation in the Lectures an Exercises and the Use Case Assignment.

Lectures and Exercises

The Lectures and Exercises cover three main topics, these are

Topic 1. Analysis and design of computer applications in power Systems with Use Cases

Topic 2. Multi-agent platforms for distributed control of power systems

Topic 3. Platforms & protocols for computer applications in power systems

In the course schedule these topics are noted as T1, T2 and T3 respectively. The course schedule also contains two voluntary sessions that introduce the topic of object oriented programming with Java. These sessions are strongly recommended for students unfamiliar with these concepts.

In addition, during the later part of the course, Guest lectures will be scheduled giving an opportunity to gain an external perspective to the topics presented in the course.

Use Case Assignment

The Use Case assignment completes the first part of the course, and is intended to introduce the analysis and design techniques useful in performing the Project Assignment. The Use Case Assignment is performed in groups of two students, documented in a short report with diagrams as specified in the Use Case Assignment. The results are then discussed at a seminar. The Use Case assignment is mandatory, but it is graded only as Pass or Fail, see Use Case Assignment specification for details.

Project Assignment

The core of the course is the project assignment in which the project team is tasked with analysing requirements for an automation function, design a system solution and implement the solution in Multi-agent platform for distributed control of power systems. The project group works independently during the course assisted by the lab coaches to perform the project. The project assignment is performed as a group assignment, and the groups are expected to work independently.

N.B. The final date to hand in Project Assignments for 2011 is on December 2012. However, the final grades for the assignment will not be given until January 12th 2012. This is to provide time for groups that do not pass the presentation and/or hand-in in December to have the opportunity to complete their task.

Course Administration

For course administration and group communication the KTH Social platform is used. KTH Social can be reached at www.kth.se/social. At the course pages for EH2750 in KTH Social, it is possible to download all course material, access information about lectures and seminars and to interaction with students and teachers of the course.

Course updates, schedule changes etc. will continually be posted on the KTH Social platform.

Course Schedule

Date, Time		**Description**	**Literature**	
Mon 29 Aug 10.00 – 12.00	L1	Course Admin Introduction • Course Contents • Course organization and administration • Course assessment • Course groups organization Course Topic introduction Modern control approaches in electric power systems • Centralized vs decentralized vs distributed control • Hierarchical and hybrid control • Aggregation based control	Course-Memo NIST Report	LN
Wed 31 Aug 10.00 – 12.00	L2	Smart grids Use Cases • NIST Conceptual Model Intro to Use Case creation • Developing Smartgrid Use Cases	NIST Report Intelligrid Smartgrid use case guidelines	LN
Mon 05 Sep 10.00 – 12.00	Ex1	Developing Smartgrid Use Cases • Developing Use Cases for the Smartgrid	Smartgrid Use Case template	LN
Mon 12 Sep 10.00		Hand-in Use Case Assignment		
Mon 12 Sep 10.00 – 12.00	S1	Smartgrids Use Case Seminar	Developed Use Cases	LN
Mon 12 Sep 15.00 – 17.00 **N.B. Voluntary**	*	Introduction to Object Oriented Programming in Java - Lecture	Java reference	AS
Wed 14 Sep 10.00 – 12.00	L3	Agent based control in electric power systems • Introduction to agents and multiagent system MAS • Agent based control architecture • MAS as distributed intelligent control framework • Implementation platforms and Technologies	Wooldridge Chapters 1-3	AS

Fri 16 Sep 10.00 – 12.00 **N.B. Volontary**	*	Introduction to Object Oriented Programming in Java Exercises		AS
Mon 19 Sep 10.0 – 12.00	L4	Agent based control in electric power systems • General setup • Hardware and software • Technical configurations • Multiagent based system development	Woolridge Chapters 4-6	AS
Wed 21 Sep 10.00 – 12.00	Ex2	Multi-agent programming in JACK • Working with ICS MAS platform	JACK Tutorials	AS
Thu 22 Sep 10.00 – 12.00 **N.B New date**	Ex3	Multi-agent programming in JACK Working with ICS MAS platform	JACK Tutorials	AS
Mon 03 Oct 10.00 – 12.00	L5	IEC 61850 Overview • IED configurations OPC Architecture Communication • Network reconfigurations • Project specific work		NH
Mon 10 Oct 10.00 – 12.00	Lab	OPC Interconnection		NH
Mon 10 Oct 13.00 – 17.00	Lab	IEC 61850 Configuration		NH WY
Wed 26 Oct 13.00 – 15.00	L6	Project Assignment Introduction		LN
Wed 02 Nov 13.00 – 15.00	L7	**Cancelled** **Time used for Steering group meetings**		LN
Wed 09 Nov 13.00 – 15.00	L8	Guest Lecture I - Multi-agent projects *Rune Gustavsson, Guest Professor KTH* *Presentation about European projects on Multi-agent systems and Smartgrids*		
Wed 16 Nov 13.00 – 15.00	L9	Guest Lecture II – Cybersecurity *Robert Malmgren, ROMAB AB* *Cybersecurity expert with many years of experience from critical infrastructures.*		
Mon 12 Dec 10.00		Hand-in Project Assignment		
Mon 12 Dec 13.00 – 15.00	L10	Guest Lecture III – Substation Automation *Andrea Bonetti, ABB, presentation about state of the Art Substation Automation.*		

Thu 15 Dec 10.00 – 12.00	S3	Project presentations		LN AS
Thu 15 Dec 13.00 – 15.00	S4	Project presentations		LN AS

Project Assignment steering group sessions

To monitor the progress in the project, each project group is requested to participate in at least 5 steering group meetings during the project. Each steering group meeting is 15 minutes long, and the purpose of the meeting is that the group can present to the steering-group (a.k.a Professor Lars Nordström) the progress in the project.

The table below lists the topic to be discussed at each meeting. Since time is short, please come prepared to the meeting with supporting documentation, for example Time-plans with milestones and deliverables, clear documentation of allocation of people to tasks, Use case descriptions, Architecture diagrams etc. Keep in mind that this documentation is necessary not just at the meeting, but also for the grading of the project assignment.

The steering group meetings take place at the following dates & times. Should it prove impossible to meet at the suggested time, alternate dates & times are possible schedule. This is done by sending an e-mail to larsn@ics.kth.se requesting a new slot.

Date & Time	**Topic of the meeting**	**Available slots**	
Monday 7 Nov 09.00 – 10.00	Present a time plan for the project Present allocation of people to tasks Present responsible persons.	09.15 – 09.30 09-30 – 09.45 09.45 – 10.00	LN
Thursday 10 Nov 14.00 – 15.00	Present Use Cases for the solution Present risks in the project	14.15 – 14.30 14.30 – 14.45 14.45 – 15.00	LN
Wednesday 16 Nov 09.00 – 10.00	Present architecture for technical solution	09.15 – 09.30 09.30 – 09.45 09.45 – 10.00	LN
Friday 25 Nov 10.00 – 11.00	Progress update	10.15 – 10.30 10.30 – 10.45 10.45 – 11.00	LN
Thursday 30 Nov 15.00 – 16.00	Progress update	15.15 – 15.30 15.30 – 15.45 15.45 – 16.00	LN
Mon 08 Dec 15.00 – 16.00	Progress update	15.15 - 15.30 15.30 – 15.45 15.45 – 16.00	LN

Course Literature

NIST Special Publication 1108 - NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0

An Introduction to MultiAgent Systems - Second Edition, by Michael Wooldridge. John Wiley & Sons press. ISBN-10: 0470519460

Additional material will be handed out during the lectures.

Course Teachers

Course Responsible & Examiner:	Prof Lars Nordström
Course Lecturer:	Arshad Saleem,
Lab coaches	Arshad Saleem Wu Yiming Nicholas Honeth