Course Analysis

EI2439 Power System Protection 6p

HT16 P1 (Sep/Oct 2016)

Organization

Responsible department: Electromagnetic Engineering (EES/ETK)
Course leader, Lecturer, Examiner: Nathaniel Taylor (writing this analysis)
Examiner (formally): Hans Edin

Course "moments" and points

The course's 6 points are distributed between the written exam (TEN1, 3p, A-F grade) and projects (PRO1, 3p, P/F).

Numbers and results

6 students took the course: several others came to one or two early meetings but did not continue.
The final whole-course grades after exam (5 students) and re-exam (1 new, 1 retake) were:
A (1) B (0) C (3) D (1) E (1)
All who passed the exam also completed the project work.

Events

Meetings: 14 double-period sessions, i.e. two per week. These include presentation of projects. With breaks: ~21h.
Guest lectures: Jianping Wang [ABB]; didn't manage to find a utility guest to fit the schedule - *long* booking-time!
Comments: The majority of the class was present at meetings.

Course material

A webpage was used to describe each week's topics and schedule to course participants, including links to course literature, and project exercises and solutions.
For the topics other than low-voltage systems, two books formed the main course-literature:
Fundamentals of Power System Protection, Paithankar and Bhide (2.ed)., 2003, Prentice Hall of India.
Network Protection and Automation Guide ('NPAG'), GE Relays 2011 (online).
The first of these was introduced last year, and is considered good as a compact paper-based source about the fundamental principles for protection at medium- and high-voltage. The second is from a manufacturer, and fills the need of providing more up-to-date information about relay implementations, along with pictures: this is very lacking in the first book. It also helps provide that choice that is often useful with course literature due to the very different tastes that students have about explanation style.

Structure

The same structure of topics was used as in 2016, and there were again 14 meetings.

Changes to tasks

A lab task was introduced. A numerical transformer-protection relay was connected to get its input signals from a real-time simulator. Students had an initial homework task of simulating a system (in Simulink) with a transformer and various internal/external faults. They then used the relay manufacturer's settings program to set the relay, and tested its tripping and non-tripping for various fault-cases when the simulations were run on the real-time simulator.

A further home-task on asymmetric fault current was introduced early in the course, to reinforce this concept and to get students started with a very simple case in Simulink, in order not to delay their work with the bigger Simulink model in the preparation for the lab task (above).

The longer project task from last year was modified from a line-distance to a line-differential algorithm. Different simulated input-data sets were provided to each group. A part of the project was taken out as a separate task: see below.

Yet another home-task was introduced, about performing calculations on sampled data to implement sliding-window rms and dft. This was really just a split of the longer project task, to avoid that this part of the project should take over attention from the more key parts of the differential protection algorithm.

The earlier task on current-transformer saturation was kept (formerly 'projA', now just the homework of topic 4).

There is therefore now a task running in most weeks, bearing in mind that the project takes two weeks.

Evaluation

Two students were questioned about their views on the course, after the whole class was told in advance that those two could pass on any comments from the group. Besides this, there were informal discussions with students during breaks and project-discussions.

More incentive with the tasks: not just mandatory P/F, but some sort of bonus also?

Students considered that without their background knowledge (unusually high this year), some parts of the book and lectures could have been hard to follow.

Textbook and NPAG are good. Manuals (ABB manual used in the lab task) also very useful for the specific subject.

Nice to have this year's quite strong focus on a few specific topics, i.e. line and transformer differential protection.

Making a full set of lecture slides

Comments (on the above, and from my observations)

This was an unusual class, as all six had worked for a year more more in a related subject in industry. That made it easy in some ways: they could concretize ideas easily, liked the subject, and showed a real interest in understanding some underlying principles that made sense after their experience.

The increase in number of tasks, and splitting of the project task, seems good: it gives easily manageable bits of work, with quick feedback.

The lab was strongly appreciated; perhaps another too should be considered.

Giving significant merit (not just P/F) for tasks could mean changing the course (P/F -> A-F). My intention in choosing P/F was that the focus during tasks would be to learn, explore and 'show sufficient results', without the stress of striving for A. Giving strong bonus points is not something I like, since the exam is intended as an independent double-check that students are capable of explaining and solving problems alone.

Plan for 2017

Keep the same base literature: P&B book (paper) and NPAG (online).

The exam can remain in similar style, making one or two more questions equation-based.

Add more project-work on regular tasks, spread across the weeks.

Include again the laboratory exercise with relay settings (in a modern numeric relay): integrate with projects.

Try to find utility guests: in particular, having at least one female guest working with protection in industry would help improve the rather balance shown to students.

The field-visit idea remains shelved unless discussion with utilities reveals a suitable option: security is a hurdle.

Plan for longer-term

What are the best choices for simulation tools? There's some merit in learning what industry uses in this field. commonly-used simulation tools (PSCAD and Simulink), as a side-effect of projects that demonstrate general principles and give scope for analytic calculations.

Move towards even *more* tasks: more 'doing' throughout the course. Timing becomes hard when we have just one period.

It may be worth spreading the course across the whole autumn, like several other of the MSc courses.