Course Analysis

EI2439 Power System Protection 6p

HT15 P1 (Sep/Oct 2015)

Organization

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

10 students took the course: several others came to one or two early meetings but did not continue.
In the regular exam (2015-10-28), 8 passed, 1 failed, 1 could not attend.
In the re-exam, 1 passed and 1 obtained Fx which was then completed to E.
This year, all who passed the exam also completed the project work (although one took a long time).
The final whole-course grades, the same as the exam grades were then:

A (1) B (3) C (1) D (2) E (3)

Events

Meetings: 14 double-period sessions, including presentation of projects: with breaks ~21h.
Guest lectures: 3h + 1h (Bonetti [FMTP], Wang [ABB])
Comments: The majority of the class was present at meetings, with obvious reasons (other courses) for any absence.

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, a single book was the main course-literature:

Fundamentals of Power System Protection, Paithankar and Bhide (2.ed)., 2003, Prentice Hall of India.

This choice was a consequence of thoughts and comments from last year: in the absence of thorough course-material (compendium, detailed slides) it seemed desirable to have a clear, basic book in paper form as the focus for studies. The above book has good diagrams, and some numeric and conceptual questions at the end of each chapter. Its main downside for our purposes is that is has a lot of references to electromechanical relays and their wiring configurations. The course webpage still contained links to a few other books and papers as further sources for particular parts of a topic, and to various product brochures and corporate-produced videos about protection schemes.

Structure

A similar basic structure was followed as in the previous (first) year: basic purpose and concepts, then examples from low-voltage systems, moving up through medium-voltage and to high-voltage, introducing different principles that are needed by the conditions (of cost, risk, system-structure, etc) at each level, and finally summarizing modern trends such as generation in distribution networks, bigger DC systems, etc. The following list shows the session topics.

01 Introduction: purpose, faults, hazards, different system levels, importance!
02 LV: basic system layout, overcurrent devices, zones
03 LV: earth-faults and shock protection, bigger devices of MCCBs+CT
04 Beyond LV: constraints of higher parts in the power system.
05 More zones and relays: start on MV lines.
06 MV line-protection
07 HV line-protection
08 Busbar
09 Generators and motors
10 Transformers
11 Numerical relays
12 Final-Project introduction
13 Project presentation
14 Summary and Future

There were 14 meetings rather than the 8 that we had last year: this was another intention after last year, which made it easier to split the course into neat subjects. Only two projects were run: the first was integrated into meetings 04 and 05 (above), but the second was introduced and presented (by groups) in dedicated sessions. The project that last year was considered too loosely defined was modified accordingly. The project considered trivial was dropped.

Evaluation
Again, there were informal discussions with students during breaks and project-discussions. Two students who had taken related MSc-thesis topics in industry were then questioned in more detail about their views on the course. Comments were also given by student from *last* year's round, who is now a PhD student working in the group that has several relays and a real-time simulator: together we are forming a lab-based project task for the 2016 course-round.

In summary of the general views:
– It is an improvement to have the book. No one had a generally negative view of it. It covers most of the subjects, in an approachable way, with good use of diagrams and quiz questions. (But my comments on its slightly too electromechanical viewpoint can be seen above.)
– Still, a more calculation-focused exam seems desired by most students: however, this was not such a strong opinion as last year, which might be partly because of the exam having changed a bit, and partly because of students having more indication in advance of what the exam would be like, by looking at last year's exam.
– The student from the earlier round had a strong recommendation to cut down the breadth of the course and focus on details of just a few types of protection scheme.

Comments (on the above, and from my observations)
– We should move towards more calculations being done in the reading/discussion and in projects. This can be integrated with the general conceptual considerations. It would go well with projects that involve simulating small systems to demonstrate concepts and verify analytic calculations.
– Although a narrow, deep course can be rewarding for some students, I consider it important to give students a broad overview of the common principles for protection of all conventional power-system plant. Probably it would be an improvement to change from uniform quite shallow coverage to a slightly more shallow coverage combined with further deeper coverage of one or a few subjects that can be treated in simulation projects and/or lab.
– As last year, I had very limited time: I inherited a large undergraduate course (circuit analysis) running simultaneously, that was not expected when I initiated this MSc course and decided the period in which it would run. I therefore did not get a chance to work more on suitable material and motivation methods for getting good reading of literature before meetings, and active useful discussion in meetings: it became slightly interactive lectures, using whiteboard and a moderate number of slides.
– Four of the students from this round now have MSc theses in related subjects: 2 with industry, 2 just at KTH.

Summary
It certainly seems that the course has improved, from my and the students' perception. This is not a great achievement, given that the previous round was the first, and that we're still getting used to what level and content are reasonable.
There were not quite so many students as last year: 10, compared to 12 (completing) or 15 (taking exam). That's a small change, and doesn't [yet] seem worrying for the future. If we're going to work towards a very interactive course with good discussions at meetings, then a smaller group made of only the most subject-interested students would probably be better.

Plan for 2016
Keep the Paithankar book as the base literature, unless able to find something clearly better.
Make the LV part (not in that book) clearer: e.g. make new slide material about this.
The exam can remain in similar style – perhaps a bit more of equation-based questions.
Adapt the projects a lot: split into smaller pieces, involving several simulations and analytic calculations.
Include a laboratory exercise with relay settings (in a modern numeric relay): integrate with projects.
Have one or both guests again, also try [again] to find one from a utility.
(Probably not try field-visit unless an obviously useful one is easily found: focus on new labs/projects.)

Plan for longer-term
Even more project-focus: aim at developing familiarity with commonly-used simulation tools (PSCAD and Simulink), as a side-effect of projects that demonstrate general principles and give scope for analytic calculations.
Possibly a further lab task: we'll have to see how it goes in 2016.
It seems a choice is needed of whether we'll do as the students seem to want (lectures with extensive slides) or what still seems more desirable (well-prepared students present and discuss material themselves). In the former case I need to develop slides, and less importantly to define what other sources should be studied. In the latter case I do not need slides, or at least not the same type, but I do need to define reading material and some clear way to make it desirable for students to extract particular points from this and present and discuss them well; that is challenging!