Course Analysis

EI1120 Elkretsanalys för Energi och Miljö (CENMI) 7.5p

VT14 P3 (start 2014-01-20, exam 2014-03-20)

This information can be complemented by the Course Evaluation summary given by W-sektion SNO.

People

Responsible department: Electromagnetic Engineering (EES/ETK)
Course leader, Lecturer, Examiner: Nathaniel Taylor (writing this analysis)
Examiner: Lars Jonsson
Teaching assistants: Roya Nikjoo, Xiaolei Wang

Events

Lectures: 14 double-period sessions, i.e. 21h.
Practice (övning): 14 double-period sessions, i.e. 21h (two parallel groups, free choice of which to join).
Pre-exam practice/study sessions (räknestuga): before KS1 and Exam: 2 sessions, each one around 3h.
Laboratory task (optional): 2 opportunities offered; the task takes from 2 to 4 hours.
Homeworks: 12 homeworks, submitted by email (no timetabled hours are associated with these).

Comments:
Lectures were generally well attended, i.e. the strong majority of the class (80% at a guess).
The practice sessions were also highly attended.
In the pre-exam study sessions it was closer to only 50% attendance.
Almost all students (>90%) kept up to date with the homeworks, within permitted tolerances!
The optional laboratory task was chosen only by 15 students, i.e. hardly 20% of the total, probably because of difficulties in finding suitable times and rooms; around 50% has been more common in previous years.
At least 2 more lecture/practice occasions were wanted, but did not fit into the timetable; see later comments.

Registered students

72 (as of 2014-01-21) were in the "Anmälningslista" on KTH-Social; 57 had "J[a]" for "Registrering" at that date.
99 were seen at some point during the course (homeworks, KS1, KS2, exam or re-exam).
78 took the exam, and only 5 failed it.
Further queries about registration statistics should be addressed to STEX/Ladok! There are too many "states" of registration for me to try to understand.

Results

Exam (ordinarietenta VT14) 2014-03-20: 78 students: 5 failed (F), and 73 passed: A (22), B (26), C (11), D (11), E (3).
So, 94% pass-rate on ordinarietenta. Passing the exam means getting 7.5p, failing means getting 0p.
Re-exam: (omtenta VT14) 2014-05-22: 4 students, not yet graded.

Course "moments" and points

The course's 7.5 points are distributed between the final exam (TEN1, 5p) and two "projects" (PRO1/2, 1.0 & 1.5 p). The significance of the PRO1/2 can vary between course rounds. In this round, all moments were considered fulfilled by a passed final exam. However, by getting good grades in a KS and/or homework (even without a passed final exam), it could be possible to get a PRO* moment approved: this option did not turn out to be relevant this time, since all the students who put significant work into the earlier activities also passed the final exam and thereby the whole course.

Course material

Notes, Homeworks, A suggested book, Alternative books. See later section for more details about course material.

Course Aims

See the official course plan, catalogue etc for formal aims.
The main aim is that students should be able to solve idealised circuit diagrams, to find typically voltages, currents or powers. This is done for discrete linear circuits, with dc, transient and ac conditions. This main skill can be built upon in later courses that more directly apply circuit analysis to electric power applications.
There are several more general skills that are also cultivated in the course:

- Familiarity with computer-based methods is encouraged by homeworks, which have to be submitted as short Matlab code; it is also encouraged as a checking method.
- Dimensional analysis is refreshed and strongly encouraged as a habit for checking.
- Checking reasonableness of results, and alternative more intuitive ways of seeing a result, are trained in several parts of lecture quizzes and homeworks.

Summary (overall impression)

The students in this round did a really good job of their studies; only very few fell behind. This is partly helped by the changes in course design, as is confirmed by students' comments. The regular homeworks, the style of the homeworks, and the division of work between 2 KSs and the Exam, seem very useful in motivating regular work and giving confidence. Comments from students, including ones who were retaking the course, make clear how important the “confidence” is, so that they feel that they are not going to get stuck at a dead-end in their attempts at solving early problems in the course. The introduction that points out the subject's relevance to energy, and the more general skills that can be acquired in the course, also seem appreciated as important motivation.

We must not forget the practices (övnings): nothing has been deliberately changed about these since the last round, but they were again highly rated by most students: one teaching assistant was even called a “light in the dark” (which perhaps speaks badly for the rest of the course!).

It is a pity that the timetabling choices made the important last part of the course feel rushed. It is also a pity that I fell behind in producing homeworks, notes and lecture plans: the load was too much with these several changes all at once. Nevertheless, it has not seemed to make the final outcomes too bad, but just made the course less polished than I would like. The students' motivation is really inspiring.

Changes in this Course-round

Changes were influenced by:

- my experience from last year's course-round,
- students' evaluation comments from last year, particularly about my suggestions for changes,
- my experience from the IT-program's course EI1102 in the autumn, particularly about homeworks,
- discussion with the teacher from another program and with the earlier teacher of the Circuits courses.

This is the first time I have made big changes to this course.
Last time (VT2013), I was new to the course, and made changes only during the course, when there was clear reason. Some of these changes were that:

- An A4 page of notes (any content) could be taken to the exam: the purpose was to avoid study-time being wasted on trying to memorize things, but nevertheless to encourage some selectivity about what it important.
- The publisher's solution-manual to problems in the main textbook was made available, to allow checking of practice solutions.

This time (VT2014), the changes were planned before the course.
In summary, the implemented changes were:

- A second kontrollskrivning (KS) has been introduced, to cover the Transients part of the course.
- The exam still has three parts: but KS1 and KS2 now correspond directly to two of these, and the *better* grade out of the KS and corresponding exam-part is what is used towards the final exam's grade. In this way, there are two attempts at each of the first two parts. If a student's grades in both KSs are good, then they can focus on just the third part during the exam.
- Instead of just 4 homeworks, there was a homework for each of 12 Topics (lectures): the only lectures not having a corresponding homework were the introductory lecture and a lecture near the end of the course

during a week that had three scheduled lectures (too tight).

- Homeworks had only a relatively small part that was *required* to be submitted in order to pass: the rest of the homework had solutions usually provided earlier, with encouragement to practice on these, check the solutions, and then try doing the part for submitting. This was intended to build confidence with the methods, and to prevent the "obligatory" part of homework becoming a time-stress.
- Homeworks did not have peer-marking or any scheduled time. However, it was clear that most students were anyway doing their assignments in groups in which a lot of useful discussion went on; so they were helping each others' understanding, but they were able to plan this study time for themselves.
- The homeworks were submitted by email, to a special account. The answers were short, and were to be given as Matlab code along with a numeric result. This encouraged familiarity with a useful computer tool, and made it easy for me to check. Comments could also be given so that I got feedback about whether the tasks were easy or hard, and whether the style was helpful. This was extremely valuable to me, although I regretfully did not get time to optimise some of the later homeworks based on the feedback from comments ... next time!
- The homeworks did give a small bonus to the exam (maximum 5%) if 80% of them were on time; but in any case, students were told that all the homeworks have to be done as part of the course. They were warned against slipping behind: it would be very hard to catch up.

Examination

The results were very high for a circuit-analysis course. That would be pleasing if it could be attributed mainly to high motivation and useful guidance by the course structure. I believe the marking, shared between three of us, was quite kind. However, from my own view of the work and exams, and from comments from students who took the course in previous years, I don't believe the exam is very different in level now, nor that the style of marking is the main factor explaining higher grades and passes. Mainly, I think the regular work, and my strong encouragement to students to try to keep up to date on the course, have been the cause. This is not strange when one considers a common story from those who have failed on the first exam (for example, Elektro students interviewed in the autumn): "you said I would not be able to cram it in the last week, but I didn't believe you".

Teaching (approach, perceived results)

The changes in the course appear to have a very good effect. My main views about this are related to the notes, homeworks and examination structure, which are discussed in the other sections. In this section I will consider my feelings and students' feedback about the lectures and practice sessions.

The teaching assistants clearly had two quite different styles in the practice sessions, with one being more keen on forcing students' own work: this approach appears to have been preferred, although it is not the classic style of KTH-övning. A teacher's own style is important here: some do not find it easy to command everyone to solve something, and to wait a suitable time; students also have differerent tastes. So I do not want to force a particular method onto the teaching assistants. I try to make suggestions before the course starts; next time there will probably be different assistants, so I can just hope that they also manage to be so highly regarded.
I have wondered whether to force a change in style, by encouraging slower but deeper work in these practice sessions, or to deliberately orient them to well-known problems. In any case, if we no longer have an official course-book, I will have to consider what set of exercises to have in these sessions. It seems most likely that the style of solving several problems per session will continue, perhaps from a variety of books or from the old compendium. The homeworks are a suitable vehicle for me to emphasise special cases.

About lectures, the majority of responding students were satisfied (about 70% of responses said "good", and 10% were negative). There are several comments that came up multiple times, particularly among the negative commenters, and similar comments were present last year too. One such comment is from students who want the style on the board to be easier for taking notes: i.e. headings, more writing, all steps written up. I do want to improve at presentation style, and think that these suggestions could be good to follow to a small degree; but I don't want to aim for writing a book on a board – that is what the notes (or book) are for, and it is time-consuming and boring in an oral presentation. My biggest hope is to get rooms where board space and a projector can be used at once, throughout the period. Then I can have headings, structure, quiz-questions, and some good pictures and diagrams on the slides, but can use a board for developing some equations that work more smoothly in that way. In most of our rooms this has not been possible. I have also not had time during this course-round to work on slides, when developing new homeworks and notes. Another complaint is that there is sometimes too little time given to the core

of how to solve that day's type of problem – too much time to the practical basis or “something I find interesting”. I accept that this also is a valid complaint: I think it will be helped by having a stronger time-plan coming from fully finished notes and from slides.

I intend to keep a quite traditional style of lecture in this course, although including some breaks for own/group thinking. Feedback from several students tells me that they find it helpful to meet new material in spoken as well as written form; this is particularly strong for students who have some difficulty with reading. Others have commented that it's good for motivation to hear the subject described along with some pictures and examples of applications. I make clear that no one has to come to lectures, but can study from written sources if they prefer ... the majority still come. Having seen the wide variation in levels of understanding, I don't think a very sustained dialogue between lecturer and class would be a better use of time: the level would always be wrong for a lot of the people present. The students already do a lot of useful collaborative work on homeworks, outside scheduled hours, and can ask any of the teachers for help if they are stuck; this suggests that it would not be pointful to add more scheduled time for group-help when we already have the practice sessions.

Student workload

The course is certainly regarded as mainly hard and quite demanding.
The scheduled time is not a large part of the course; even if they came to all scheduled events, that would only be about 25%-30% of the total ~200 working hours of a 7.5p course. A lot of the work is for the students to schedule for themselves. Some clearly worked very hard, on homeworks and other preparation. I did not get the impression that there was disturbingly high stress (this was more the feeling on earlier occasions).

Course literature

The officially declared course-book was again the error-filled “Introduction to Electric Circuits”, 8 ed, Dorf & Svoboda (Wiley). Exercises for practice sessions were taken from this book. The choice was partly due to teaching assistants wanting to re-use their earlier notes, and partly because I was asked in the autumn to decide quickly on a book so that it could be converted to other formats for students with special needs. Without these constraints I would have chosen a different book. I will not use this one again.
The extensive solutions from the book's “Instructor's Manual” were made available to the students, with the publisher's consent. This was done last year, for the first time, in response to students pointing out how important it was to them to have solutions to all the questions. Many students want to do some practice questions and check that they are on the right path. The importance of this has been confirmed by the course-evaluation responses from last year, and by interviews with students from the autumn 2013 course for Elektro (electrical engineering program).

The old KTH Compendium (Elkretsanalys, Gunnar Petersson) was also made available for those who prefer its compact style and Swedish language. One other book, in English, was suggested as a good choice for a student wanting a different circuits textbook. It was made clear in the introductory lecture that the course's structure and emphasis is determined by the lectures and associated notes, which cover the Topics listed in the course syllabus (KursPM).Any Circuit Analysis textbook that the student likes should be able to cover much of these Topics, so there is no requirement to buy a specific book.

Exams and homeworks from earlier years and from other circuits-courses, were also made available on the website along with solutions. These are useful guidance for the level of the exam questions.

It was planned that thorough notes about the theory, solutions and practical relevance of everything in the course would be written and made available before the respective lectures. The purpose of this is to have a clear written source that shows exactly what the students are intended to cover, and thereby permits them to avoid lectures if they prefer, or to avoid being distracted by trying to make extensive notes at lectures. It also provides a clear plan for me or other teachers for lectures in the future. My choice of content and its sequence is not well followed by any book that I have found, although various books could be useful for supplementary/complementary material. Students' tastes are very different about preferred styles of book, so I prefer to leave several books as suggestions.
Writing thorough notes, at the same time as writing lots of new homeworks, turned out so time-consuming that it was only partially achieved: some notes were late, some were just not as clear or thorough as is desired for the long term.
On the other hand, the intended homeworks and solutions were forced to be published in step with the lectures, so they took priority in time; they provided a lot of description of how to solve the problems, and why; they therefore compensated for some delayed notes.

From the student questionnaire, conversations, and emailed comments, I got similar opinions to what I had expected based on earlier course-rounds with this and other programs. Some found the textbook (Dorf/Svoboda) good on explanations, several complained it was too long-winded, and many thought it very unhelpful that it has so many errors that one almost trusts oneself better about solutions! The provided solutions (instructor's manual) were considered very useful by some, although a few others reported that the provided notes, homeworks and past-exams were perfectly sufficient without having a book at all.

Prerequisites

There seemed not to be much grasp of electrical basics, such as field quantities, potential, voltage, etc. But I judge this mostly from questions I received: these may be mainly from the students who found it hardest. Having expected this weakness, based on last year and other programs, our "Repetitionshäfte" (mainly school-level) was recommended for working through before the first lecture.
The main cause of lost points in the exam was errors in circuit-analysis concepts, not simply errors in handling equations. I therefore would say that mathematics was not a serious problem. As far as I'm aware, complex numbers are not intended to be a big part in the previous education, so it is not strange that our heavy use of these requires some practice. Differential equations had been largely forgotten, but came back quickly; I know the feeling.
Summary: adequate.

Other

There were some timing problems between the parallel courses EI1120 and KE1060. We had no link-meeting before Period 3. I thought this would be ok, but it turned out that we hadn't considered the case where some students need extra time for kontrollskrivnings; lectures booked close after a KS would be partially missed by these students. We worked around this for one case by moving a lecture. This is something to note in the timetabling for next time.

The first part of the course went very well, with regard to students following the material and finding the style of lectures, practices and homeworks to be clear. Later, the subjects were not so clearly divided between lectures, and too much material was included in each Topic (lecture and corresponding practice and homework). It was reported by several students in the evaluation that the course felt less clear and planned at this later stage, when we started on ac, and was particularly rushed for the final topic. For example,

"Bra tempo genom hela kursen förutom sista blocket som gick väldigt snabbt."

I agree.
Part of the problem was that I had wanted 2 more double-period lectures and övnings, but had not realised that the final week shown in the timetabling system was only re-exam week. Because of including a second KS and trying to fit some space around each Topic, it was not possible to get as many occasions as I wanted. When the timetable was finished, and we only had 14 lectures and practices, I tried to split subjects and fit them in. For next round, I must try to fit more occasions, or rely more on notes and therefore have more concise lectures, or else remove (or marginalise) some of the smaller subjects. I don't like that last option, as everything already in the course strikes me as quite basic requirements for giving a good "circuits background". This year, we marginalised mutual inductance and diodes, by stating that they *could* be in an exam question (in the final, hard part of a question) but there would not be whole questions dependent on these subjects.

The homework format, with encouragement to think independently but to move forward if stuck, was well appreciated. Some comments (sent with submitted homeworks) were:

- "The different steps were great guidance (when needed) for the task."
- "Jag tyckte det var bra att man fick leding genom frågan, då man både kunde kontrollera sina steg efterhand man hade gjort dem, men samtidigt få ledning om man skulle fastnat! Kände att det var väldigt pedagogiskt upplagt och hoppas att framtida uppgifter kommer läggas upp liknande!"

With some later homeworks I don't feel this principle continued to be so well acheived (by me) – the final subjects were too squeezed in, and I had less time to write them carefully (see the above paragraph about the timing of the last part of the course).

Course evaluation (questionnaire)

The student representatives, SNO, organised a web-based evaluation questionnaire around the time of the exam, and summarised the responses.
I also received a few emails with spontaneous comments, and received a few comments on a simple text-box on a webpage that I put up after the exam results were announced.

Some comments are summarised in other sections of this analysis: e.g. some negative things about timing.
Some further comments relevant to motivation and the new structure, are:

- "Jag tyckte kursen hade ett väldigt bra upplägg den här omgången. Det var lätt att hänga med i alla kursmoment tack vare dina sammanfattningar och hemuppgifterna. Det var också jättebra med två kontrollskrivningar!"
- "Thanks for the great course, didnt think i would find circuits interesting but you proved me wrong."
- "Helheten! Bra med många inlämningsuppgifter och deadlines regelbundet. Väldigt välskrivna anteckningar och lösningar till hemuppgifterna, det har varit mycket användbart."
- "Kursen ar ett lyft jämfort med ovriga kurser som ges specifikt for energi- och miljo. Jag har lärt mig betydligt mer."

Planned changes

This course went well. I have no doubt that it has improved since last time. The newly introduced changes to homework and assessment were good. I do not intend to change these aspects significantly for the next round.

Some **small** intended refinements are:

- The homeworks will be improved: writing lots of new works and solutions was heavy on time, but in the next course-round it will be possible to re-use this work with some minor modification and polishing.
- The book that was still suggested for this year (Dorf and Svoboda, ed.8) will not be used or even suggested. One or two other textbooks will be mentioned as options for students who want advice on a further book. The course notes, provided on the course website, will be the main material. Like the homeworks, these were extremely time-consuming this year, but for the next round (and with some use in Elektro's course in the autumn) they will be relatively light work to refine.

The **main** planned change is more – and obligatory – laboratory tasks!
We currently have a single, optional lab, at the end of the course. I intend to change this to around 4 obligatory lab tasks, spread through the course. They need not be very long, e.g. 2 hours each. The purpose is that I think students would much better understand the concepts if they have some real experience to connect the theory to. I also think that they should have some familiarity with common instruments.

This has been a problem to try to implement, because the department has no well-suited room or equipment, for dealing with a large class in just one or two sessions. Our lab exercises are normally for small groups of master students, or for a single lab in undergraduate courses. The room is a particular trouble, because of rental costs.

The current plan is to borrow a lab with 24 places (12 pairs) already equipped with suitable instruments, that is available from another department in the EES school. For a class of around 80, this will require 3 or 4 sessions for each exercise, which is tolerable although not ideal.

In the first week of the course, we can have an exercise to clarify the idea of "nodes", components, multimeters and dividers. Likely later labs would be opamps and equivalents, then transients, then something about filters. If well planned, this will do a lot to make the subject more alive.