**Course Analysis**
**EI1120 Elkretsanalys för Energi och Miljö (CENMI program) 7.5p**
**VT18 P3 (2018-01-16 – 2018-03-13)**
**Nathaniel Taylor**

## Staffing
*Responsible department:* Electromagnetic Engineering (KTH/EECS/EME)
*Course-responsible, Lecturer, Examiner:* Nathaniel Taylor (writing this analysis)
*Examiner (formally):* Daniel Månsson
*Other teachers (övning, medrättande):* Md Zakaria Habib, Mrunal Parekh

## Events
*Lectures:* 15 double-period sessions (i.e. 22.5h), usually two per week.
*Tutorial (övning):* 15 double-period sessions (22.5h), usually 1 day after corresponding lecture.
*Laboratory tasks:* 2 lab sessions (obligatory), each taking ~2 hours, each organized in 4 sessions of up to 10 pairs.
*Homeworks:* 12 homeworks, submitted by email or paper; obligatory to pass 6, exam bonus from doing more.
Lectures and tutorials were generally well attended: definitely the majority of the class (>70% at a guess).
55 students passed all the first 6 homeworks, and 38 passed all the last 6; 35 passed all 12; the mode was 11 passes.

## Registered students
As of 2018-02-15, 72 students were in the "Anmälningslista" (KTH-Social), with 70 of them marked as being registered.
68 took the main exam in March. 84 participated at some point during the course (KS1, KS2, exams, homework, lab).
In summary, this is quite similar to VT2017, but with a few (<10%) more participants, more like VT2016.

## Results
The same principle was used as last year: a final exam and two partway exams (KS) that can contribute to it.
Exam questions were in a similar style to last year.
Exam, 2018-03-13: 68 students, 83% pass (92% if all Fx→E): A (9), B (20), C (15), D (10), E (5), Fx (6), F (5)
Compare to earlier years (pass rates are after any Fx completions):

2017: 64 students, 80% pass: A (6), B (9), C (12), D (15), E (9), Fx→E (1), F (12)
2016: 69 students, 90% pass: A (2), B (18), C (14), D (10), E (8), Fx→E (10), F (7)
2015: 81 students, 88% pass: A (7), B (21), C (19), D (20), E (4), F (10)

Re-exam, 2018-05-29: 7 students: D (1), E (1), Fx (4), F (1).
Most students were newly registered to the course this year, and passed either all or none of PRO1/PRO2/TEN1; thus the proportion of available points (hp) obtained during this round is similar to the pass-rate of the exam.

## Course "moments" and points
The course's 7.5 points are distributed between the final exam (TEN1, 5p) and two "projects" (PRO1, 1.5p; PRO2 1.0 p).
PRO1 is passed by the minimum number (6) of homeworks being approved. PRO2 is passed by attending both labs.
The final course grade (A-F) is the same as the exam grade, when all three moments are approved.

## Prerequisites
The impression is similar to several previous years. Maths seems adequate, as the main cause of lost points in the exam was errors in circuit-analysis concepts, not in handling equations. A little time is needed for learning / remembering / deepening about complex numbers, ODEs and particular algebraic steps that arise often in this subject.

## Course material
This was essentially the same as last year. Lectures were almost entirely board-based, with scanned hand-written lecture 'notes' made available on the course webpage in advance to prevent undue focus on note-taking and to facilitate students missing some lectures; the older (≤VT2016) computer-written chapters were available as an alternative for those students who prefer more detailed text. Exercises and solutions corresponding to each lecture topic were also available in advance. Tasks for tutorials and homeworks were posted around the relevant time, with their solutions provided after the tutorial or deadline. Several years of past exams with solutions were also available for practice, and the Exercises contained direct links to specific exam questions that students were recommended to try after completing the basic exercises. Lab tasks were available some days before the event, and files with explanation of what was seen in the lab were available after the last session of the respective task.

### Changed in 2018, according to plans from 2017

The final homework #13, on the topic of three-phase systems, was radically changed: instead of being abstract and based on algebraic solution by hand, it was 'highly applied' and was to be solved by computer, with a matlab/octave script as the hand-in solution. Its subject was a domestic electrical installation typical of Sweden, which is something that should be somewhat familiar to the students, or could be hoped to awaken some practical interest even if they've never considered this part of their everyday environment. Questions did not directly show a circuit and sought quantity, but used text to describe a situation and the quantities to be determined. Students therefore needed to consider what circuit to draw and solve. Computer solution was used in order to focus attention on the principles rather than the complex algebra; this is realistic to how such circuits are usually solved in practice. If approved, this final homework caused full points to be given for the final question in the exam, which is the only question about three-phase calculations. This was intended to make the homework very desirable to do, even for those students who had completed the requirement of 6 approved homeworks. In this way, students could work hard on the homework for a few days around the final two topics, and then focus back on other topics for the exam.

One of the three compulsory lab tasks from VT17 was removed: this was the one about opamps, which had been considered in the feedback from VT17 to be the least clear and useful. The fourth lab task was not even offered, as only two people attended when it became optional in VT17. Reduction of the compulsory labs was considered in the VT16 and VT17 analyses. I consider the two remaining labs to have some use and to be worth keeping for next time. The first is good as an early introduction to some actual circuits, dividers and measurements: labs were introduced a few years ago partly in order to allow students early in the course to have something concrete to think about when asking e.g. “what is a node”. The other is a bridge that reinforces concepts from section B of the course, shortly before the respective mini-exam (KS), and that helps us move into section C (ac) by having seen responses of circuits to sinusoidal stimulus.

Instead of having two parallel sessions for tutorials, with free choice of which to attend, tutorials were in a single session held in U21, which can accommodate 70 people. This was driven partly by how the sessions tended to become one large and one very small group in several previous years, and partly by a sudden lack of available PhD students with suitable employment for this role.

### Changed in 2018, *not* as planned from 2017

Only one guest lecture was given (L. Söder, KTH) instead of also having a presentation from former KTH students who work in the electric power industry (SvK). This was due to illness rather than intention.

### Not changed in 2018, in spite of plans from 2017

Lecture notes (hand-written) were not updated. There was no time for this. After the VT17 round, I felt that neater re-writing would be good; it was also commented in the evaluation that some of the later notes were not as clearly formulated as the earlier ones. This is something still to consider for VT19 – one VT18 evaluation response commented that the hand-written notes were in some places a bit hard to read.

Compulsory preparation for labs was suggested in the evaluation, and considered in the analysis. As it happened, we just didn't get round to finding a suitable system, other than to warn of this perceived problem and plead for everyone to read the task beforehand and try to predict the results. In view of the tight schedule, one cannot easily have an assignment and assessment squeezed between the necessary lecture and the lab, unless marking is automated in some online system or is done on arrival at the lab. One of those options might be tried in the future, if preparation is still seen as a problem. This year, it wasn't commented on by students, and preparation wasn't perceived as a problem by teachers in the lab sessions.

## Evaluation

A part-way evaluation was also done by a web-form after the course had settled to a routine (the form was open 2018-02-05—2018-02-08); the purpose was explicitly just to catch anything needing attention. A summary along with planned changes was published for course participants soon after the form closed. The issues raised were primarily delays in getting results for homeworks, and perceived high load from homeworks. It was even requested that all homework submission dates be set on the course homepage from the start, in spite of tasks not being published until later; this was implemented immediately. Some positive comments were also received about course structure.

The CENMI program held a "link-meeting" on 2018-02-12. Positive comments came about course structure and tempo, labs, lectures, and the principle of the frequent homeworks. Problem areas were the delayed marking of homeworks, somewhat stressful level of work, and tutorials that felt stressed and not sufficiently organized. Further exercise sessions (räknestugor) were requested: these were soon set up in the schedule.

The final evaluation was done by distributing paper in a lecture (2018-03-05) and providing a web-form (2018-03-05—2018-03-15), as alternative response+methods in order to try to get plenty of responses. These were not structured questions, and in contrast to some previous years we didn't even provide lots of example subjects to consider, but just asked for any comments to guide us about what to keep and what to change. Only 23 responses were received, which is the lowest we've had, and as bad as when we used the KTH evaluation form (perhaps we should simply use that next time). A possible explanation is that the availability of a web alternative was announced at the same time as papers were handed out, which might have lead to students postponing their responses. Postponement was not seen as a problem, as comments were wanted on the newly introduced final homework which was completed after the final lecture. But perhaps postponement caused the evaluation to get forgotten by many.

Responses from the final evaluation are summarised below:

*Course-load:* Heavy but manageable; our efforts to coordinate timing of tasks with the parallel course were noticed and thanked by one respondent.

*Course structure:* Very good, with clear flow, well defined and regular tasks.

*Course material:* The webpage was liked for having everything on one clear page in time-order; the course material had mainly positive comments, except for noting that hand-written parts can be a bit hard to read in some places.

*Examination:* KS2 was seen as harder than its historic average.

*Lectures:* Comments were surprisingly positive (similar nature to last year) in spite of external pressures having reduced the amount of preparation; we'll try not to become complacent.

*Tutorials*: Definitely less criticism than last year, and not so critical as it felt from the summary of this year's link-meeting.

*Guest lecture:* The one guest lecture was well appreciated in the evaluations.

*Homeworks:* It was widely pointed out that the long delays in marking were annoying and not good for the enthusiasm to continue submitting homeworks.

*Lab:* No critical comment this time, possibly due to removal of the lab that last year was considered least clear and least useful.

We make the following comments regarding important criticisims in the above. Delays in marking homeworks were due to this year's special mixture of understaffing (at the start) combined with the lecturer being unsually busy due to external causes. The situation should not be repeated. We do however point out that *solutions* were made available within hours or a day of the hand-in deadlines, enabling students to check their own work even if not getting prompt individual grades. The tutorial teacher was new to the course, and had the whole class in one big group. He was not familiar with the first three years of the KTH civilingenjör programs, so has been getting familiar with the needs of these students as well as our way of handling the subject. He now feels well prepared for next year. The difficult KS2, on reflection, may have been partly due to a structure with a few fairly hard tasks rather than several quite easy ones ending in a distinctly hard one.

## Overall impression from the course and the evaluation responses

As in several previous years, the overall impression is very positive, both about the student group and the way that the course fits them. There has been good, focused work: circuit skills and general skills have grown strongly. Uncomfortable workload has only been hinted at in a few cases, and is a combination of two intensive courses. Particular features of the course-design that appear important for working well with this program are: a very clear structure for what technical content comes into each part of the course, and what is required; regular homeworks, and the style of these homeworks; and division of work between two KS, a final homework, and the main exam.

The problematic final topic (three-phase) *does* seem to have been strongly improved by the computer-based final homework that was introduced this year. In spite of no hard evidence, my strong suspicion from looking at answers and talking with a few students is that the memory and conceptual understanding of this subject will be better as well as grades being better ... provided that all students did actually do their own homeworks.

Desirable changes implied by the evaluation comments all fall in the category of small changes and operational details: for example, loading or timing of homeworks, speed of feedback on homeworks, and clearer hand-writing in scanned notes. See “Thoughts for the future”, below, for some of the course-responsible's more far-reaching or fundamental thoughts about changes to the course.

## For the next (VT2019) round

Largely as this time.

Again, take care to coordinate with parallel course (esp. early and last week and KS) and ski-trip (early week).

The single group for tutorials is expected to be kept, as there isn't an obvious teacher candidate for a second group, in the style of previous years, and we think the tutorials will be a lot improved after the new teacher's experience this year.

There's a temptation to shrink some earlier topic a bit so as to put even more time into the final topics and associated long homework. One more lecture/tutorial pair might be inserted if the scheduling makes this reasonable.

Should we reduce the homework load somehow? There were several evaluation comments with this suggestion. It seems that in order to achieve this we would have to sacrifice the principle of having “exam-level tasks” or of getting each topic's homework completed by the day when the next topic starts. Only half of the tasks are required, and the purpose is mainly to encourage keeping up throughout the course, with the main assessment coming in exams rather than homeworks. It does not seem likely we'll be convinced to change this much beyond seeking and correcting any unusually time-consuming parts of homeworks.

## Thoughts for the future

Remove or reduce something earlier, and extend the three-phase topic so it starts earlier: thus, obtain much of the practice of earlier AC concepts (complex power, transformers, compensation) *within* more practical examples.

Opamps: this is a bit of a strange topic to include among power-oriented linear circuit theory ... remove or reduce, as has already happened to diodes a few years ago?

Including second-order systems in the 'transients' part of the course has long been a temptation. This part of the course tends to feel not so demanding for content/time ratio as the other parts: it's like 2.5 topics in the space of 3. The addition would make the subject treatment feel more complete, and the ODEs more interesting...

Looking at the course material, which has grown over several years, a thorough revision would seem good: advantages could be even more coordination between notes, exercises and homeworks, besides better readability of the hand-written parts.

It's worth considering computer-based questions to supplement or replace homeworks, self-study or lab preparation. Colleagues teaching electromagnetic field theory to several programs have successfully used such quizzes with automatically generated and marked values, and a large bank of questions from which some are selected for each student. The former teacher in measurement theory (CELTE program year 3) used automatically-marked questions to test eligibility for lab sessions. If we could replace our homework marking with automatic marking, it would speed feedback to students while also saving us time after the initial investment. A major factor against this is time availability for making a hard effort on a big bank of really good questions. A good counter to the claim of the previous sentence is that one can start small and add little bits at a time.

See the 2015 course analysis for further comments about possible major changes that the course-responsible has considered (e.g. more applications, projects, simulations etc) and reasons for not having implemented these.