Challenges in electromagnetics education design as a part of curriculum reform process

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Aalto University was established in 2010 as a merger of three different universities; Helsinki University of Technology (TKK), Helsinki School of Economics, and University of Arts and Design. Currently, it consists of six Schools; the School of Arts, Design and Architecture, the School of Business, the School of Chemical Technology, the School of Electrical Engineering, the School of Engineering, and the School of Science. Already in 2010, it was decided that teaching evaluation process (TEE) was designed for the whole university focusing on the practices and issues of planning, management, implementation, and development of the undergraduate and graduate degree programmes. The TEE process took place at the entire university level in 2010-2011. Its results, suggestions, and ideas for the degree programmes are used in the curriculum design at Aalto Schools (Learning together 2011). Later on, the university management launched a curriculum renewal process at the Schools. As a first result, new Bachelor programmes in engineering fields have been instigated in September 2013. During the next two years, new Master’s programmes will be instigated in 2015/2016. The new programmes will be systematically designed in cooperation with different stakeholders, and professional competencies required in working life will be integrated into them concurrently concentrating them on the research focus areas at Aalto.

Accordingly, the curriculum design is also in progress at the Aalto School of Electrical Engineering (ELEC). Aims in the design have been, for instance, fluency and flexibility of the study path. Furthermore, links between different courses and substances have been significant as well. Courses in electromagnetics form the basis of the Degree Programme of Electronics and Electrical Engineering at Aalto ELEC. Together with courses in circuit analysis theory, they give theoretical foundation for the further studies at Aalto ELEC. However, learning electromagnetics is very challenging (Leppävirta, Kettunen and Sihvola 2010). Teachers and professors seek new pedagogical methods to teach the very theoretical substance in a way that students can form conceptual understanding, and they are able to apply the theoretical knowledge into practical problem-solving tasks. One of the essential methods in teaching electromagnetics is to integrate possible practical solutions and examples to the theoretical substance. Such examples can be found, for instance, with mobile phones, antennas, or radar technology.

In the curriculum design process at Aalto ELEC, the importance of pedagogical approach and collective planning between different levels (School, departments, and teachers) has been emphasised. In addition, new pedagogical approaches in teaching have been launched. For instance, electrical voting systems (‘clickers’) have been used in teaching field theory courses. When the new programmes for Aalto ELEC were designed, the starting point was the substance. Physics and electromagnetic field theory teachers and professors examined the existing courses as a unity, and
designed new courses to respond the larger area of knowledge that students learn in their Degree. Very close collaboration will be completed between mechanics and circuit analysis courses for the first year students. The grades and phase of studies will be correlated between these two courses, and the success and learning of the students will be followed.

During the following years of study, feedback and other data will be collected on the adoption of the new, designed courses. In the future, it will be significant how the courses form an entity in the degree programmes. The role of the responsible professor will grow, and also the significance of the cross-scientific collaboration in the degree programme, and in-between them. In addition, even more thought-provoking it will be to analyse whether the entire comprehension of the students in this very difficult and theoretical field will increase.

REFERENCES

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Structure of the degree
Wide-ranging choices
Professional competencies
Options for mobility
Internationality
Bachelor’s degree in Engineering
Bachelor’s degree - structure

- Basic studies (65 - 70 ects)
  - Aalto-studies + mandatory language courses
  - Courses defined by the programme

- Major (60 - 65 ects)
  - Basic studies in major
  - Subject studies
  - Bachelor seminar and the thesis (10 ects)

- Minor (20 - 25 ects)
  - Students can choose their minor

- Optional studies (25 - 30 ects)
  - Further major or minor studies
  - Strengthening the minor (mobility)
  - Another minor or other study unit

Total of optional studies 50 ects
Curriculum design process

- Starting point for the process: the international TEE Teaching Evaluation Exercise at Aalto University in 2010-2011
- Curriculum design process changed into a more collaborative direction (between different degree programmes and ELEC departments) – continuum into Master’s programmes design – new programmes start in autumn 2015
- Learning outcomes and professional competencies taken into account in the course design process
Curriculum reform at Aalto ELEC

- New Bachelor programmes starting in autumn 2013
- Bologna process adapted – programme resources (teaching personnel, funding)
- New structure significant for students’ mobility
- Bachelor programmes in Finnish, Master’s programmes in English
- Four majors at Aalto ELEC
  Automation and Systems Technology
  Bioinformation Technology
  Electronics and Electrical Engineering
  Information Technology
- International minor (25 cr) available
Electromagnetic and physics courses in the new Bachelor degree

- Electricity and Magnetism (5 ects) and Mechanics (5 ects) mandatory for all ELEC Bachelor level students
- Field Theory (5 ects) for the students in Electronics and Electricity-major
- Hands-on-course Electrical engineering Workshop (8 ects) – theory, practice and motivation into the field with collaborative teams and hands-on-building (with Arduinos)
Electromagnetic and physics courses in the new Bachelor degree

• Hands-on-course Electrical engineering Workshop (8 ects) – theory, practice and motivation into the field in collaborative teams
• Teaching consists of hands-on-building (with Arduinos), project reports and writing, lectures, programming, mathematics
Thank you for your attention!

More information
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