Towards a blended approach to teach and supervise Electrical Engineering students

Dr. S.M. Gómez Puente, EE Education Policy Advisor
Prof. dr. ir. A.B. Smolders, EE Director of Studies
TU/e Electrical Engineering department

15-12-2015

Table of contents

1. Project title and applicants

Project title: *Towards a blended approach to teach and supervise Electrical Engineering students*

This proposal is submitted by the Electrical Engineering (EE) department at the Eindhoven University of Technology (TU/e). The main applicants are:

- Dr. Sonia M. Gómez Puente, EE Education Policy Advisor.
- Dr. ir. Marion Matters-Kammerer, EE responsible teacher *Terahertz systems* course
- prof.dr.ir. E.R. Fledderus, EE responsible teacher *Wireless communication* course
- prof. dr.ir. Peter Baltus, EE responsible teacher *RF Transceivers 2: design* course
- prof. ir. Ton Koonen, EE responsible teacher Intro Telecom
- dr. Oded Raz, EE responsible teacher Telecommunication systems

In consultation with prof. dr. ir. A.B. Smolders, EE Director of Studies.

2. Background and justification of the project

The Electrical Engineering (EE) department has experienced a rapid increase in the number of students in the last years. The students' differences in prior knowledge and sometimes in disciplines and background demands a tailored-made approach to supervise students in learning concepts and to have them apply in problem-solving exercises. Moreover, due to the large number of the students and differences in learning styles it becomes relevant to pay attention to individual needs and study progress both at the undergraduate and graduate courses. Supervision of learning and the provision of feedback for learning[1]-[2] are the two key elements we pursue to enhance in order to meet individual learning paths. In addition, we want to boost self-study time by involving students in meaningful assignments and providing just-in-time feedback. The integration of ICT tools will facilitate the process of making supervision and feedback efficient and tailored-made.

ICT tools can reinforce the power of giving feedback by:

- Focusing on individual needs;
- Supporting students to understand the concepts and applying them in solving problems exercises;
- Using digital tools (i.e. Oncourse) as learning analytics to monitor students' progress;
- Providing just-in-time feedback to the students;
- Providing feedforward and feed up to boost learning;
- Enhancing the quality of self-study time based on time-on-task.

[1] Hattie J. & Timperley, (2007). The Power of feedback. Review of Educational Research. DOI: 10.3102/003465430298487. *Vol. 77, No. 1, pp. 81–112*

[2] Kristina Edström, effectiveness of Teaching. Workshop, Dec. 2015.

Within this proposal, we will introduce Oncourse, as an online platform for supervision, feedback and assessment. Furthermore, we will explore the use of weblectures and screencasts as a form of enhancing the self-study time.

In addition to this and regarding the master courses, the Electrical Engineering department has recently redeveloped the master study programs to enable students to *work independently on complex research and design projects with the ability to rethink existing concepts and develop new ones*[3]. The supervision of individual progress to achieve desired graduate profiles, e.g. research, industry and teaching, requires tailor-made feedback and supervision in the choices students make in the application of that knowledge and in research. New ways of supervising students such as *knowledge mapping*[4] allow students to monitor own progress and facilitate the supervision of choices based on engineering profiles, interest in career path, disciplines and background.

3. Objectives of the project

We aim at enhancing the learning process and study activities of the EE students at bachelor and master level by focusing on supervision and quality of feedback. We also aim at optimizing the learning process before, during and after the contact hours, and maximizing the study time.

The objectives of the project are to integrate forms of online supervision and feedback methods that allow to target the individual needs of the student. In particular, we will introduce:

- Diagnostic test: The diagnostic test is meant to provide the students with enough information about deficiencies and lacunas regarding prior knowledge. In this context, we also want to use diagnostic tests as a form of self-assessment to provide feedback on level of prior knowledge.
- Fed-up and forward functions of feedback.
    - Fed up: The first component of an effective feedback system involves establishing a clear purpose and linking this purpose to meaningful assignments (quality of self-study time and time-on-task).
    - Forward: In some courses we will use results of the assignments and assessment quizzes (formative assessment) to re-plan instruction and contact-hour time. As teachers look at students' work, whether from a checking-for-understanding task or a common formative assessment, it will be used to modify their teaching. Likewise, students will get additional assignments to practice to meet the required level.

[3] Education Guide 2015-2016- Electrical Engineering Graduate Program. Eindhoven University of Technology (TU/e).
[4] *"…Knowledge mapping is a process of surveying, associating items of information or knowledge, preferably visually, in such a way that the mapping itself also creates additional knowledge determining for example where the knowledge assets are, and how they flow in the system…"* Modified from Vail E. (1999) and Hylton A. (2002) In Ebener S., Knowledge Management and Sharing (KMS) World Health Organization http://www.who.int/kms/events/KMapping_SEbener.pdf

- Online tutorials: In some courses, we will include some questions in the practical and assessment quizzes as a form of short tutorials and/or explanations based on the mistakes made by the students. The students can type in again a new answer supported by the input of the tutorial.
- Formative feedback and assessment: weekly practice and test quizzes will provide both the student and the teachers with just-in-time information on the progress. This is meant to signalize where the student still need to improve.
- Maximizing self-study time: by providing assignments and problem-solving exercises both to apply the concepts and the newly-gained knowledge in the lectures. This will allow to flip-the-classroom and to focus on difficult staff in lectures and instructions.
- Having students to watch additional audio visual materiasl, such as weblectures and screencasts on specific topics before they do the homework. In this way, students will deepen into in parts of theory, concepts and content.

** Regarding the course *RF Transceivers 2 design*, the responsible teacher has developed online small team interactions in order to create digital content that also has spin-off for audio and video material. The development of this material took place during the CEE-EE project proposal *'Efficient Creation and Sharing of Educational Content via Internet Media'* (2014/2015). This material is now ready and suitable for use and dissemination. We want to further exploit this ICT tool and use it to enrich the self-study time. Students making mistakes in Oncourse exercises will have the opportunity to watch again the content explained during the interactive small-scale meetings. New exercises will be again provided to retest again the understanding and provide feedback on progress.

The selection of the different modes of feedback in the EE courses will be determined after conducting an analysis of the course context together with the teacher(s). This may have consequences for the redesign and/or adjustments in the organization and structure of some courses. The analysis of the courses will be based on the following:

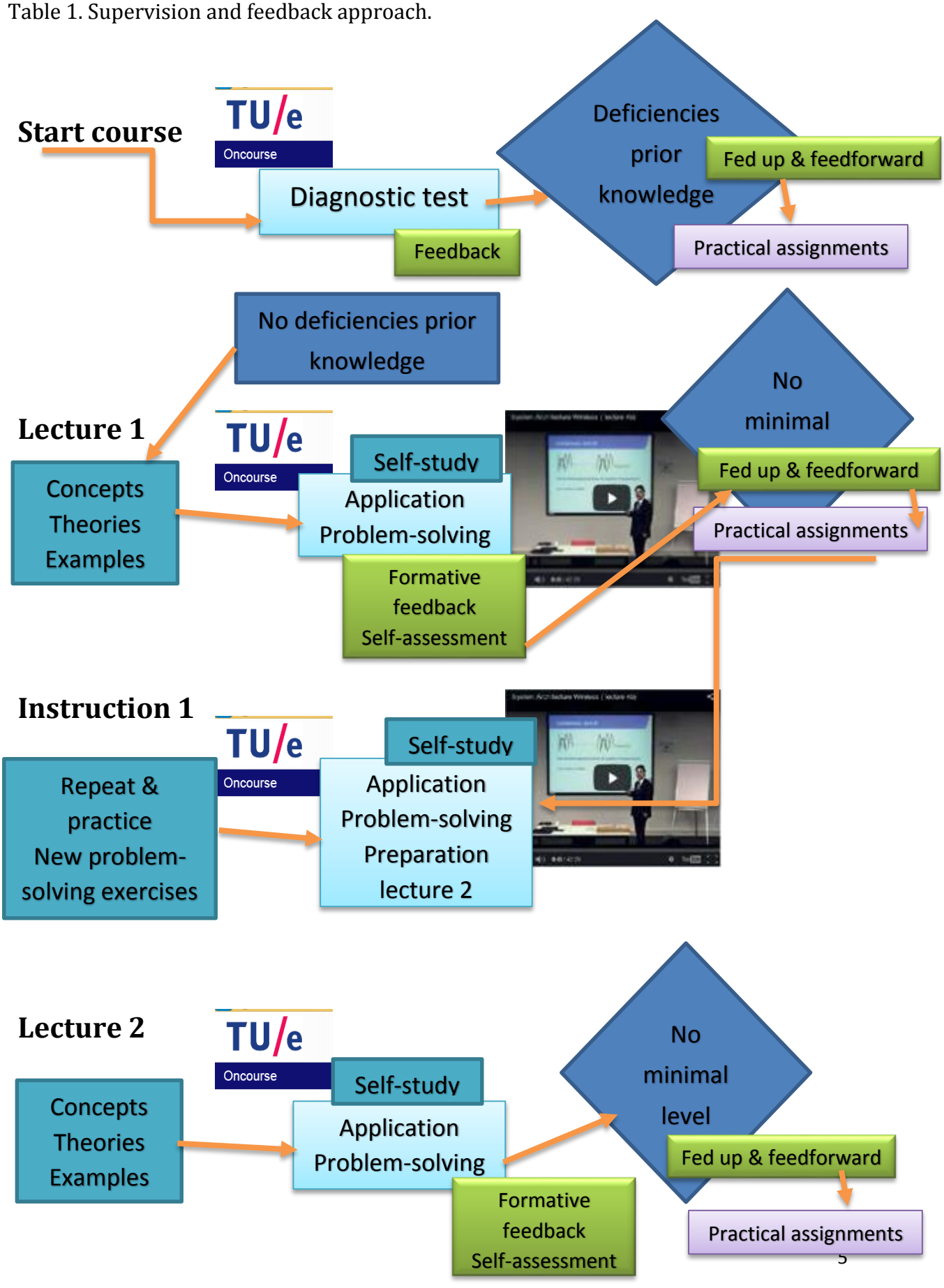
- Categories of learning outcomes;
- Required compulsory prior knowledge;
- Students' intake: EE students and/or from other disciplines;
- Assessment methods;
- Number of students;
- Organization of the course in slots (we will take into consideration the limitations).

Our approach to integrate online supervision and feedback will take place as follows (depending on the analysis of the course):

- Diagnostic test
    - ***Self-assessment/feedback*** on prior knowledge
    - ***Fed up and forward*** function
- Lecture
- Self-study time
    - Online practice and assessment quizzes: feedback on learning process and progress ***(Optimizing quality of self-study time/time-on-task);***
    - Fed up and forward function ***(enhancing students' activities);***
    - Weblectures/screencasts (for those courses in which these ICT tools are used) and having again students to apply their understanding in quizzes; ***(Optimizing quality of self-study time/time-on-task);***
    - Preparation of assignments for instructions/practical work;

- Instructions and/or lectures: in zooming on theories, concepts and/or explanations of examples ***(Improving quality of time and contact hours).***

Table 1. Supervision and feedback approach.



4. Expected outcomes of the project

The specific outcomes for each course will vary according to the feedback approach that we will introduce. In general, we expect to achieve the following outcomes in the courses:

- Identified and minimized deficiencies in prior knowledge;
- Limited number of students failing oral exams (due to just-in-time identification of limitations in prior knowledge);
- Applied correctly concepts in problem-solving practical exercises (in comparison to previous years);
- Teachers' satisfaction with students' progress and tests' results (due to formative feedback of weekly assignments);
- Students' satisfaction with quality of feedback they received on assignments and quizzes.
- Addressed individual needs;
- Increased attendance of instructions
- Self-study became more efficient due to meaningful assignments (difficult to measure);
- Collected a selection of feedback methods and 'good practices' that work. The lessons learned are to be disseminated among other teachers.

5. Project design and management

We provide in table 2 an overview of the project management and phases.

Table 2.

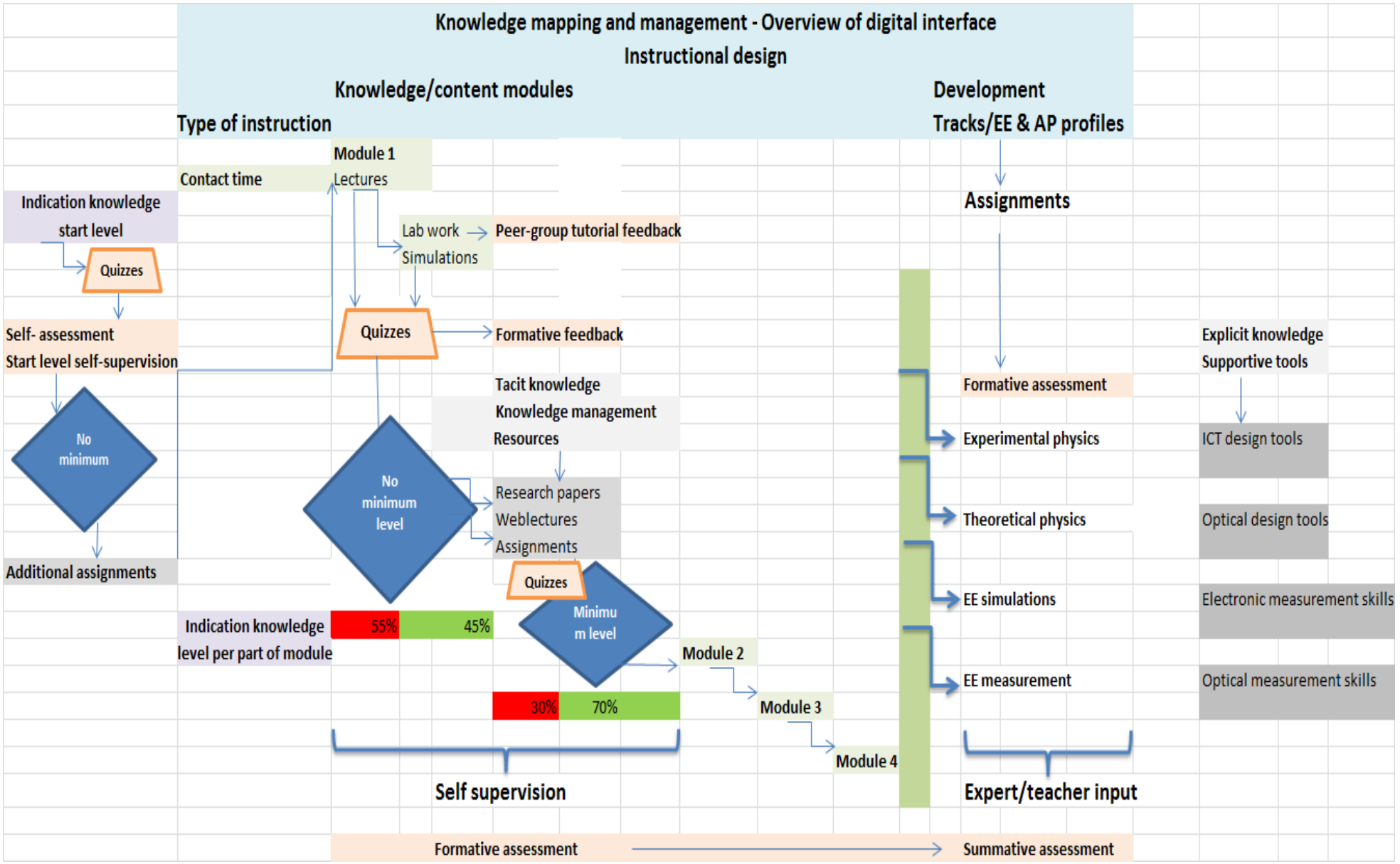
Project management and phases	**Time line**
Initial phase	
• Project organization & management (e.g. contact with ICT company, etc)	Jan., 2016
Project implementation	
Preparation of blended-learning materials	
• Implementation of workshops (weblectures, pencasts, Oncourse, other blended-learning tools, etc) for the courses: - *Terahertz systems (5LFB0)*	February-April, 2016
• Development of online supervision materials for *Terahertz systems*: - Identification of intake level (prior knowledge) – Advice feedback routes (forward & feed-up) - Development of EE & TN engineering profiles - Development of knowledge mapping modules - Development of online self-feedback quizzes - Development of peer feedback materials	February-April, 2016
• Development of Oncourse assignments for - *Terahertz systems (5LFB0)* - *Wireless communication (5LPA0)* - *RF Transceivers 2:design (5SFE0)* - *Intro Telecom (5ETA0)* - *Telecommunication systems (5XTA0)*	Jan.-March, 2016
Implementation of courses	
- *Terahertz systems (5LFB0)* - *Wireless communication (5LPA0)* - *RF Transceivers 2:design (5SFE0)* - *Intro Telecom (5ETA0)* - *Telecommunication systems (5XTA0)*	
Evaluation of results	July through October 2016
- *Terahertz systems – Q4*	
- *Wireless communication – Q2*	
- *RF Transceivers 2:design – Q3*	
- *Intro Telecom – Q3*	
- *Telecommunication systems – Q4*	
Dissemination	June through Dec., 2016
• Project presentation at annual conferences: 3TU CEE, SEFI • EE education day	
• Conference paper	Sept. through Dec., 2016
Final project report	December, 2016
• Report writing: final report for 3TU management	

Appendices

Appendix 1 – Description of the course *Terahertz* ***systems***

Course name/code	**Content & Learning outcomes**	**Innovative character of this project**
Terahertz systems (elective course EE/TN)	**Outcome of innovation:** • Entry level of from diverse EE/TN students is identified at an early stage. Tailor- self-supervision of acquisition of knowledge and skills of engineering profiles is enhanced; • Just-in-time feedback through online teaching modules and interface (e.g. content modules, self-feedback quizzes, logbooks, research papers, etc.) to supervise students to acquire engineering profiles (e.g. knowledge mapping modules) are developed. • Selected profiles can be chosen (e. g. specialization in the direction of measurement proficiency or simulation proficiency on top of the core profile of the Terahertz systems field).	**<u>New teaching methods:</u>** • Knowledge mapping modules to allow self-supervision and assessment on progress and development of engineering profiles • Teaching theory (prior knowledge) through weblectures/pencasts • Addressing deficiencies by identifying shortage of knowledge via Oncourse intake tests • Individual supervision of students by intake and progress online test • Individual supervision on gaining engineering profiles through knowledge mapping **<u>New tools:</u>** • Weblectures • Oncourse • Knowledge mapping
Educational & assessment form	Lectures (4 hours/week) Simulations, lab work & experiments **Assessment:** 1) Simulation assignment (20 %) 2) Experimental assignment (20 %) 3) Written/oral exam (60 %)	**<u>Application of existing educational methods in new context:</u>** **Supervision methods and techniques** (e.g. peer feedback/small tutoring group, results of Oncourse tests) applied to individual needs and tailor-made feedback on progress through modules including: • self-feedback online quizzes • Data bank: - Handbook; - Publications; - Logbook: outcomes of the measurements of experiments;

		- Online self-feedback questions - Links to other sub-modules (knowledge mapping) **Supervision takes place**: **<u>Intake:</u>** to identify deficiencies and give feedback to minimize shortage of prior knowledge **<u>Learning process</u>**: expert feedback & to self-provide feedback on engineering profiles and knowledge application by • Knowledge mapping technique • Peer feedback/small tutoring group sessions; logbooks;


Knowledge mapping and management - Overview of digital interface
Instructional design
Knowledge/content modules
Development
Type of instruction
Tracks/EE & AP profiles
Module 1
Contact time
Lectures
Assignments
Indication knowledge
start level
Lab work
Simulations
Peer-group tutorial feedback
Quizzes
Quizzes
Formative feedback
Explicit knowledge
Supportive tools
Self- assessment
Start level self-supervision
Tacit knowledge
Knowledge management
Resources
Formative assessment
No
minimum
No
minimum
level
Experimental physics
ICT design tools
Research papers
Weblectures
Assignments
Theoretical physics
Optical design tools
Additional assignments
Quizzes
Minimu
m level
EE simulations
Electronic measurement skills
Indication knowledge
level per part of module
55%
45%
Module 2
EE measurement
Optical measurement skills
30%
70%
Module 3
Module 4
Self supervision
Expert/teacher input
Formative assessment
Summative assessment

Appendix 2 – Description of the course *Wireless communication*

Course name/code	**Content & Learning outcomes**	**Innovative character of this project**
Wireless communication (5LPA0)	**Outcome of the innovation:** • Supervision of students' progress and feedback (weekly *Oncourse* quizzes).	**<u>New teaching methods:</u>** • Online self-feedback and assessment • Supervising progress **<u>New tools:</u>** • Oncourse online platform
Educational & assessment form	Lectures Assignments	**<u>Application of existing educational methods in new context:</u>** Supervision methods and techniques (e.g. Oncourse as a tool for self-monitoring and feedback; and overview of progress).

Appendix 3 – Description of the course *RF Transceivers 2: design*

Course name/code	**Content & Learning outcomes**	**Innovative character of this project**
RF Transceivers 2: design (5SFE0)	**Outcome of the innovation:** • Identified and minimized deficiencies in prior knowledge by developing diagnostic tests; • Addressing priorities to level the prior knowledge of students before making the oral exam (Carrousel); • Supervision of students' progress and self-feedback (weekly *Oncourse* quizzes). • Making more efficient the contact time by focusing on theory and examples, and by giving feedback on the assignments.	**<u>New teaching methods:</u>** • Diagnostic test to identify deficiencies • Online weekly and self-feedback and assessment **<u>New tools:</u>** • Oncourse online platform
Educational & assessment form	Lectures Assignments	**<u>Application of existing educational methods in new context:</u>** Supervision methods and techniques (e.g. Oncourse as a tool for self-monitoring and feedback; and overview of progress). By identifying deficiencies in prior knowledge at the beginning and providing guidance on additional exercises to manage the expected level, much time will be saved. The rationale behind is to address lack of knowledge before students go to the Carrousel to make an oral exam. This method will assure efficiency in supervision as students are aware of deficiencies in an early stadium.

Appendix 4 – Description of the course *Intro Telecom*

Course name/code	Content & Learning outcomes	Innovative character of this project
Intro Telecom (5ETA0)	**Outcome of the innovation:** Integrating online Oncourse assignments as a mean to: ○ make self-study more efficient ○ raise presence during the instructions by providing feedback on homework, and activating students; ○ pay attention to individual learning problems as many assignments will be made available to practice;	**<u>New teaching methods:</u>** **<u>Intro Telecom is a course which uses a rather traditional way of teaching</u>** • Diagnostic test to identify deficiencies • Online weekly and self-feedback and assessment **<u>New tools:</u>** • Oncourse online platform
Educational & assessment form	Lectures Instructions	**<u>Application of existing educational methods in new context:</u>**

Appendix 5 – Description of the course *Telecommunication systems*

Course name/code	Content & Learning outcomes	Innovative character of this project
Telecommunication systems (5LL91)	**Outcome of the innovation:** Integrating online Oncourse assignments as a mean to: ○ learn students concepts; ○ have concepts to be applied in practical exercises; ○ provide feedback on progress; ○ use feedback to improve face-to-face instruction time by recalling concepts which are not yet been learned.	**<u>New teaching methods:</u>** • Diagnostic test to identify deficiencies • Online weekly and self-feedback and assessment **<u>New tools:</u>** • Oncourse online platform
Educational & assessment form	Lectures Assignments	**<u>Application of existing educational methods in new context</u>**