Course Analysis EQ2411 Advanced Digital Communications

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Course Data

Course name	Advanced Digital Communications					
Course code Credits	EQ2411 7.5 cu					
Prerequisites	EQ2310 Digital Communications					
Term	VT 2021, period 3					
Participation	4 registered students (0 women) Targeted groups of students: TINNM1, TINNM1-COE, TIVNM2- DMTE					
Teachers	Ragnar Thobaben (course responsibility and lectures) Email: ragnart@kth.se Phone: +46 8 790 8452					
	Baptiste Cavarec (TA at the tutorials) Email: cavarec@kth.se					
Lectures Tutorials	12 lectures, 2h per lecture 12 tutorials, 2h per tutorial					
Examination	Continuous examination and written exam reported as INL1 and TENT					
Examination rate	3 of 4 students passed the course					

General Information

Background The course Advanced Digital Communications has been given once per year since 2001 by teachers from the Signal Processing Lab and the Communication Theory Lab at the School of Electrical Engineering at KTH. Between VT-2008 and VT-2014, R. Thobaben has been the responsible teacher for the course. Between VT-2015 and VT-2017 Ming Xiao has given the course. Since VT-2018, R. Thobaben is again course responsible. The course has been redesigned in VT-2018 and is now given as a flipped class room course. The course has not been offered in VT-2020 due to sick leave of L. Kildehøj Rasmussen, who was planned to teach the course in that period.

Students The course targets students from the Information and Network Engineering Master's Programme (mandatory for students with specialization in communication engineering; otherwise optional but recommended) and the ICT Innovation Master's Programme (optional).

Goals This course aims at introducing advanced topics in digital communications and provides students with up-to-date knowledge of the techniques used in modern communication systems and the principles underlying their design. The teaching an learning outcomes are defined as follows:

After passing the course the student should be able

- 1. use mathematical models for describing advanced communication channels and systems such as communication systems with dispersion, interference, multiple users, multipath propagation, multiple carriers and multiple antennas
- 2. use mathematical models for characterising properties for advanced communication channels and systems and identify properties that limit the communication
- 3. explain basic principles and concepts behind advanced communication technologies such as multi carrier modulation, advanced channel coding with iterative decoding, encoding, detection in multi antenna systems and equalisation and encoding and detection in multiuser systems
- 4. summarise advantages and disadvantages with different advanced communication technologies and be able to discuss their optimality and complexity
- 5. choose and optimise design parameters (e.g., power distribution, modulation, redundancy, speed) in advanced communication technologies to adapt them to a given channel model and given requirements
- 6. for a given combination of channel model and communication technique use mathematical models for analysing the expected performance (e.g., error probabilities, speed) and compare the performance for different solutions.

Lecture and Tutorial Format The course is offered as a flipped classroom course. Eight of the 12 lectures are available online as video lectures, and the corresponding meetings in class are used to deepen the understanding and work more interactively with the students. To achieve this, preparation quizzes are offered in Canvas that students complete before coming to class and form one basis for the learning activities in class. The remaining four lectures are currently taught in a classical format with power point lecture material. During the tutorials, the TA demonstrates the solutions of relevant problems. We ask the students for every other tutorial to prepare the solutions in advance. Due to the pandemic, the course was completely offered in Zoom.

Main Textbook Fundamentals of Digital Communications, Upamanyu Madhow, 2008.

Examination In this course round, the examination in the course is changed to a continuous examination format, complemented with a 5h written exam. The continuous examination consists of:

- Oral Presentation (OP): The oral presentation is linked to Course Goals 3 and 4, graded with a pass/fail grade, and reported as INL1.
- Homework Assignment 1, 2, and 3 (HW1-3): The homework assignments are linked to the Course Goals 1, 2, 5, and 6 and graded with grades C, E, and F, reported as part of TENT.

The written exam (WE) links to the Course Goals 1, 2, 5, and 6, consists of three exam problems comparable to earlier exam problems, and is graded with grades A, C, or F. Since the written exam was also conducted as an online exam due to the ongoing pandemic, the three problems were released one-by-one on a predefined schedule giving the students 75 min per problem to solve the problems and upload the solutions, and a 15-min break between the problems.

The grades from the oral presentation and the homework assignments are reported together with the grade from the written exam in TENT as specified in Table 1.

Table 1: Composition of the grade for TENT from the oral presentation, and homework grades.

Grade A	Exam passed with A							
	HW1-3 all passed with C							
	-							
	Exam passed with A	Exam passed with C						
Grade B	HW1-3 passed but only two with	HW1-3 all passed with C						
Grade C	Exam passed with C							
	HW1-3 passed and at least two with C							
Grade D	Exam passed with C	Exam failed or not attended						
	HW1-3 passed and at least one	HW1-3 passed and at least two						
	with C	with C						
Grade E	All homework assignments passed and at most one with C							
Grade Fx	One homework assignment with F							
Grade F	Two or more homework assignments with grade F							

Student Performance in VT21 Table 2 shows the distribution of final grades in VT21 (aggregated results from the first exam and re-exam) and the grades from VT18, VT19, and VT21 for comparison. Unfortunately, only one student attended the written exam, however without passing, which explains why only grades D and E are acquired by students. This is consistent with earlier exams that were based on a 5h 5-problems exam.

Table 2: Distribution of final grades in VT18, VT19, and VT21.

	А	В	C	D	Е	$\mathbf{F}\mathbf{x}$	F
VT21	0	0	0	2	1	-	-
VT19	0	0	2	1	2	-	-
VT18	1	0	1	4	1	-	-

Course Development

The main course design (i.e., video lectures, preparation quizzes, class-room material) was kept as is in this course round, and the addition of the continuous examination was the main design effort in this period. The voluntary student projects from previous years were the basis for the three homework projects of continuous examination, and a video presentation was added.

Course Evaluation

Due to the low number of students in the course, and consequently, the low number of responses, the students' responses to the learning experience questionnaire are not available to the course responsible for analysis.

Personal Reflection

The challenges in this course round were mainly due to the online format due to the ongoing pandemic and due to the generally low number of students, which clearly impacted the interaction with the students and the quality of discussion in the "class-room" sessions. That is, the sessions, even though designed for interaction and open discussions, were to a large degree centered around the teacher. When introducing the continuous examination, we reused the design that was successfully developed in the course EQ2310 Digital Communications, and re-used existing material from the voluntary student projects as a starting point for the homework projects. The advantage was that the students already were familiar with the format, and the overall design of the examination received a lot of positive feedback in EQ2310. Unfortunately, only one student attempted the written exam and failed, which lead to grades being concentrated at D and E. Due to the lack of student feedback, it is difficult to draw additional conclusions; however, based on discussions in the meetings, my conclusion is that the students appreciate the overall format and the depth of the course but also criticise the large volume of material and concepts that are covered in the course. This is consistent with student feedback from previous years.

Conclusions and Next Steps

Due to the lack of student feedback and the major impact of the online format on the course activities, it is difficult to draw any conclusions on how the course can be developed further at this point in time. However, from the positive experience of introducing continuous examination in the course EQ2310 Digital Communications, the questions arise which of the two concepts continuous examination and flipped classroom is better suited to activate the students and make them engage with the course material, and which is the right approach to combine these concepts. We hope that future course rounds will give better insights into this.