Course Analysis
EQ2411 Advanced Digital Communications

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Course Data

Course name	**Advanced Digital Communications**
Course code	EQ2411
Credits	7.5 cu
Prerequisites	EQ2310 Digital Communications
Term	**VT 2022, period 3**
Participation	7 registered students (3 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 **Samie Mostafavi** (TA at the tutorials) Email: `ssmos@kth.se`
Lectures	12 lectures, 2h per lecture
Tutorials	12 tutorials, 2h per tutorial
Examination	Continuous examination and written exam reported as INL1 and TENT
Examination rate	7 of 7 students (3 of 3 women) 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.

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 multi-user 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. While the previous course round was offered online in Zoom, the course is back in class for this course round.

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

Examination The examination in the course is based on a continuous examination format, complemented with a 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, graded with grades C, E, and F, and 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. To eliminate time pressure, students are given 5 hours to solve the three 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	
Grade B	Exam passed with A HW1-3 passed but only two with C	Exam passed with C 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 HW1-3 passed and at least one with C	Exam failed or not attended HW1-3 passed and at least two 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 VT22 Table 2 shows the distribution of final grades in VT22 (aggregated results from the first exam and re-exam) and the grades from VT18–21 for comparison[1]. Compared to previous years, we can observe that the grades have improved notably, which is due to the fact that a larger number of students (3 of 7) successfully attended the written exam.

Table 2: Distribution of final grades in VT18 – VT22.

	A	B	C	D	E	Fx	F
VT22	1	1	1	4	0	-	-
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) and the continuous examination were kept as in the previous course round. A minor effort was put on improving the homework projects.

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.

[1]Note: The course was not offered in VT2020.

Personal Reflection

The course significantly benefited from being brought back into the classroom. The classroom meetings had many interesting discussions and were very enjoyable from a teacher's perspective. However, the classroom meetings often strongly relied on individual students who are willing to engage in the discussion and dare to ask questions, which helps other students to chime in once the discussions were rolling. From the grades we can observe that the students were more engaged with the course. All students scored well on the continuous examination (i.e., they tried to maximise the grades). This can be seen from grade D being the lowest grade in this course round. Four out of seven students attended the written exam, of which three students passed the written exam successfully. As in the previous course round, 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. No information is available that allows for any conclusions on the students' time spent on the course.

Conclusions and Next Steps

Due to the lack of student feedback, it is difficult to draw any conclusions on how the course can be developed further at this point in time. It appears that the continuous examination is working well, whereas the classroom activities rely on students becoming active. This year there were always 1-2 students who were very active in the discussions which made it easy for other students to chime in as the discussions were unfolding; however, it also becomes clear that the students tend to try to maximise their outcome in the continuous examination suggesting that the continuous examination has a much stronger steering power in terms of directing the learning efforts of the students compared to the classroom activities in this course.