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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 2023, period 3**
Participation	6 registered students (2 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	6 of 6 students (2 of 2 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

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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.

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 VT23   Table 2 shows the distribution of final grades in VT23 (aggregated results from the first exam and re-exam) and the grades from VT18–22 for comparison[1]. Similar to previous years, we can observe that most students perform well on the continuous examination (i.e., four students acquire grade D, which is the highest grade without passing the written exam); however, only one student chose to attend the written exam and reached the highest grade A. This is a lower number compared to previous years.

Table 2: Distribution of final grades in VT18 – VT23.

	A	B	C	D	E	Fx	F
VT23	1	0	0	4	1	-	-
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.

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.

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

Personal Reflection

Teaching this course in this course round was more challenging than in previous years. Even though the number of students attending the course was similar to previous course rounds, students more often chose to study on their own (e.g., since there were collisions with other courses) and the few students that came to class did not engage as much in the discussions as usual. A possible reason for this is the lack of diversity in the student group that attended the meetings in class, which in my experience can limit the productivity of interactive discussion-based learning activities. This lead to many situations where I had to resolve to explaining and lecturing instead of getting to the same outcome interactively via discussions, which is a quite different teaching experience compared to earlier course rounds. This lack of engagement is also visible in the grades; most students tried to maximise their outcome in the continuous examination (i.e., grade D) and only one student attended the written exam resulting in grade A. Finally, in general discussions with students from the programme students point out that the learning strategies have changed since the introduction of continuous examination in 2021. Students confirm that during the lecture period, students concentrate on courses with continuous examination, whereas during the exam period, the students focus on courses with conventional exams. This new strategy seems to explain why only few students choose to attend the written exam in this and previous course rounds.

Conclusions and Next Steps

As in the previous years, due to the lack of student feedback beyond undocumented discussions in the classroom, it remains difficult to draw any conclusions on how the course can be developed. It has however become clear during the last 2-3 course rounds that the students engage more in continuous examination and try to maximise their outcome there, and engage less in the class-room activities. The class-room activities suffer additionally from the low number of students and rely on individual students who are eager to engage in the discussions. Also, the volume of the covered material remains a challenge as repeatedly pointed out in earlier course evaluations. This suggests a few changes that should be investigated in the coming course rounds:

1. A revision of the course content: Which concepts are essential for professionals in the field, which concepts should be treated in more detail, and which concepts are outdated?

2. A revision of the course design: how can the steering power of the continuous examination be utilised to create more engagement in classroom and potentially replace current classroom activities, and (how) should continuous examination be expanded to eventually remove the written exam?