

Course analysis for FIK3510 Multiple Antenna Communications

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Course Design

The course is designed to cover the fundamental theory for how antenna arrays are utilized to achieve efficient wireless communication systems, in particular, to achieve higher data rates, serve more user devices, increase reliability, and achieve higher energy efficiency. The theory is conveyed in a series of 15 lectures, with prerecorded theory descriptions in video format (available in KTH Play and YouTube) and live examples. The students are practicing applying the theory by solving mathematical homework problems, implementing basic methods in two lab exercises, and writing an exam that focuses on the basics. The homework problems were discussed in weekly online meetings (before the submission deadline) and the solutions were then discussed in seminars (after the submission deadline). The teaching was developed to be given during the pandemic and only featured online meetings.

The course has its roots in a second-cycle course at Linköping University, but has been extended for third-cycle students by requiring a deeper understanding of the fundamentals and by covering a few additional parts of the textbook.

The Students' Workload

Among the 8 students that participated in the course evaluation, 75% believed that the workload was in line with the number of course credits, whereof 25% believed that the workload was too high. The free-text comments from the students revealed two reasons for the latter comment. Firstly, a few students believed that the pace of the course was too high since all the lecturing was squeezed into one quarter. Secondly, some of the homework problems were more time-consuming than others and required a deep understanding of probability theory.

Both issues were identified during the course and the preliminary solutions were to extend several deadlines, allowing students to finalize some tasks after the summer break, and to clarify that the expectation for passing the course was to solve at least 66% of the homework problems correctly. Hence, it was fully acceptable to not submit any solutions to the most challenging problems. Each student was only asked to present solutions on the homework seminars that he/she had actually solved correctly or almost correctly.

The Students' Results

All the 11 registered KTH students passed the course (100%). Five doctoral students at Linköping also attended the course and they also passed.

Overall Impression Of The Learning Environment

To obtain input from students at both universities, the questionnaire was inspired by questions that are commonly asked at the respective universities, but none of the university systems were

utilized to gather the answers. The questionnaire asked the students to rank the following statements:

- The teaching activities of the course gave me the opportunity to achieve the learning outcomes of the course.
- The components of the course that were subject to grading were relevant to the learning outcomes of the course.
- Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?
- My study during the course has functioned well considering the consequence of the Covid-19 pandemic (hybrid mode)
- What is your overall evaluation of the course?

The outcome of all these questions was that 87.5% (7 students) answered 5 out of 5, while 12.5% (1 student) answered 4 out of 5. Moreover, everyone answered no to the following question: “The university works actively to counter all forms of discrimination, harassment, victimisation and exclusion. Have you seen or witnessed any problems during the course with respect to this?”

In the free-text answers, several students pointed out that the lecture videos were of high quality and that the course books were well written. The structure with organized discussions around homework problems (before the submission deadline) was appreciated. It was also appreciated that the examples that were given in the lectures were written into a OneNote document that was then shared with the students, so there was no need to make personal notes during the lectures. The overall impression was very positive.

Analysis Of The Learning Environment

The course was generally well appreciated, but the workload became too high for some students since 1) a few of the homework problems were too complicated and 2) the lecturing was given jointly with a second-cycle course at Linköping University. The latter required the lecturing to finish within 2 months. These issues can be resolved in the next edition of the course by:

- Reducing the number of homework problems per homework set and reformulating some of them to give clearer hints in the right direction.
- Decoupling the course from the second-cycle course, as the lecturer will no longer be having dual affiliations.

Answers To Open Questions

Two students brought up how solutions to the homework problems were delivered. There exist written solutions to all problems, but these are purposely not shared with the students in written form but instead shared at the seminars where the problems are discussed. Due to the high pace, these seminars were delayed to give room for other activities in the student’s schedule. In the next edition, the course schedule will be stretched so that there is a clearer structure with lectures, followed by homework problems, and then seminars discussing those homework problems.

Priority in Course Development

Although most students agreed that the work required to pass the course was in line with the number of credits, a priority is to slightly reduce the workload per week by:

- 1) Give the course over a longer time period (i.e., starting earlier during the semester);
- 2) Remove the homework problems that focused more on statistics than communications;
- 3) Revise problem formulations in a few homework problems to avoid misunderstandings (this has already been done during the course).

After the lecturing was finished in the spring, a few of the lecture videos have been edited and further background videos have been prepared to be available the next time the course is given.