

Course Analysis

EQ2411 Advanced Digital Communications

Ragnar Thobaben, ISE, EECS, KTH

Course Data

Course name	Advanced Digital Communications
Course code	EQ2411
Credits	7.5 cu
Prerequisites	EQ2310 Digital Communications
Term	VT 2019, period 3
Participation	5 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 Sahar Imtiaz (TA at the tutorials) Email: sahari@kth.se
Lectures	12 lectures, 2h per lecture
Tutorials	12 tutorials, 2h per tutorial
Examination	Written exam, 5h
Examination rate	5 of 5 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 and learning outcomes are defined as follows:

In order to pass the course, the students should be able to

- Describe the limiting effects in digital communication systems.
- Explain the basic principles of the transmission techniques.

- Apply the learned transmission techniques to standard problems in digital communications and to evaluate their performance in an analytical/mathematical way.

In order to acquire a higher grade, the students should also be able to

- Apply the learned transmission techniques to new and advanced problems, to adapt them appropriately, and to evaluate their performance under these new conditions analytically.
- Combine different techniques and perform an analysis in an analytical/mathematical fashion.

Lecture and Tutorial Format In the previous course round, the course has been redesigned, and it is now 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. 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.

Homework Projects Three voluntary homework projects are offered that allow the students to obtain bonus points on the exam. The projects are hands-on and combine simple matlab implementation tasks with analytical methods. The projects are partly solved in group work.

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

Examination Written exam (5h) consisting of five problems, each of which can give a maximum of 5 points. Up to 4 bonus points can be obtained from the voluntary homework projects. In order to pass the exam with grade E or better, both of the following two criteria have to be fulfilled:

- More than 11 (eleven) credits have to be obtained (including the bonus from the homework projects).
- 4 (four) out of 5 (five) exam problems have to be passed with 2 (two) or more credits.

This year, all 5 students passed the course.

Course Development

Since the course has been substantially redesigned in the previous course round, course development has mainly focused on improving the class-room material and simplifying the project assignments. Especially the project assignments have been criticized in the previous course round since students found them to be too time consuming and difficult and felt unsupported.

Course Evaluation

The course was evaluated using the online system provided by KTH social. The course evaluation was anonymous and based on the standard learning experience questionnaire used at KTH. The answers were submitted after the final exam. **4 of 5 students participated in the course evaluation.**

Summary Generally, the answers to the questions in the course evaluation were very positive. All students gave positive or at least neutral marks. For example, the students felt that they worked with interesting issues, the course was challenging in a stimulating way, understanding of key concepts had high priority, they were able to practice and receive feedback without being graded, they were able to learn by collaborating and discussing with others, the course activities enabled them to learn in different ways, they were able to learn from concrete examples that they could relate to, they were able to get support if they needed it, and the assessment on the course was fair and honest.

Criticism Overall the students perceive the course as very well organized and interesting but demanding. The comments provided by the students also show that not all students managed to learn and understand all concepts in the class-room session. In this case, the tutorial sessions apparently were able to resolved the issues and to clarify misunderstandings. In other comments, the students also criticize that the content of the course is too dense and that the video lectures are dense, fast and time consuming and suggest to add additional lectures and to focus more on key concepts.

Workload The course credits of 7.5 hp translate into an expected full-time workload of 5 weeks and an average workload of roughly 22 hours per week over a 9-week period. The responses by the students show that the students stayed below the expected workload, and in one case only half of the expected time is spent.

Personal Reflection

As in previous course rounds, the biggest challenge in the course is coverage of topics. Even though many concepts are related and reoccur (in fact, many topics can be seen as a special case or application of basic signal space and optimal detection concepts), students do not necessarily see these connections immediately. In the classroom sessions we have worked hard to highlight the connections and relate the topics back to basic communication course, but still more can be done as it seems from the comments. In this course round, we have also continuously worked on emphasizing the relevance of the topics for 4G-5G systems, which has been well appreciated by the students and was a point of criticism in previous years. The homework projects were a disappointment this year. Even though the instructions were clarified and time-consuming parts were removed, the students did not succeed in solving the projects and gave up after the first project. This is still surprising since students in 2011 and the following years never complained about the projects and solved them without a problem. All in all, we enjoyed teaching the course in this course round since the positive atmosphere that is documented in the course evaluation and the low number of students enabled us to respond to the needs of the students and triggered interesting discussions during the classroom sessions.

Conclusions and Next Steps

We conclude that even though this course round has been a success, the course can be improved in the following way: The classroom material can be improved to better emphasize on key concepts, to show connections across the different topics, and to provide additional examples. The homework projects need to be revised further (e.g., by adding additional explanations) in order to provide useful learning activities to the students.

EQ2411 - 2019-04-01

Respondents: 5
 Answer Count: 4
 Answer Frequency: 80.00 %

ESTIMATED WORKLOAD

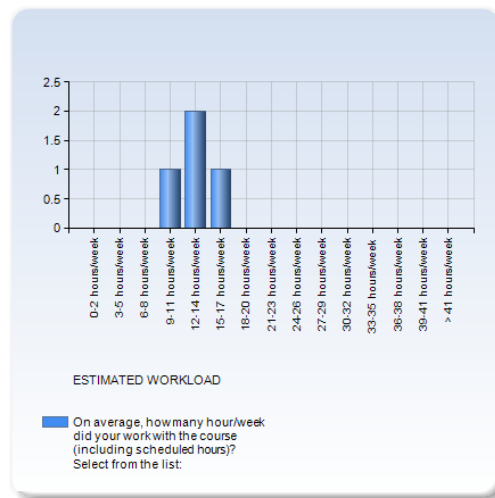
On average, how many hour/week did your work with the course (including scheduled hours)?

Select from the list:

ESTIMATED WORKLOAD

On average, how many hour/week did your work with the course (including scheduled hours)?

Select from the list:	Number of Responses
0-2 hours/week	0 (0.0%)
3-5 hours/week	0 (0.0%)
6-8 hours/week	0 (0.0%)
9-11 hours/week	1 (25.0%)
12-14 hours/week	2 (50.0%)
15-17 hours/week	1 (25.0%)
18-20 hours/week	0 (0.0%)
21-23 hours/week	0 (0.0%)
24-26 hours/week	0 (0.0%)
27-29 hours/week	0 (0.0%)
30-32 hours/week	0 (0.0%)
33-35 hours/week	0 (0.0%)
36-38 hours/week	0 (0.0%)
39-41 hours/week	0 (0.0%)
> 41 hours/week	0 (0.0%)
Total	4 (100.0%)



<u>ESTIMATED WORKLOAD</u>	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
On average, how many hour/week did your work with the course (including scheduled hours)?								
Select from the list:	5.0	0.8	16.3 %	4.0	4.5	5.0	5.5	6.0

Please comment on the course from this perspective:

Spot on

The hours spent on this course is slightly more than the other courses because we had to watch video lectures before the classroom session. Apart from that we had the tutorials too. I think the classroom session can be more organised to be a good investment of time spent. The video lectures helped a lot with the understanding of concepts, but they also took a lot of time to watch. That was because every lecture was very dense and I had to rewatch many parts in order to get a gist.

ESTIMATED WORKLOAD

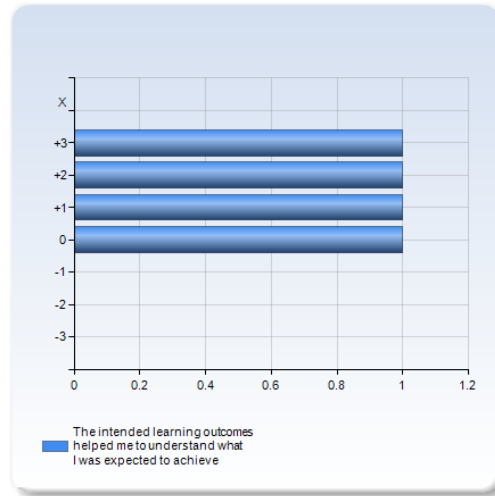
On average, how many hour/week did your work with the course (including scheduled hours)?

Select from the list:

- 5
- 6
- 5
- 4

The intended learning outcomes helped me to understand what I was expected to achieve

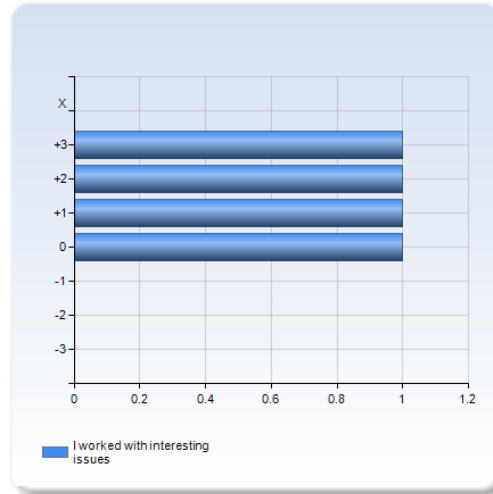
The intended learning outcomes helped me to understand what I was expected to achieve	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	1 (25.0%)	1 (25.0%)
+1	1 (25.0%)	2 (50.0%)
+2	1 (25.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The intended learning outcomes helped me to understand what I was expected to achieve	5.5	1.3	23.5 %	4.0	4.5	5.5	6.5	7.0

I worked with interesting issues

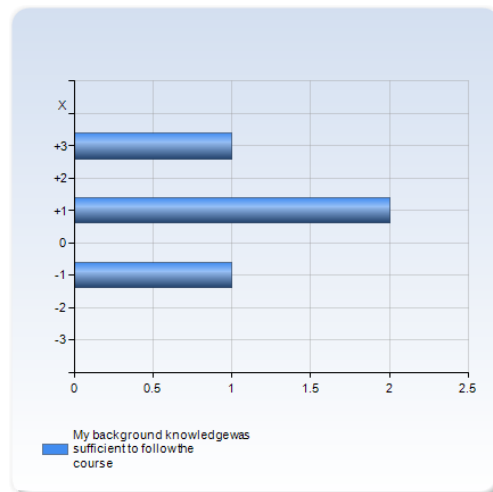
I worked with interesting issues	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	1 (25.0%)	1 (25.0%)
+1	1 (25.0%)	2 (50.0%)
+2	1 (25.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I worked with interesting issues	5.5	1.3	23.5 %	4.0	4.5	5.5	6.5	7.0

My background knowledge was sufficient to follow the course

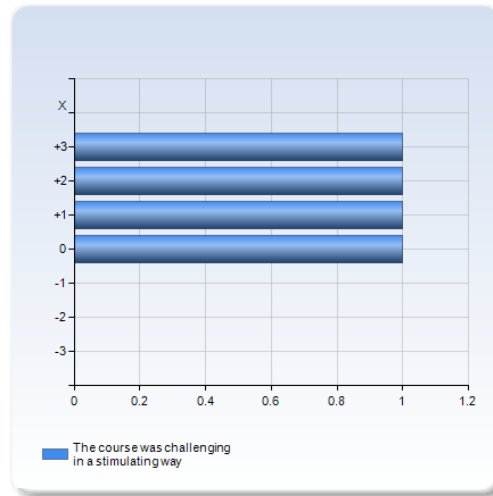
My background knowledge was sufficient to follow the course	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	1 (25.0%)	1 (25.0%)
0	0 (0.0%)	1 (25.0%)
+1	2 (50.0%)	3 (75.0%)
+2	0 (0.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
My background knowledge was sufficient to follow the course	5.0	1.6	32.7 %	3.0	4.0	5.0	6.0	7.0

The course was challenging in a stimulating way

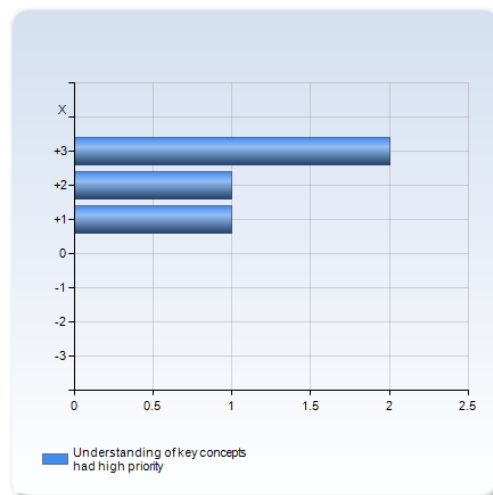
The course was challenging in a stimulating way	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	1 (25.0%)	1 (25.0%)
+1	1 (25.0%)	2 (50.0%)
+2	1 (25.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The course was challenging in a stimulating way	5.5	1.3	23.5 %	4.0	4.5	5.5	6.5	7.0

Understanding of key concepts had high priority

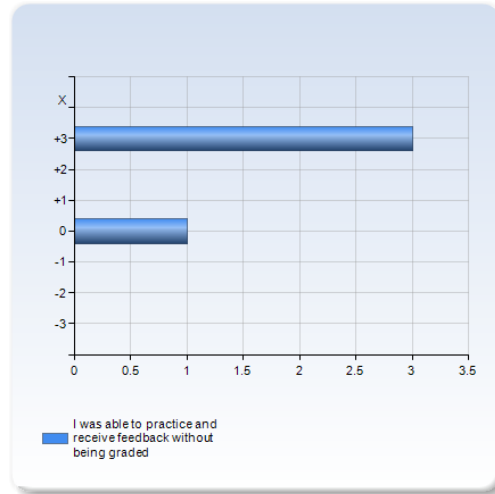
Understanding of key concepts had high priority	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	0 (0.0%)	0 (0.0%)
+1	1 (25.0%)	1 (25.0%)
+2	1 (25.0%)	2 (50.0%)
+3	2 (50.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
Understanding of key concepts had high priority	6.3	1.0	15.3 %	5.0	5.5	6.5	7.0	7.0

I was able to practice and receive feedback without being graded

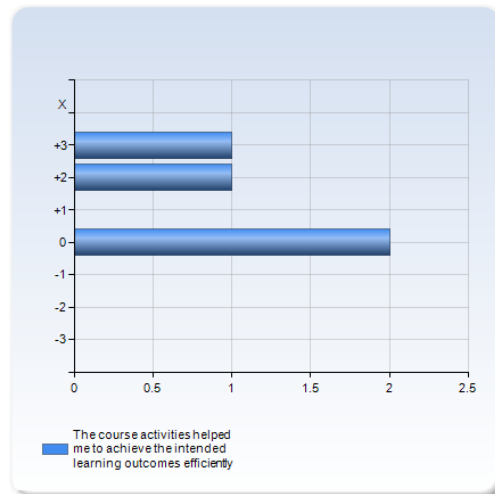
I was able to practice and receive feedback without being graded	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	1 (25.0%)	1 (25.0%)
+1	0 (0.0%)	1 (25.0%)
+2	0 (0.0%)	1 (25.0%)
+3	3 (75.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I was able to practice and receive feedback without being graded	6.3	1.5	24.0 %	4.0	5.5	7.0	7.0	7.0

The course activities helped me to achieve the intended learning outcomes efficiently

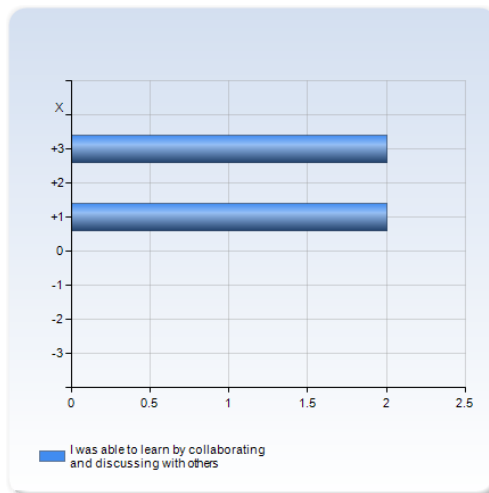
The course activities helped me to achieve the intended learning outcomes efficiently	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	2 (50.0%)	2 (50.0%)
+1	0 (0.0%)	2 (50.0%)
+2	1 (25.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The course activities helped me to achieve the intended learning outcomes efficiently	5.3	1.5	28.6 %	4.0	4.0	5.0	6.5	7.0

I was able to learn by collaborating and discussing with others

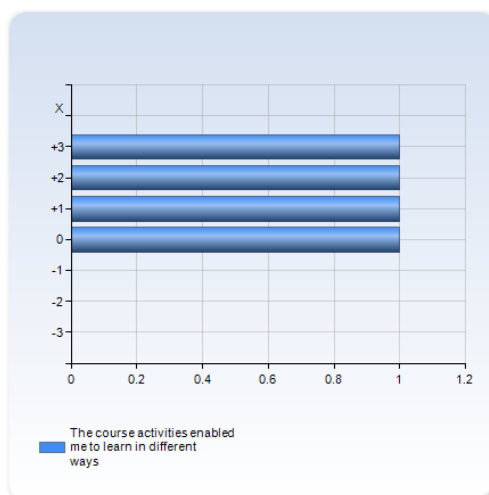
I was able to learn by collaborating and discussing with others	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	0 (0.0%)	0 (0.0%)
+1	2 (50.0%)	2 (50.0%)
+2	0 (0.0%)	2 (50.0%)
+3	2 (50.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I was able to learn by collaborating and discussing with others	6.0	1.2	19.2 %	5.0	5.0	6.0	7.0	7.0

The course activities enabled me to learn in different ways

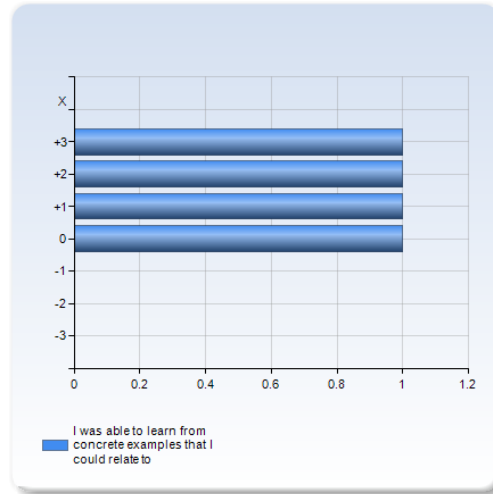
The course activities enabled me to learn in different ways	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	1 (25.0%)	1 (25.0%)
+1	1 (25.0%)	2 (50.0%)
+2	1 (25.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The course activities enabled me to learn in different ways	5.5	1.3	23.5 %	4.0	4.5	5.5	6.5	7.0

I was able to learn from concrete examples that I could relate to

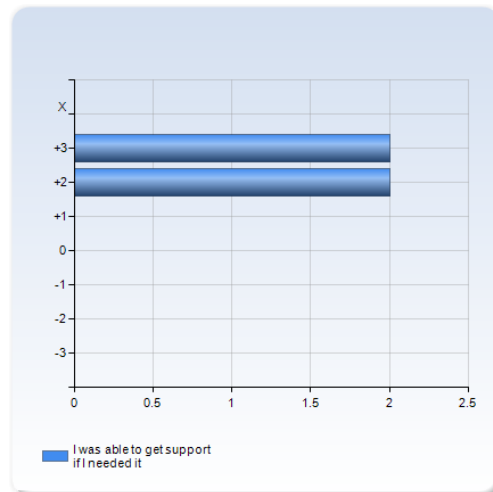
I was able to learn from concrete examples that I could relate to	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	1 (25.0%)	1 (25.0%)
+1	1 (25.0%)	2 (50.0%)
+2	1 (25.0%)	3 (75.0%)
+3	1 (25.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I was able to learn from concrete examples that I could relate to	5.5	1.3	23.5 %	4.0	4.5	5.5	6.5	7.0

I was able to get support if I needed it

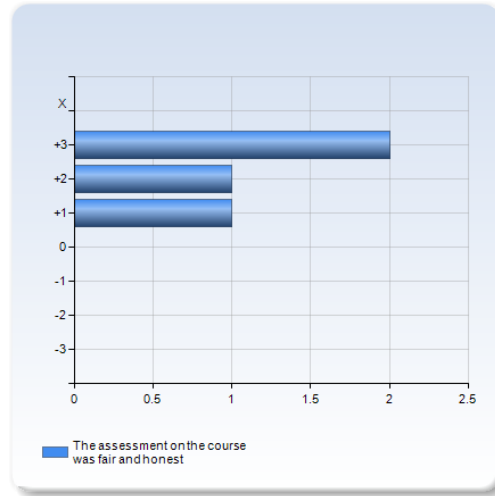
I was able to get support if I needed it	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	0 (0.0%)	0 (0.0%)
+1	0 (0.0%)	0 (0.0%)
+2	2 (50.0%)	2 (50.0%)
+3	2 (50.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I was able to get support if I needed it	6.5	0.6	8.9 %	6.0	6.0	6.5	7.0	7.0

The assessment on the course was fair and honest

The assessment on the course was fair and honest	Number of Responses	Cumulated Responses
-3	0 (0.0%)	0 (0.0%)
-2	0 (0.0%)	0 (0.0%)
-1	0 (0.0%)	0 (0.0%)
0	0 (0.0%)	0 (0.0%)
+1	1 (25.0%)	1 (25.0%)
+2	1 (25.0%)	2 (50.0%)
+3	2 (50.0%)	4 (100.0%)
X	0 (0.0%)	4 (100.0%)
Total	4 (100.0%)	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The assessment on the course was fair and honest	6.3	1.0	15.3 %	5.0	5.5	6.5	7.0	7.0

GENERAL QUESTIONS

What was the best aspect of the course?

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What was the best aspect of the course?

The best aspect of this course was the tutorials. Even though they were lengthy and tiring, they cleared lot of concepts which were not that clear during the classroom sessions.

Both the professor and the TA were very welcoming to the students, clarifying unclear concepts, and were open to any questions. They both showed that they genuinely cared about us learning the material, and that was very well appreciated. The course was also very well structured.
No comment

What would you suggest to improve?

What would you suggest to improve?

I think the videos were very dense and fast paced. Maybe adding couple of more lectures to equally distribute the study load would be a good idea.

The structure of the course was generally very well organised. But I feel that some concepts should have been treated with more emphasis. Because in many cases during the lecture, the same attention was given to all parts of the material to be covered. So, I think it would be better if more emphasis is put on explaining the key concepts in each lecture, and then to connect the pieces.

The video lecture can have more graphical illustrations

What advice would you like to give to future participants?**What advice would you like to give to future participants?**

I would say watch the video lectures again and again till you understand its contents. Reading from book does not really help because the coursework is vast and takes a while to get a grasp of what's going on. Understanding the tutorials is very important even though you will rarely find such lengthy questions in the exam. They help in understanding the concepts better. Any doubts must be cleared when the topic is being taught because the topics in this course are not very interlinked.

The course is very demanding, but interesting. But even though I did not have strong Digital Communications understanding, both the professor and the TA were always more than willing to help with explaining any of my questions.

Work on the bonus project and finish it on the suggested dates

Is there anything else you would like to add?**Is there anything else you would like to add?**

The projects for bonus points were really hard and time consuming. Eventually we all gave up, if that could be replaced by something then that would be good. Also the course book Upmanyu Madhow is not a good reference book, it is very hard to understand the material provided in that book and hence impacts the overall performance in this course.

The course was very interesting, covering a lot of hot topics in telecommunications, and certainly needed for anyone who wants a better understanding of how things work. I have to say it is the first course so far that teaches us concepts that are implemented so widely. Still, demanded a lot of work to be able to keep up.

YOUR PROFILE

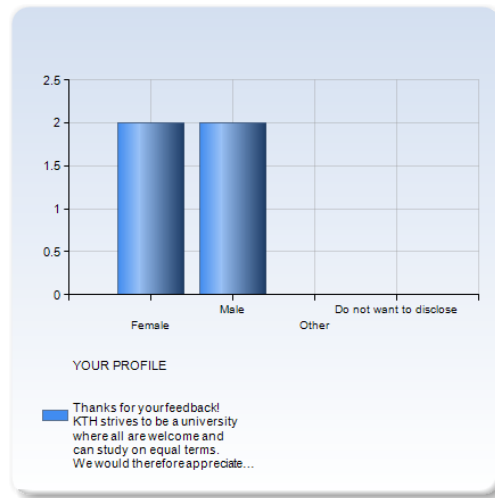
Thanks for your feedback!

KTH strives to be a university where all are welcome and can study on equal terms. We would therefore appreciate if you provided some background information about yourself.

These data are used only to compare the learning experience between different groups of participants, where at least three need to be included in a group in order to display any results.

I am:

<u>YOUR PROFILE</u>	
Thanks for your feedback!	
KTH strives to be a university where all are welcome and can study on equal terms. We would therefore appreciate if you provided some background information about yourself.	
These data are used only to compare the learning experience between different groups of participants, where at least three need to be included in a group in order to display any results.	
I am:	Number of Responses
Female	2 (50.0%)
Male	2 (50.0%)
Other	0 (0.0%)
Do not want to disclose	0 (0.0%)
Total	4 (100.0%)



<u>YOUR PROFILE</u>	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
Thanks for your feedback!								
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These data are used only to compare the learning experience between different groups of participants, where at least three need to be included in a group in order to display any results.								
I am:	1.5	0.6	38.5 %	1.0	1.0	1.5	2.0	2.0

Please comment on the course from this perspective:

Did not face discrimination or any other issue because of my gender.

YOUR PROFILE

Thanks for your feedback!

KTH strives to be a university where all are welcome and can study on equal terms. We would therefore appreciate if you provided some background information about yourself.

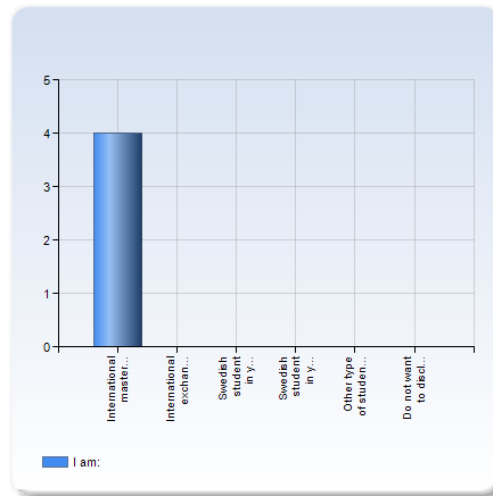
These data are used only to compare the learning experience between different groups of participants, where at least three need to be included in a group in order to display any results.

I am:

2
1
1
2

I am:

I am:	Number of Responses
International master student	4 (100.0%)
International exchange student	0 (0.0%)
Swedish student in year 1-3	0 (0.0%)
Swedish student in year 4-5	0 (0.0%)
Other type of student	0 (0.0%)
Do not want to disclose	0 (0.0%)
Total	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I am:	1.0	0.0	0.0 %	1.0	1.0	1.0	1.0	1.0

Please comment on the course from this perspective:

The KTH curriculum expects a certain level of academic knowledge from an incoming student. But this assumption should not be there and hence some bridge course to revise the basic required for the programme should be given. Also, all courses from KTH somehow are taught using presentations which I think is not a effective way of learning. Atleast the mathematical concepts should be written and derived on the board inside classroom to make things more clear.

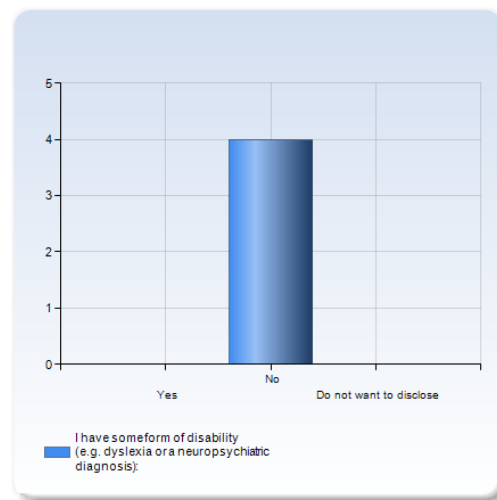
Everyone in class was international master student. All of us had the same background.

I am:

1
1
1
1

I have some form of disability (e.g. dyslexia or a neuropsychiatric diagnosis):

I have some form of disability (e.g. dyslexia or a neuropsychiatric diagnosis):	Number of Responses
Yes	0 (0.0%)
No	4 (100.0%)
Do not want to disclose	0 (0.0%)
Total	4 (100.0%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
I have some form of disability (e.g. dyslexia or a neuropsychiatric diagnosis):	2.0	0.0	0.0 %	2.0	2.0	2.0	2.0	2.0

I have some form of disability (e.g. dyslexia or a neuropsychiatric diagnosis):								
2								
2								
2								
2								