

# Course Analysis for SF2812 VT24

Course analysis carried out by (name, e-mail):  
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## Main changes in the course since last year

The main weakness in the course that was identified in 2023 was the exercise sessions. Student participation was low in the exercise sessions, and from the students' feedback, it seemed like there was not enough value in attending the exercise sessions. The TA in 2023 was a new PhD student, and I believe the material can feel a bit overwhelming for a new PhD student as we cover many topics, and being a TA requires quite deep knowledge on these topics.

The course TA in 2024 was also a new PhD student. To help him in the role and to develop the exercise sessions, I asked to have a second TA in the course. The second TA was also new to the course and teaching at KTH. The idea was to have them divide the topics between them to make the task easier. The idea was also to change the format of the exercise sessions, with the goal of "creating more value" for the students attending the exercise sessions.

- The first change was to have the students try to solve some exercise questions independently with guidance from the TA:s for a part of the exercise sessions. I have seen this format being successful, for example, in courses with similar topics at Imperial College London and Åbo Akademi University. Answering questions and helping the students solve the exercise problems on their own requires two TAs to be effective, in my opinion.
- The second change was to allocate some time in two of the exercise sessions to cover some "advanced bonus topics" that are strongly connected to the course, but not covered in the lectures, nor considered a part of the course. The idea was to have these topics to provide a bit more for the very ambitious students (in the previous year, I felt that some of the top students were not provided enough challenges). But, we also made it clear that these "advanced bonus topics" will not be in the exam.

Besides the changes to the exercise sessions, and new project assignments, the course was given in a similar format as last year (the feedback in 2023 about the lectures and course format were very positive).

## DESCRIPTION OF THE COURSE EVALUATION PROCESS

Describe the course evaluation process. Describe how all students have been given the possibility to give their opinions on the course. Describe how aspects regarding gender, and disabled students are investigated.

This was the third time I taught the course, and I was now familiar with the course and challenges from previous years. I have used a similar course evaluation process as last time which is described in more detail below.

The course evaluation is based mainly on the LEQ course evaluation and on the feedback received by students in the course committee. During the course, I met with the course committee consisting of 3 students from two different programs (applied mathematics and industrial engineering) and students of different genders. I believe having a mixture of students with different backgrounds on the committee is important to get a better overview of students' opinions and potential issues. However, I have observed that the students who volunteer to be on the course committee are clearly more active and high-achieving students. Therefore, there is some bias in their feedback.

The discussions with the course committee went well, and I believe the students felt comfortable giving honest feedback. The discussion clearly showed that the course works well overall and that the students are happy with it. The students also gave suggestions for some possible improvements for next year.

My long-term plan is to renew the course and the other courses in optimization that we offer at the math department (update the course material and slightly adjust the course design). Therefore, I have actively asked the students for feedback during the course to get a better overview of the current state of the course. For example, I have discussed the course content and difficulty level with several of the

students after and before the lectures and after project meetings. The feedback was very useful and overall positive.

I have also held office hours where the students could meet with me, and we also had meetings with the student groups (3 students) to discuss the projects. During these meetings, I also discussed the course with the students and tried to identify any possible problems.

With regard to aspects of gender and students with disabilities, we have followed standard KTH practice. For example, students with disabilities are given support by Funka during exams according to KTH standard practice.

In the course, we have worked towards creating an inclusive atmosphere and have a good mixture of students in the projects. In the course committee, we had both male and female members. From the course evolution and meetings with students, we cannot identify any clear problems.

The reply frequency for the course evolution was not great (29.8% ), but better than last year. The course evaluation was sent before the students received the results from the exam. I would have preferred it to be sent out after the results were available.

To summarize, the course evaluation was based on feedback received by:

1. LEQ course evaluation form
2. Discussion with the course committee
3. More informal discussions with students (before/after lectures)
4. Discussion with students during office hour meetings and project meetings

## **DESCRIPTION OF MEETINGS WITH STUDENTS**

Describe which meetings that has been arranged with students during the course and after its completion.

The student meetings were done similarly to how I did it in 2023.

It is worth pointing out that many of the students taking the course are highly motivated and interested in the subject. One of the reasons behind this is that most students take the course during their 4th year, and for most students, it is not a mandatory course but a course they have chosen. The high motivation level of the students also makes discussions/meetings with the students easier, as there are typically many students who actively participate in the course. By active participation, I mean actively asking questions and giving feedback, coming to most lectures, and overall taking an active role in learning. In the course, I believe I successfully created a friendly atmosphere with a low threshold for asking questions. Therefore, it is also easier to get feedback from the students. This has been the case all the time I have taught the course, and I hope to continue the course in the same spirit.

The different forms of meetings with students are briefly described in the paragraphs below.

- Office hour meetings. During the course, I had regular meetings with students during office hours. The main purpose of these meetings is to give the students extra support and guidance. However, the meetings also gave me some insights into how students were doing in the course and if they were struggling with something. The office hours were held virtually over Zoom, and I believe this format worked well.

- Project meetings with students. As a part of the examination of the projects, I had individual meetings with each project group (3 students). The purpose of these meetings was to discuss how they had worked on the project (division of the work), how they solved the problems, to check that all the group members understood all parts of the project, and to discuss the self-evaluation that the students had submitted.

- I also met with the course committee consisting of 3 students. The meeting was held at the end of the course. This meeting was very fruitful, and the discussion clearly showed that the course works well. Earlier in the course, I also spoke with the students in the course committee briefly after some lectures.

## COURSE DESIGN

Briefly describe the course design (learning activities, examinations) and any changes that have been implemented since the last course offering.

I followed the same course design as the year before, as it worked well. However, I do have plans for changes in the course material. However, this change requires changes to the other optimization courses and coordination between the teachers. I have been investigating and discussing changes with the other teachers. My goal is to renew the curriculum for our optimization courses, but these changes will most likely not be ready and implemented for the course in 2025.

The course design is described briefly below, and as the design is very similar to last year (so is the description):

The course covers linear and integer programming, and the course focuses on two aspects:

- 1) For the course participant to develop a deeper understanding and intuition of the fundamental aspects (theory, methods, and algorithms) of linear and integer programming.
- 2) Have the students train and develop their problem-solving skills by I) studying classical optimization applications, II) having the students work on "real world" application in the projects, and III) giving the students experience in using state-of-the-art optimization algorithms and software.

The theory is presented during classical lectures, where I also encourage active participation by the students. This format has worked well, which can also be seen from the feedback by the students. I'm also happy with the students' engagement during these classical blackboard lectures, as they actively follow the lectures and ask questions. The students are also given preparatory questions before each lecture, which helps the students prepare before lectures. The theory is also practiced during exercise sessions, where the goal is to have the students work on solving exercises and are given guidance (and some exercises are solved on the blackboard by the course assistant). The exercise sessions could be improved, which I will describe in more detail in the "Analysis" section. The course had 13 "normal" lectures and 8 exercise sessions. During the lectures, I have used an Ipad as the blackboard and I believe this format has worked well (the students were also happy with this choice). I have also uploaded the Ipad notes after the lectures, but I have been clear that these are not really intended as lecture notes. The students have actively taken notes during the lectures. I mainly use the blackboard (Ipad), and not lecture slides, as I believe it creates a more interactive environment and it automatically sets an appropriate speed for the students to follow. After the lecture I also gave the students access to some slides for each lecture as extra material.

The course is, to some extent, based on a classical textbook, which I recommend that the students get (the same book is also used in the nonlinear course). The book does not match the course perfectly, but it is ok. It also makes sense to use the same book as in SF2822. However, the book is more used as support material. During the lectures I mainly use the Ipad but also prepared some slides for some examples and my laptop for some demonstrations in GAMS and Matlab.

The course also focuses on two larger projects that the students need to complete and that the students work on together in groups of 3 (I will consider reducing the group size to 2). The projects are intended to replicate optimization tasks that the students might face in industry, and they are quite challenging. This year, I spent quite some time on renewing the project assignments to keep them up-to-date and interesting for the students. The projects are intended to give the students a practical hands-on understanding of the theory and methods covered in the course, and also to give the students experience of: working on a project, teamwork, problem-solving, using state-of-the-art optimization software, and presenting results.

The project groups were randomly assigned by me, and they worked in different groups for both projects. The reason for random assignments is that I believe it is valuable for the students to get experience from collaborating with different people on the project and not only work with their friends. I have received some feedback from the students about the projects, and I will discuss this in more detail in the "Students' Opinions" section.

The examination of the projects and the project presentations consist of 4 parts.

1. Each group hands in a written report that is corrected by me and the teaching assistant. The report is also checked for plagiarism.

2. Each student hands in a self-evaluation where they declare if they have contributed equally to the projects or if they have skipped the advanced questions (the projects consist of some mandatory base questions and some advanced questions that must be answered for the higher grades).
3. For each project, we have a presentation session, which consists of two parts. I) The students meet with students from other groups that have worked on the same task and discuss how they have solved the problem II) They present their solution to students that worked on different tasks.
4. Each group has a meeting with me and the TA to discuss how they have solved the problem, to test how well they have understood different parts of the project, and to give them feedback.

In the beginning of the course, the students are given nine theory questions that cover different topics of the course and are a bit more challenging to answer. The students are also informed that one of the theory questions will be in the exam. These questions focus on important theoretical concepts in linear optimization, and they are intended to have the students dive a bit deeper into the theory. We can give the students some advice on the questions, for example, where to find some additional information, but the students are expected to answer the theory questions on their own. I also provide information on which questions are covered in different parts of the course. I think the concept of having these theory questions works well, and it promotes self-learning for the students by giving them targeted tasks to study on their own.

In the course, we use the Canvas platform for distributing material, giving information about the course, and as a discussion platform. In all the courses I have taught, I have strived to use the exam as a learning opportunity. I have also used this approach in this course. In the exam, I typically present a new framework or interesting type of problem (that was not covered in the course), where the students need to use theory from the course but in a slightly different setting. The idea behind these exam questions is to have the students learn some important properties (that we did not have time to cover in the course), and, equally important to test their ability to apply the theory from the course. This is typically in the last and more challenging exam question. The idea of using the exam as an active learning opportunity has worked well, and I plan to develop this further. In the future, I intend to hold a "last lecture" after the exam to go through the exam with the students. I think this could significantly increase the learning outcome from the exam. This creates some logistic challenges, but I definitely think it would be worth the effort.

This year, the course was taught by:

- Teacher/course responsible, Jan Kronqvist (Assistant professor)
- There were two Teaching Assistant in the course.

### **THE STUDENTS' WORKLOAD**

Does the students' workload correspond to the expected level (40 hours/1.5 credits)? If there is a significant deviation from the expected, what can be the reason?

It is important to remember that the students reading the course have quite different backgrounds. Most of the students come from programs in Industrial Engineering, Engineering Physics, Applied Mathematics, and Vehicle Engineering. Some students have just completed the course "SF1811 Optimization" and have this fresh in memory. For some of the others, it has been a year since they read the course "SF1861 Optimization". Some of the students are also more experienced in mathematics, for example, in rigorously proving mathematical properties.

One of the key challenges in teaching the course is finding a suitable level for the students. For some students, there is perhaps more repetition than needed in the first three lectures. But, there is clearly a need for this repetition when considering some other groups of students. With the large spread in the students' backgrounds, there will inevitably be some spread in the workload needed by the students.

First, considering the course is 7.5 credits, the expected level should be approximately 20h/week.

The student's workload is difficult to assess from the course evaluation as the response frequency is quite low. A few students have reported that they spend 27-29 and 24-26 hours per week. But, there are also a few students who have reported that they spend significantly less time, about 10 hours per week. With the low response rate, I don't think one should not over analyze these numbers. From discussions with the students, the workload also seems to be appropriate. As we already have two larger project assignments, I don't believe there is time for a third assignment in the course. Some

sort of assignment could maybe be connected to the "Theory Questions" forcing the students to work on these throughout the course (and not just before the exam).

I would like to offer some advanced reading/exercises for the highly motivated top students. Each year, there are some exceptionally strong students and I think they would have appreciated such material. We tried to have some "advanced bonus topics", but I am not convinced that these were successful in challenge the top students.

## **THE STUDENTS' RESULTS**

How well have the students succeeded on the course? If there are significant differences compared to previous course offerings, what can be the reason?

Overall, I would say that the students did very well, and several of them got top grades in the course. The results are very similar to previous years.

When analyzing the students' results, it is important to keep in mind that this is a master's course that the students have chosen. Many of the students are from the Optimization and Systems Theory track, and for them this can be considered one of the core courses. But, many students are also taking the course from other tracks. The students' motivation is overall very high in the course, and this is obviously reflected in the grades. From my impression, the students find the course interesting and relevant for their future. Therefore, it is natural that the students perform well in the course.

42 students took the first exam, and only one student failed the exam. It is worth pointing out that there were 11 students who took the course but did not take the first exam. This makes it less surprising that only one student failed the exam. I believe the students know what to expect from the exam, and they know there is no point in writing the exam without preparing.

In the grade distribution, there were two clear peaks. One at grade "D" with 13 students, and another at grade "A" with 11 students. This also supports my observation that there is one quite big group of students who really focus on the course and perform great, and another group who is less ambitious. This is also visible during the lectures, based on the students' activity and the questions that they ask. This situation was similar last year. I believe that it is quite natural to have one group of very active students who do great in the course, as this is one of the core courses for students focusing on an optimization track.

In the projects the students overall did well, and many of the students also completed the advanced questions (needed for higher grades). My impression, and also clear from the students' feedback, is that the students found the projects very interesting. Many of the students were excited to discuss the projects and how they had solved the problems.

To summarize, as a teacher I am happy with the results.

## **STUDENTS' ANSWERS TO OPEN QUESTIONS**

What does students say in response to the open questions?

The students overall seemed very satisfied with the course. There were several very positive comments. Below are a few examples:

- "The course in general is great, and the teacher is really good. Really enjoyed the lectures." (Answer to the question "What was the best aspect of the course?")
- "Jan was super engaged all the time, best course I've taken in that aspect!". (Answer to the question "What was the best aspect of the course?")
- "The lectures were great and the teacher was really good at explaining." (Answer to the question "What was the best aspect of the course?")
- "Inspirerande föreläsningar och projekt, lätt att få hjälp och stöd, bra schemaläggning. Hade både kul och lärde mig mycket samtidigt under den här kursen (Answer to the question "What was the best aspect of the course?")

- "The projects, they felt realistic. It was also great that we got to interact with other students regarding them and see different types of approaches to the same challenge." (Answer to the question "What was the best aspect of the course?")

Based on the replies, it is clear that the lecture format and projects are working well!

From the replies, it is also clear that the changes to the exercise sessions was not a success and we need to reconsider the format. Below are a few comments:

- "The exercise sessions were not very helpful. I would prefer to have them as sessions where the T.A:s go through all problems thoroughly so you really understand, and then you can do the other recommended exercises on your own." (Answer to: What would you suggest to improve?)
- "The few exercise sessions that I attended were not that helpful in my opinion." (Answer to: What would you suggest to improve?)
- "The exercise sessions could absolutely be improved. I don't think the concept of the students working with problems on their own is good, because I already do that at home. It would be better if the TAs were just going through solutions to exercises like in other courses I've taken." (Answer to: What would you suggest to improve?)

Improving the exercise sessions will be a high priority for next year, and I will discuss the exercise sessions in more detail under the sections "Analysis" and "Prioritized Course Development".

One student mentioned that two sub-questions in the exam were too difficult. I don't agree with that student, and I think the results confirm that it was on an appropriate difficulty level. After all, 11 students got an "A". Furthermore, several students wrote almost perfect exams (3 students got 49 out of 50 points).

## **SUMMARY OF STUDENTS' OPINIONS**

Summarize the outcome of the questionnaire, as well as opinions emerging at meetings with students.

As mentioned above, the students are happy with the course overall. This is clear from the positive feedback in the course analysis and feedback from the course committee.

However, the feedback also clearly points to one aspect of the course that should be improved. The replies from the course analysis show that the exercise sessions did not work great, and this was mentioned in several of them. The course committee also gave this feedback, and we discussed how this could be improved. I will actively work on improving the format of the exercise sessions and provide the TA with more support and guidance for the exercise sessions.

The format of having the students work on their own to solve problems for a part of the exercise sessions was not appreciated by the students. I am not convinced this is a bad format, but it clearly comes with challenges. I believe that this is, at least partly, due to the students not being used to this format. This format is also more demanding for the TA and may require more experience to successfully lead such a session.

The student feedback also mentions the teamwork in the projects. This year, I allowed the students to suggest partners for the first project, and this worked well. One student mentioned a problem in their group, and there were maybe some more challenges. It is difficult to fully avoid teamwork issues, and overall it seemed to work well this year.

Together with the course committee, we discussed the grading of the projects and how this is accounted for in the final grade. It was mentioned that this system could give an unfair advantage if a student is "lucky" and assigned to a group of very strong students. However, the impact of "being lucky" is somewhat controlled by the fact that the students are reassigned to different random groups. We discussed this, but it is difficult to fully avoid this.

The weight of the project grades in the final grade was also discussed with the course committee, and a student also mentioned this in the course evaluation. When finalizing the grades, it also seems like

some students' final grades are increased too much by the project grades. For example, if a student got an E in the exam but an A in both projects, the final grade becomes C. A final grade of C is quite good, and if a student barely passes the exam, it is questionable if the student deserves the final grade of C. Especially since the projects are group assignments. The computation of the final grade will be adjusted next year.

To summarize, the replies show that the students are overall happy with the course and they consider it to be a valuable course.

### **OVERALL IMPRESSION**

Summarize the teachers' overall impressions of the course offering in relation to students' results and their evaluation of the course, as well as in relation to the changes implemented since last course offering.

I very much enjoy teaching the course. It is a pleasure to teach a course when you have highly motivated students. The course is also close to my own research interests. I think the students also value that I give them some examples from the "cutting edge" of research in the field and tell them how the course relates to the research.

The course covers many topics that I believe the students find interesting and useful. During the course, I got many very good questions from the students, which showed that they were clearly interested in the topics. The students' results also clearly show that there is a relatively large group of students who perform great in the course. This was hardly surprising as there was also a group of very active students who actively participated in the lectures and asked highly relevant questions.

The exercise sessions are challenging for a new PhD student, and the changes to the format of the exercise sessions did not achieve the desired outcome. The format of having the students spend part of the exercise session solving problems with the guidance of the TA:s was not appreciated by the students. I still believe this format can work well (and I have seen it work well), but the students were not used to it, and I believe it can be very demanding for the TA. Next year, we will most likely pivot back to the previous format.

As a teacher, I am overall very happy with the course.

### **ANALYSIS**

Is it possible to identify stronger and weaker areas in the learning environment based on the information you have gathered during the evaluation and analysis process? What can the reason be? Are there significant differences in experience between:

- students identifying as female/male?
- international/national students?
- students with/without disabilities?

The main weakness identified in the course was the exercise sessions. The student participation in the exercise sessions was low, and from the student feedback, it is clear that the exercise sessions should be improved. Some changes were implemented to the exercise sessions compared to last year. The main change was that a part of the exercise sessions was dedicated to students solving exercises on their own with guidance of the TA:s and the possibility of asking questions. This change was not well received by the students, and we will most likely pivot back to the old format next year.

The exercise sessions are also quite challenging for a new TA. The course covers many topics, and the pace is high. It is a challenge for the TA to read up on the topics to the level that they are comfortable with the exercises. It can be challenging keeping up with the course and being able to prepare enough for the exercise sessions. I believe we also need to think about how to make the TA role easier for new TA:s who are helping out in the course for the first time.

Based on the results of the exam and course evaluation, I cannot see that any specific group of students would be stronger or weaker in the course. From my interactions with the students, I also got the impression that the course format is working well for all the students.

The reply frequency for the course evaluation was a bit disappointing. Next year, I will again try to encourage more students to submit the course evaluation as a higher response frequency would be useful.

### **PRIORITIZED COURSE DEVELOPMENT**

What aspects of the course should be developed primarily? How can these aspects be developed in short and long term?

The overall teaching format is clearly working well. The students are learning and succeeding well in satisfying the intended learning outcomes.

The main priority for next year will be to improve the exercise sessions and make sure students find the exercise sessions useful.

Below is a list with the main development items:

- Together with the TA work on updating the format for the exercise sessions. Also, provide the TA with more guidance and support.
- Continue updating the course projects. Several projects have already been updated for the course this year. This work is straightforward (although time-consuming), but it is important that the students continue to feel that the projects are up-to-date and relevant.
- Investigating how the course content could be updated to best fit the student's needs and complement the other courses (avoid unnecessary overlaps). This work has already started and continues.

My long-term goal is to renew the course material more substantially. But, this requires changes in the other optimization courses in the Optimization and Systems Theory track, and careful coordination with the other teachers. We have started this work, and together with the other teachers we have started mapping out what material is covered in which course and how they link together. My goal with the renewal is to optimize the learning outcome for students who take all the optimization courses and make sure all the material is relevant, up-to-date, and that we have a suitable degree of overlap. Specifically for this course (SF2812), I would like to put more focus on "Decomposition techniques" and "Integer Programming". At the moment, I believe there are important topics that we do not cover, or cover too shallowly, in our optimization courses.