- **Course number, course name, credits, student group, period of study**
  SF2822 Applied linear optimization, 7.5hp, advanced level, elective for F, M, T, and master in mathematics, scientific computing and aerospace engineering, period 4.

- **Teachers**

Instructor and examiner:	Anders Forsgren
Exercise leader and project leader:	Axel Ringh

- **Course literature**

  - *Linear and Nonlinear Programming*, second edition, by I. Griva, S. G. Nash and A. Sofer, SIAM, 2009.
  - *Exercises in applied nonlinear optimization, 2014/2015.*
  - *Supplementary course material in applied nonlinear optimization, 2014/2015.*
  - *Lecture notes in applied nonlinear optimization, 2014/2015.*
  - *GAMS, A user's guide.*
  - *GAMS.* GAMS is installed in the Ubuntu computer rooms. It may also be downloaded from the web for use on a personal computer.
  - Two project assignments that are handed out during the course, March 31 and April 28 respectively.

- **Number of registered students (in Ladok):** 39 of which 7 are PhD students

- **Number of students passing the projects:** 39 of which 7 are PhD students

- **Number of students passing the first exam:** 27 out of 37

The questions below are related to the LEQ course evaluation

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

   The course is designed around two projects and lectures/exercise sessions. The projects are carried out in groups, and the students use a high-level optimization modeling language, GAMS. Modeling is examined throught the projects, theory and method knowledge is examined through the final exam. Method knowledge is optionally examined through the second project. This is the same setup as last year.

2. **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?

   The expected workload would be 20 hours per week. The questionnaire shows a large spread. I think it differs depending on the students' background. Also, I think it is difficult for them to estimate how much time they spend on the projects.

3. **The students' results**
   How well have the students succeeded on the course? If there are significant differences compared with previous course offerings, what can be the reason?

   In the projects, the students did well. Compared to last year, a difference is that a significant majority of the students chose the method assignment for the second project. The overall result was comparable to last year.

4. **Overall impression of the learning environment**
   What is your overall impression of the learning environment in the polar diagrams? If there are significant differences between different groups of students, what can be the reason?

   The overall impression based on the polar diagrams is that this is a well functioning learning environment.

5. **Analysis of the learning environment**
   Can you identify some stronger or weaker aspects of the learning environment in the polar diagram - or in the response to each statement - respectively? Do they have an explanation?

   Stronger aspects concern support, stimulating tasks, clear goals and organization, constructive alignment, feedback and security. Weaker aspects concern choices and exploration and own experience.

   I think the main strengths of the course are based on the projects, the students are well motivated and work hard. As for the weaknesses, I assign the groups and also assign the tasks to each group. This is a choice on my part. Assigning groups is important. Letting the groups choose projects might be difficult to handle. There is a choice between modeling and method assignment in project two.

6. **Answers to open questions**
   What emerges in the students' answers to the open questions? Is there any good advice to future course participants that you want to pass on?

   The students are in general quite happy with the course. In particular, they apprecaite the work with the projects.

7. **Priority course development**
   What aspects of the course should primarily be developed? How could these aspects be developed in the short or long term?

   The course has a working setup and I do not plan any major changes right now.

   Minor changes would be to announce in advance which exercises to be handled at the exercise session, and also to develop new projects.
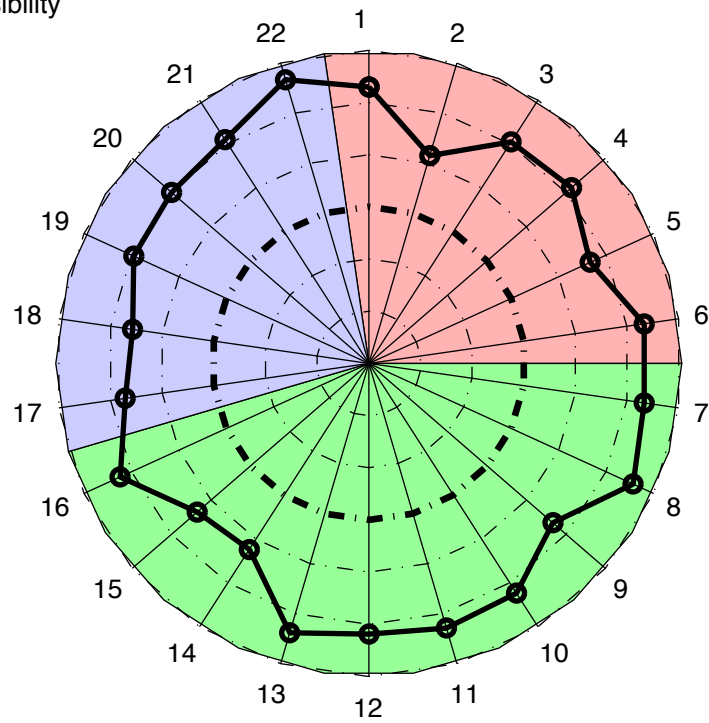
8. **Other information**
   Is there anything else you would like to add?

   The results from the course evaluation are very much in line with my own view of the course.

LEQ Footprint

SF2822 Applied nonlinear optimization

Number of respondents: 21

Red sector: Meaningfullness

Green sector: Comprehensibility

Blue sector: Manageability

KTH Learning Experience Questionnaire (LEQ) v3.1.1

Established 2015-05-05

Estimated workload

   0. On average, how many hours/week did you work with the course (including scheduled hours)? 1-3/4-6/… /37-39/≥40 hours/week (l)*

Meaningfulness – emotional level

Stimulating tasks

1. I worked with interesting issues (a)

Exploration and own experience

2. I explored parts of the subject on my own (a)
3. I could learn by trying out my own ideas (b)

Challenge

4. The course was challenging in a stimulating way (c)

Belonging

5. I felt togetherness with other course participants (d)
6. The atmosphere in the course was open and inclusive (d)

Comprehensibility – cognitive level

Clear goals and organization

7. The learning objectives helped me understand what I was expected to achieve (e)
8. I understood how the course was organized and what I was expected to do (e)

Understanding of subject matter

9. I understood what the teachers were talking about (f)
10. I could learn from concrete examples that I was able to relate to (g)
11. Understanding of key concepts was given high priority (h)

Constructive alignment

12. The course activities helped me to reach the learning objectives efficiently (i)
13. I understood what I was expected to learn in order to get a particular grade (i)

Feedback and security

14. I regularly received feedback that helped me see my progress (j)
15. I could practice and receive feedback without any grading being done (j)
16. The assessment on the course was fair and honest (k)

Manageability – instrumental level

Sufficient background knowledge
17. My background knowledge was sufficient to follow the course (f)

Time to reflect

18. I regularly spent time to reflect on what I learned (l)

Variation and choices

19. I could learn in a way that suited me (m)
20. I had opportunities to choose what I was going to do (m)

Collaboration

21. I could learn by collaborating and discussing with others (n)

Support

22. I could get support if I needed it (c)

General questions

23. What was the best aspect of the course?
24. What would you suggest to improve?
25. What advice would you like to give to future course participants?
26. Is there anything else you would like to add?

The student's profile

27. I am: Female/Male/Other/Do not want to disclose
28. I am: International Master's student/International exchange student/
   Swedish student in year 1-3/Swedish student in year 4-5/
   Other type of student/Do not want to disclose

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*The letters within parenthesis (a, b, …) refer to the learning factors that LEQ is intended to examine (enclosed).

In the electronic version of the questionnaire, the statements are presented in the following order: {7, 1, 18, 2, 17, 5, 14, 4, 20, 9, 11, 15, 12, 21, 6, 19, 8, 10, 22, 16, 3, 13}.

Factors from the literature that LEQ intends to examine

We tend to learn most effectively (in ways that make a sustained, substantial, and positive influence on the way we think, act or feel) when:

a) We are trying to answer questions, solve problems or acquire skills that we find interesting, intriguing or important (stimulating tasks and exploration: 1, 2)*;

b) We can speculate, try out ideas (intellectually or practically) and learn from experience, even before we know much about the subject (own experience: 3);

c) We are able to do so in a challenging yet supportive environment (challenge and support: 4, 22);

d) We feel that we are part of a community and believe that other people have faith in our ability to learn (belonging: 5, 6);

e) We understand the meaning of the learning objectives, how the environment is organized and what is expected of us (clear goals and organization: 7, 8);

f) We have sufficient background knowledge to manage the present learning situation (sufficient background knowledge and understanding of subject matter: 17, 9);

g) We can learn inductively by moving from specific examples and experiences to general principles, rather than the other way around (und. of subject matter: 10);

h) We are challenged to develop a proper understanding of key concepts and successively create a coherent whole of the content (und. of subject matter: 11);

i) We believe that the work we are expected to do will help us to reach the learning objectives (constructive alignment: 12, 13);

j) We can try, fail, and receive feedback in advance of and separate from any summative judgment of our efforts (feedback and security: 14, 15);

k) We believe that our work will be considered fairly and honestly (security: 16);

l) We have sufficient time to learn and devote the time necessary to do so (own effort and time to reflect: 0, 18);

m) We believe that we are in control of our own learning, not manipulated (variation and choices: 19, 20);

n) We can work collaboratively with other learners struggling with the same problems (collaboration: 21);

_____

*The information within parentheses refers to different aspects of the learning environment and the numbering of the corresponding statements in LEQ.

Literature

Bain, K. (2004). *What the Best College Teachers Do* (Chapter 5, pp. 98-134). Cambridge: Harvard University Press (see also http://www.bestteachersinstitute.org - accessed 2015-05-05).

Biggs J. & Tang, C. (2011). *Teaching for Quality Learning at University* (Chapter 6, pp. 95-110). Maidenhead: McGraw Hill.

Elmgren, M. & Henriksson, A-S. (2014). *Academic Teaching* (Chapter 3, pp. 57-72). Lund: Studentlitteratur.

Kember, K. & McNaught, C. (2007). *Enhancing University Teaching: Lessons from Research into Award-Winning Teachers* (Chapter 5, pp. 31-40). Abingdon: Routledge.

Ramsden, P. (2003). *Learning to Teach in Higher Education* (Chapter 6, pp. 84-105). New York: RoutledgeFalmer.

Survey results

Survey:	Course evaluation v3.1.1
Status:	open
Date:	2015-09-29 13:09:04
Group:	Participants (SF2822 Applied nonlinear optimization)
Answered by:	21(49) (42%)

Estimated workload

On average, how many hours/week did you work with the course (including scheduled hours)?
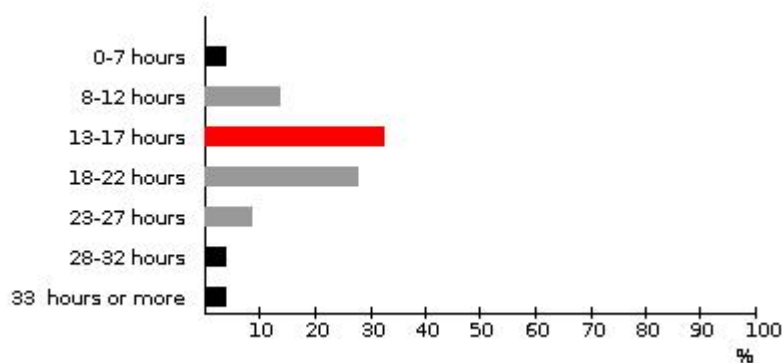
answer choice	0-7 hours	8-12 hours	13-17 hours	18-22 hours	23-27 hours	28-32 hours	33 hours or more
distribution	4,8%	14,3%	33,3%	28,6%	9,5%	4,8%	4,8%
number	(1)	(3)	(7)	(6)	(2)	(1)	(1)

Average (for numeric-answers): 15,71
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-As I haven't attended the pre-curriculum, I read the relative chapter in the textbook.
-I worked few hours on Non linear optimization, I worked mostly on optimization fundamentals because I have never followed a proper course on optimization and I need to take this course as a compulsory one among my syllabus.
-In order to keep up to date with the theory, in addition to the course projects.
-I worked more than average the weeks before the projects and the exam. I worked less than average otherwise.
-Most of time spent with projects and attending classes.

Learning experience

The learning objectives helped me understand what I was expected to achieve (S7)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)
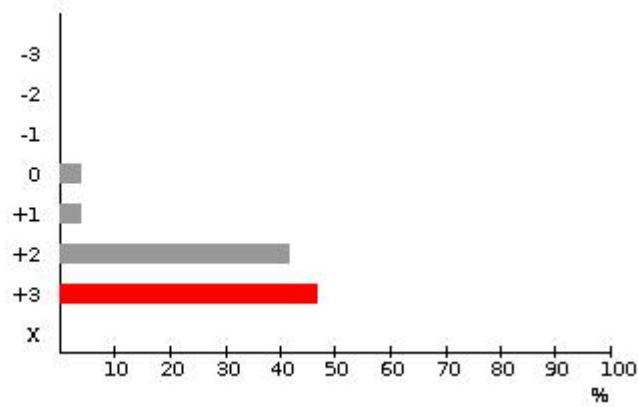
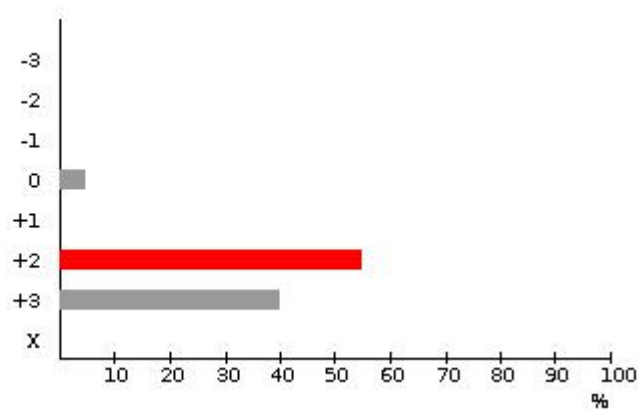| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	4,8%	0
1	4,8%	+1
9	42,9%	+2
10	47,6%	+3
0	0%	X

Average (for numeric-answers): 2,33
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-The course gave an overview of general aspects in non-linear optimization. In my opinion the amount of hours spent on theory and practice was well-balanced.

I worked with interesting issues (S1)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	5%	0

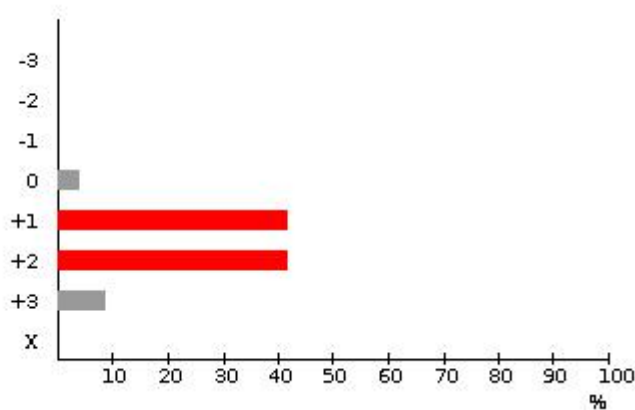| number	distribution	answer choice
0	0%	+1
11	55%	+2
8	40%	+3
0	0%	X

Average (for numeric-answers): 2,3
20 has answered of 49 (40%)
Maximum number of choices: 1

Comment:

-The project part is very interesting and useful. I learned a powerful tool in these process.
-It depends on how we define interesting, but, yes, I worked with interesting issues.

I regularly spent time to reflect on what I learned (S18)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

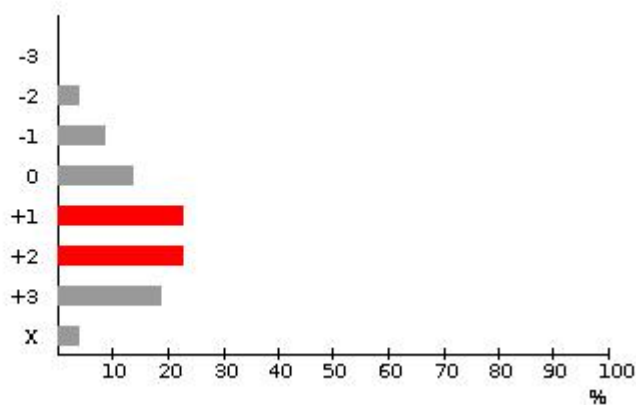| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	4,8%	0
9	42,9%	+1
9	42,9%	+2
2	9,5%	+3
0	0%	X

Average (for numeric-answers): 1,57
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-I can meet the previous knowledge in the latter study of this course, which push me to reflect what I learned again and again.
-I tried to focus on the theory behind all what we did in class, in order to have a better insight in the subject.
-I reflect on what I learned more when I need to apply it for a project.

I explored parts of the topic on my own (S2)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)
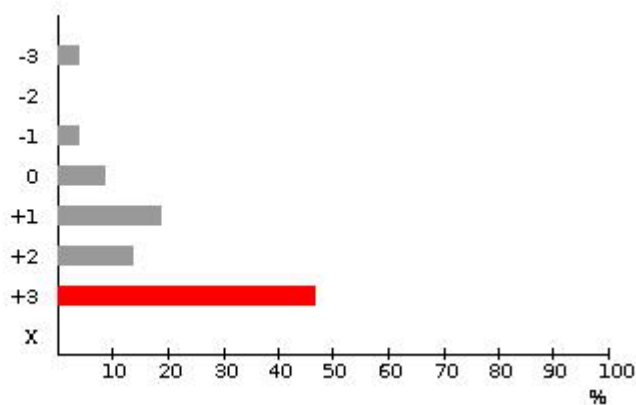
number	distribution	answer choice
0	0%	-3
1	4,8%	-2
2	9,5%	-1
3	14,3%	0
5	23,8%	+1
5	23,8%	+2
4	19%	+3
1	4,8%	X

Average (for numeric-answers): 1,15
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-Not because the lecture was not enough for the exam, but because I was interested in the topic
-I don't really understand this question.
-Yes, definitely yes.

My background knowledge was sufficient to follow the course (S17)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
1	4,8%	-3
0	0%	-2
1	4,8%	-1

2	9,5%	0
4	19%	+1
3	14,3%	+2
10	47,6%	+3
0	0%	X

Average (for numeric-answers): 1,71
21 has answered of 49 (42%)
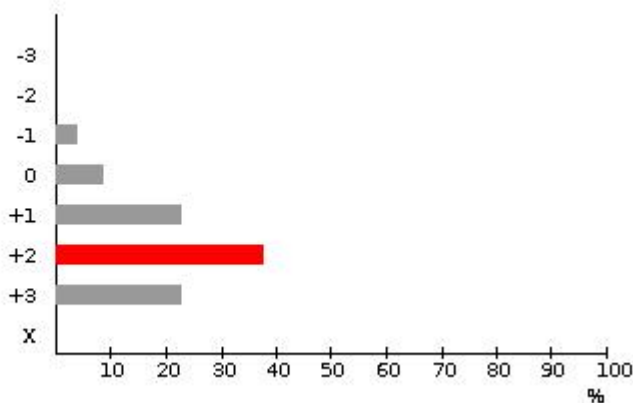Maximum number of choices: 1

Comment:

-Although I didn't learn other optimization course before, I think I can follow it through reading some materials lecturer refers.
-I followed the "Applied Linear Optimization" which is more than enough.

I felt togetherness with other course participants (S5)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
1	4,8%	-1
2	9,5%	0
5	23,8%	+1
8	38,1%	+2
5	23,8%	+3
0	0%	X

Average (for numeric-answers): 1,67
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-I really thanks to the project part, through which I know some good friends and nice guys.
-I think the projects' presentation sessions are a very good initiative. I really appreciated and enjoyed them. But apart from that, it was difficult to get to know each other and interact with my colleagues.
-Excellent idea to impose the groups for project and to discuss them together.
-The projects helped with this.

I regularly received feedback that helped me see my progress (S14)

(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)
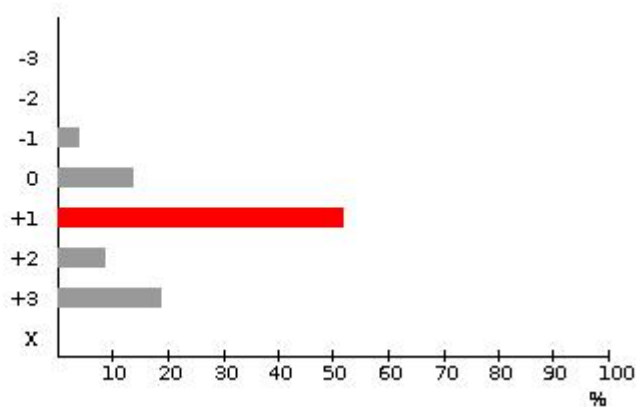
number	distribution	answer choice
0	0%	-3
0	0%	-2
1	4,8%	-1
3	14,3%	0
11	52,4%	+1
2	9,5%	+2
4	19%	+3
0	0%	X

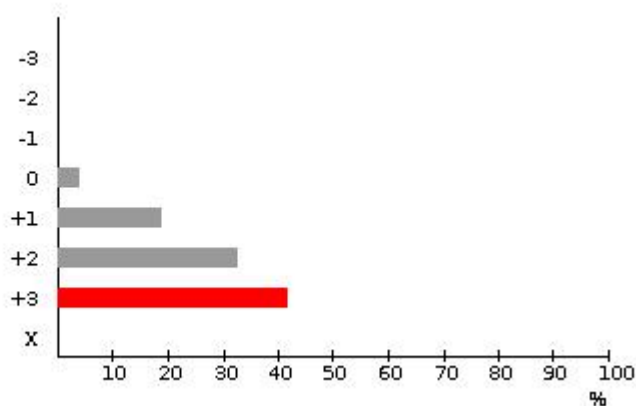Average (for numeric-answers): 1,24
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-Maybe in the project, I can receive this kind of feedback by solving the problems.
-All the partial grades came short after the assignments.
-Really appreciated the feedback for the projects.

The course was challenging in a stimulating way (S4)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3

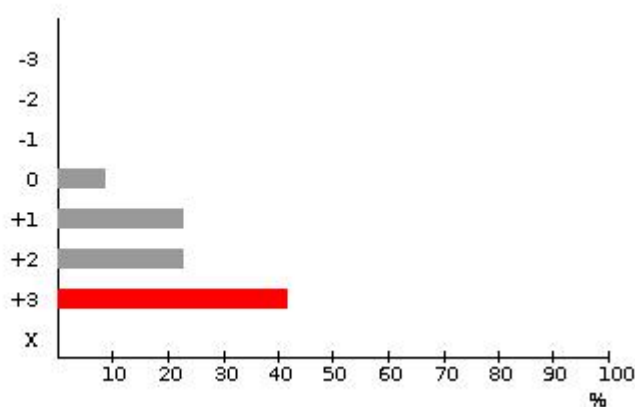| 0 | 0% | -2 |
0	0%	-1
1	4,8%	0
4	19%	+1
7	33,3%	+2
9	42,9%	+3
0	0%	X

Average (for numeric-answers): 2,14
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-It depends on how deep you want to go in the topic and on how you want to present the projects.

I had opportunities to choose what I was going to do (S20)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

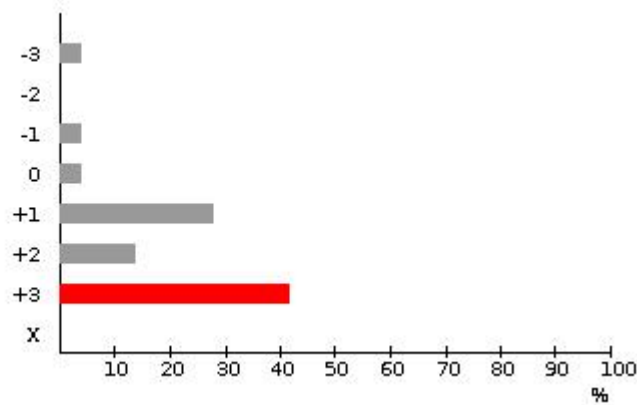| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
2	9,5%	0
5	23,8%	+1
5	23,8%	+2
9	42,9%	+3
0	0%	X

Average (for numeric-answers): 2
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-I would have liked to. But the schedule is so tight and the projects so time consuming I could not spend all the time I wanted in fully understand and read before the lectures and exercises sessions.

I understood what the teachers were talking about (S9)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
1	4,8%	-3
0	0%	-2
1	4,8%	-1
1	4,8%	0
6	28,6%	+1
3	14,3%	+2
9	42,9%	+3
0	0%	X

Average (for numeric-answers): 1,67
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-As I said I had no knowledge on this topic before
-I was always one step behind. So it helped a lot to go to lectures and exercises when studying afterwards.
-The lectures were difficult to follow if you had had no opportunity to go through the covered topics before (using the book, that, by the way, was extremely confusing at some points). Unfortunately, the project assignments do not always allow you to go to the lecture well prepared.

The exercises lectures were easier to follow. The brief theory summary done at the beginning was always helpful.

Understanding of key concepts was given high priority (S11)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
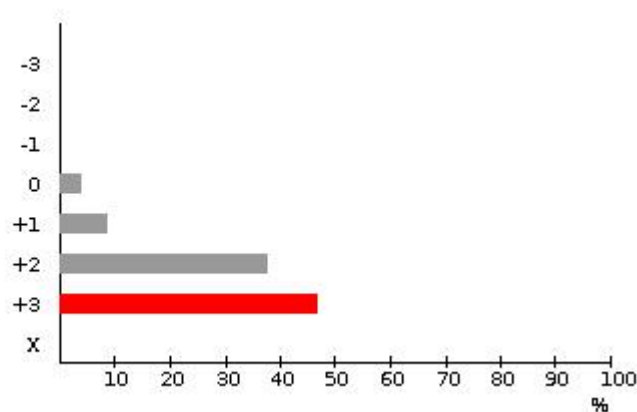
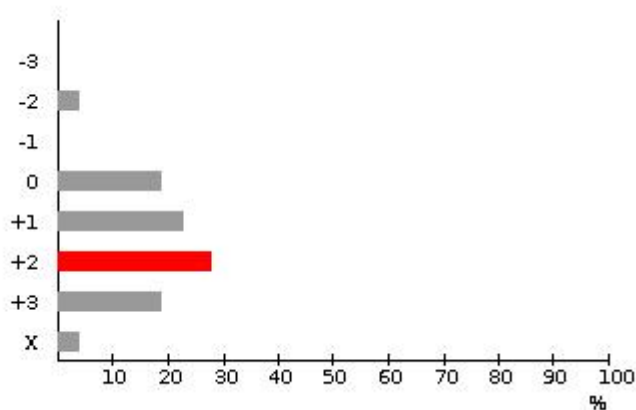| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	4,8%	0
2	9,5%	+1
8	38,1%	+2
10	47,6%	+3
0	0%	X

Average (for numeric-answers): 2,29
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-In general, yes, but some important details were overlooked.

I could practice and receive feedback without any grading being done (S15)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

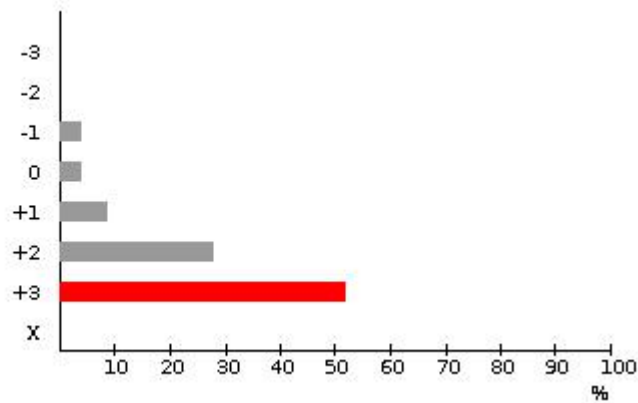| number	distribution	answer choice
0	0%	-3
1	4,8%	-2
0	0%	-1
4	19%	0
5	23,8%	+1
6	28,6%	+2
4	19%	+3
1	4,8%	X

Average (for numeric-answers): 1,35
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-I do disagree, however this is understandable and not seens a negative critisism.
-I don't understand the question. We always received our grades after doing an assignment (which was expected and appreciated).

The course activities helped me to reach the learning objectives efficiently (S12)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
1	4,8%	-1
1	4,8%	0
2	9,5%	+1
6	28,6%	+2
11	52,4%	+3
0	0%	X

Average (for numeric-answers): 2,19
21 has answered of 49 (42%)
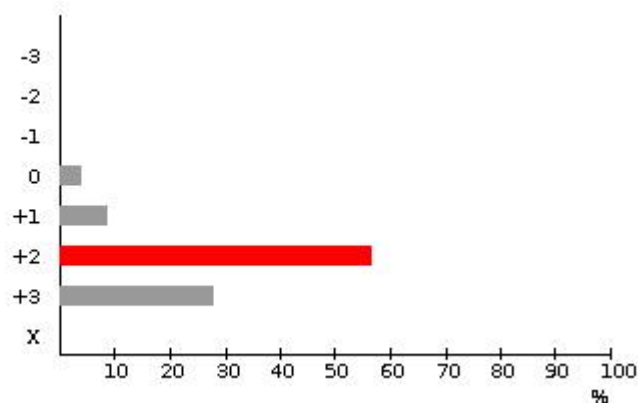Maximum number of choices: 1

Comment:

-The exercise is very good. Not only give us some problems, also offer some very useful summaries.
-I achieved the learning objectives by reading the recommended bibliography and trying to understand the theory. The implementation project was useful, but the application one only served the purpose of learning GAMS (not included in the learning outcomes) and to focus in an applied problem far from my field of study.

The lectures were not thorough enough in order to reach the learning objectives without many hours of self-learning.

I could learn by collaborating and discussing with others (S21)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice

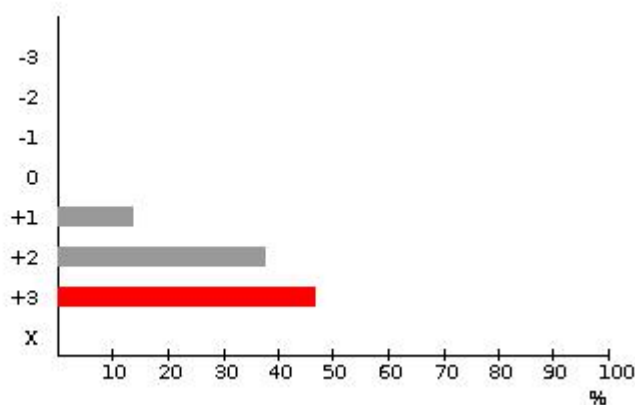| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	4,8%	0
2	9,5%	+1
12	57,1%	+2
6	28,6%	+3
0	0%	X

Average (for numeric-answers): 2,1
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-I strongly like that Anders encourage team work. And also the part where you do not get to choose the group partners.
-The project presentation sessions well really profitable to this respect.

The atmosphere in the course was open and inclusive (S6)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

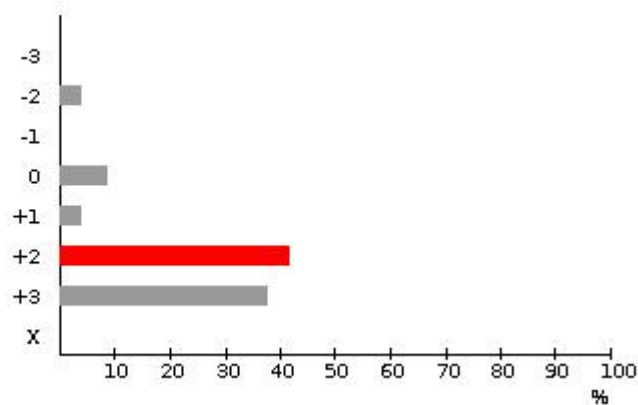| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
0	0%	0
3	14,3%	+1
8	38,1%	+2
10	47,6%	+3
0	0%	X

Average (for numeric-answers): 2,33
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-Regarding the lecturers: definitely yes.

I could learn in a way that suited me (S19)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)
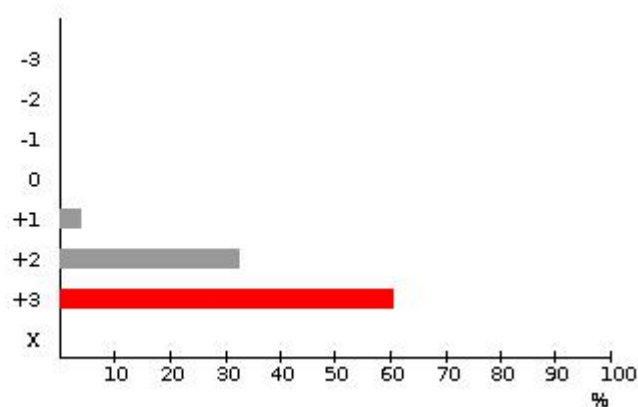
number	distribution	answer choice
0	0%	-3
1	4,8%	-2
0	0%	-1
2	9,5%	0
1	4,8%	+1
9	42,9%	+2
8	38,1%	+3
0	0%	X

Average (for numeric-answers): 1,95
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

I understood how the course was organized and what I was expected to do (S8)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
0	0%	0
1	4,8%	+1

7	33,3%	+2
13	61,9%	+3
0	0%	X

Average (for numeric-answers): 2,57
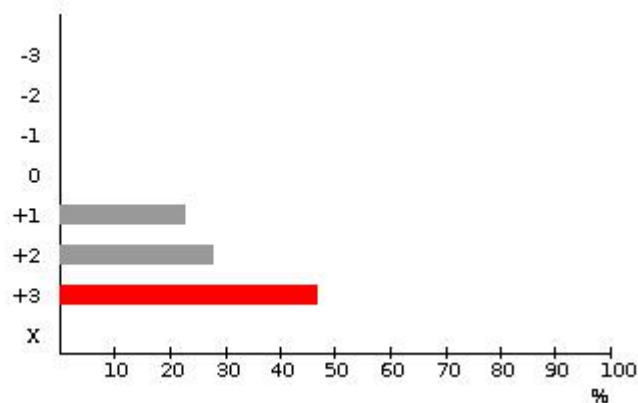21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-Yes, the course is really well organized.

I could learn from concrete examples that I was able to relate to (S10)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

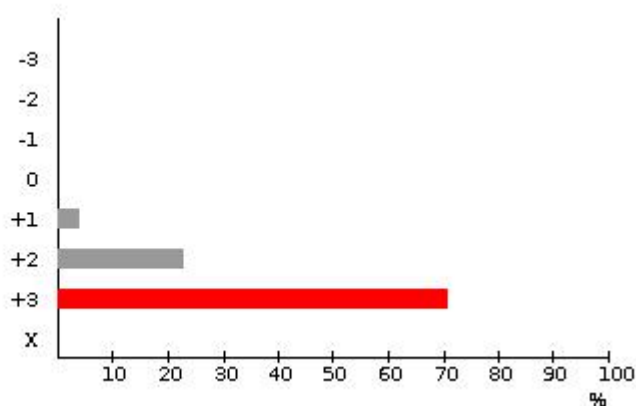| number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
0	0%	0
5	23,8%	+1
6	28,6%	+2
10	47,6%	+3
0	0%	X

Average (for numeric-answers): 2,24
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

I could get support if I needed it (S22)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
0	0%	0
1	4,8%	+1
5	23,8%	+2
15	71,4%	+3
0	0%	X

Average (for numeric-answers): 2,67
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-The main lecturer and the TA were really helpful: attentive and always willing to answer all possible questions. Thanks for that.

The assessment on the course was fair and honest (S16)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)
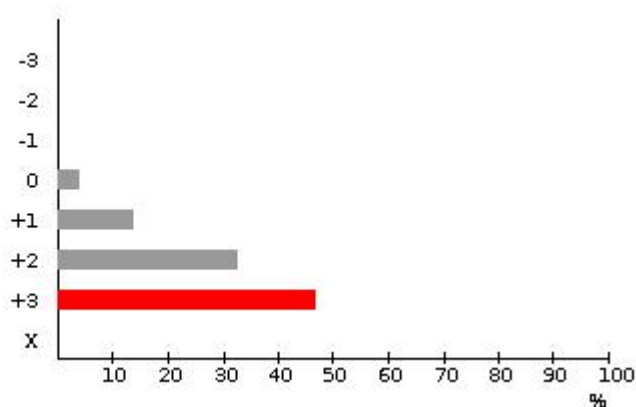
number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	4,8%	0

3	14,3%	+1
7	33,3%	+2
10	47,6%	+3
0	0%	X

Average (for numeric-answers): 2,24
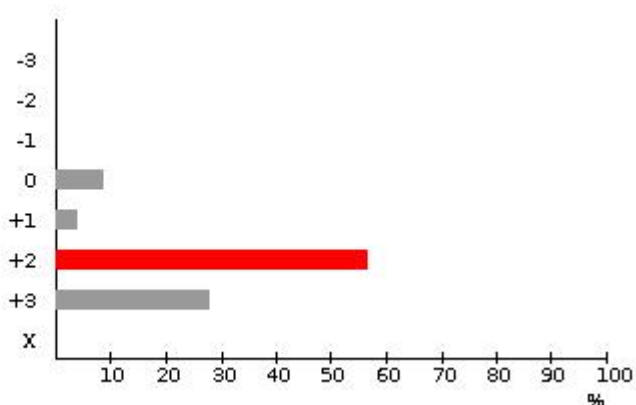21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-The exam was perhaps too focused on calculations.

I could learn by trying out my own ideas (S3)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
2	9,5%	0
1	4,8%	+1
12	57,1%	+2
6	28,6%	+3
0	0%	X

Average (for numeric-answers): 2,05
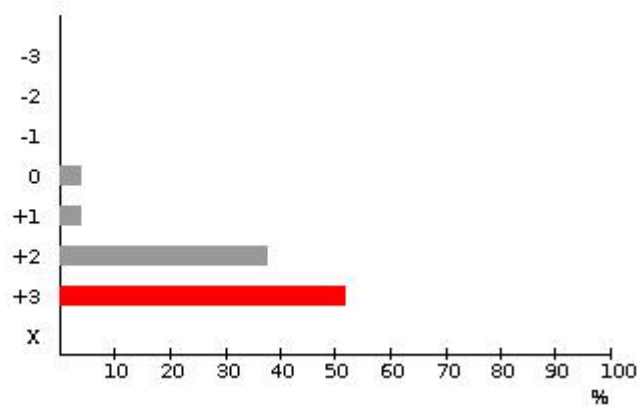21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

-In some aspects in the projects' reports and presentation.

I understood what I was expected to learn in order to get a particular grade (S13)
(Scale: -3: No, I strongly disagree with... 0: I am neutral to... +3: Yes, I strongly agree with the statement)

number	distribution	answer choice
0	0%	-3
0	0%	-2
0	0%	-1
1	4,8%	0
1	4,8%	+1
8	38,1%	+2
11	52,4%	+3
0	0%	X

Average (for numeric-answers): 2,38
21 has answered of 49 (42%)
Maximum number of choices: 1

Comment:

General questions

What was the best aspect of the course?

11 has answered of 49 (22%)

Comment:

-The course included several projects which could be related to real existing problems from different fields.
Working on these project was challenging but really interesting and essential to understand practical
implementation of optimization methods and modeling.
-homeworks
-The course was well structured and interesting
-The project part!!
-the lectures and exercise
-Learn how purely mathematical tools can be applied to real situations
-I learnt a lot, because this course was completely new for me
-It gave a good overview of the topic. When I started I knew nothing about optimization and now I have
somewhere to start from. Well organized.
-Clarity of the lectures and exercice sessions.
Consistency of the material from one lesson to the other.
-the implementation project.
-I appreciated that we have been able to choose the topic of the second project between modeling and
implementation.

What would you suggest to improve?
9 has answered of 49 (18%)

https://bilda.kth.se/servlets/AZ/courseId/12368?frame=lespol...

Comment:

-
-Give more materials that we can understand the content more deeply.
-the assigment could be easier
-GAMS support
-More practical examples, less theory
-to take out the semidefinite topic
-I thought the part of semi definite programmings was rushed through. I do understand that is has great applications and that it's going to be needed. However it doesn't really feel suitable that the last 1 week where the book describes it really vaugley stands for 1/5 of the exam points.
-Definitely, another recommended bibliography book should be considered (rather than the Griva and Nash). More specifically, a better organized book that followed the structure and topics covered in the course (e.g., starting from simple QPs and moving towards general non-linear problems).

There is no time in class to cover all the relevant aspects and therefore a good choice of the recommended bibliography is essential.
-Nothing, good course!

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

12 has answered of 49 (24%)

Comment:

-To pass the course once should follow all the lectures and prepare in advance for each lecture by reading materials from previous lectures and going through lecture slides for upcoming one.
-Go to the exercises, it's really helpful
- preview before class!
-study during the course
-start early with gams, it can freak you out
-Enjoy the projects and try to study step by step
-work on their own
-Make sure you can prove the theory questions, and the applied part gets much simplier
-Work regularly on the theory questions during the course.
-Keep up with the theory. The exam is not easy to pass in case you don't know it well enough.

Do not underestimate the projects: they are time consuming.
-They should read the notes before going to class and go to the exercice sessions.
-Go to lectures and exercise sessions ;)

Is there anything else you would like to add?
7 has answered of 49 (14%)

Comment:

-
-no
-have fun!
-No
-no
-Don't be mislead by the word "APPLIED" in the course title. This course is within a maths program.
-Nope

**Optimization and
Systems Theory**

SF2822 Applied Nonlinear Optimization, 7.5hp, 2014/2015

Instructor and examiner

Anders Forsgren (andersf@kth.se), room 3533, Lindstedtsv. 25, tel 790 71 27.
Office hours: Monday 11-12. (Or by agreement.)

Exercise leader and project leader

Axel Ringh (aringh@kth.se), room 3734, Lindstedtsv. 25, tel. 790 66 59.
Office hours: By agreement.

Course material

(The course material will be available at Bilda in the form of pdf files.)

- *Linear and Nonlinear Optimization*, second edition, by I. Griva, S. G. Nash och A. Sofer, SIAM, 2009.
  Information on how to order the book can be found here.
- *Exercises in applied nonlinear optimization, 2014/2015*. Available at Bilda.
- *Supplementary course material in applied nonlinear optimization, 2014/2015*. Available at Bilda.
- *Lecture notes in applied nonlinear optimization, 2014/2015*. Can be downloaded from this web page, see the schedule below. Also available at Bilda.
- *GAMS, A user's guide*. May be downloaded from the GAMS web site.
- *GAMS*. GAMS is installed in the KTH linux computer rooms. It may also be downloaded from the GAMS web site for use on a personal computer.
- Two project assignments that are handed out during the course, March 31 and April 28 respectively.

Additional notes that may be handed out during the course are also included.

Course goals

After completed course, the student should be able to:

- explain fundamental concepts of nonlinear programming;
- explain how fundamental methods for nonlinear programming work;
- illustrate how these methods work by solving small problems by hand calculations;
- starting from a suitably modified real problem, formulate a nonlinear program; make a model in a modeling language and solve the problem;
- analyze the solutions of the optimization problem solved, and present the analysis in writing as well as orally;
- interact with other students when modeling and analyzing the optimization problems.

Examination

The examination is in two parts, projects and final exam. To pass the course, the following is required:

- Pass project assignment 1, with presence at compulsory presentation lecture on Tuesday April 28, and presence at the following dicussion session.

- Pass project assignment 2, with presence at compulsory presentation lecture on Tuesday May 19, and presence at the following dicussion session.
- Pass final exam.

Course registration

Due to the project based nature of this course, students must register no later than March 30. Registration lists will be circulated at the initial lectures. Each student must give an e-mail address where he/she can be reached.

Project assignments

The project assignments are performed in groups, where the instructor determines the division of groups. This division is changed between the two assignments. Assignment 1 is carried out using the modeling language GAMS. For project 2, there is a choice between a modeling assignment, to be carried out using GAMS, or a method assignment, to be carried out using Matlab. The project assignments **must** be carried out during the duration of the course and completed by the above mentioned presentation lectures. Presence at the presentation lectures is compulsory. For passing the projects, the following requirements must be fulfilled:

- At the beginning of the presentation lecture, each group must hand in a well-written report which describes the exercise and the group's suggestion for solving the exercise. Suitable word processor should be used. The report should be on a level suitable for another participant in the course who is not familiar with the group's specific problem.
- When handing in the report, each student should append an individual sheet with a brief self-assessment of his/her contribution to the project work, quantitatively as well as qualitatively.
- At the presentation lecture, all assignments will be presented and discussed. Each student is expected to be able to present the assignment of his/her group. In particular, each student is expected to take part in the discussion. The presentation and discussion should be on a level such that students having had the same assignment can discuss, and students not having had the same assignment can understand the issues that have arisen and how they have been solved.
- Each group should make an appointment for a discussion session with the course leaders. There is no presentation at this session, but these sessions are in the form of a 20 minutes question session, one group at a time. There will be times available the days after the presentation session. One week prior to the presentation lecture, a list of available times for discussion sessions will be made available at Doodle, reachable from the course home page. Each group should sign up for a discussion session prior to the presentation lecture.
- Each participant in the course must contribute to the work of the group. Each group must solve their task independently. Discussion between the groups is encouraged, but each group must individually solve the assignments. It is **not** allowed to use solutions made by others in any form. If these rules are violated, disciplinary actions in accordance with the KTH regulations will be taken.

Each project assignment is awarded a grade which is either fail or pass with grading E, D, C, B and A. Here, the mathematical treatment of the problem as well as the report and the oral presentation or discussion is taken into account. Normally, the same grade is given to all members of a group.

Final exam

The final exam consists of five exercises and gives a maximum of 50 points. At the exam, the grades F, Fx, E, D, C, B and A are awarded. For a passing grade, normally at least 22 points are required. At the exam, in addidion to writing material, no other material is allowed at the exam. Normally, the grade limits are given by E (22-24), D (25-30), C (31-36), B (37-42) and A (43-50).

The grade Fx is normally given for 20 or 21 points on the final exam. An Fx grade may be converted to an E grade by a successful completion of two supplementary exercises, that the student must complete independently. One exercise among the theory exercises handed out during the course, and one exercise which is similar to one exercise of the exam. These exercises are selected by the instructor, individually for each student. Solutions have to be handed in to the

instructor and also explained orally within three weeks of the date of notification of grades.

The final exam is given Wednesday June 3, 14.00-19.00.

Final grade

By identitying A=7, B=6, C=5, D=4, E=3, the final grade is given as

round((grade on proj 1) + (grade on proj 2) + 2 * (grade on final exam)) / 4),

where the rounding is made to nearest larger integer in case of a tie.

Preliminary schedule

"L" means lecture, "E" means exercise session, "P" means project sesstion.

Type	Day	Date	Time	Room	Subject
L1.	Tue	Mar 24	10-12	D42	Introduction. Nonlinear programming models. (pdf)
L2.	Wed	Mar 25	15-17	E52	Optimality conditions for linearly constrained problems. (pdf)
L3.	Fri	Mar 27	15-17	E33	Optimality conditions for nonlinearly constrained problems. (pdf)
P1.	Mon	Mar 30	15-17	D42	Introduction to GAMS.
P2.	Tue	Mar 31	8-10	Orange	GAMS excercise session.
E1.	Wed	Apr 1	10-12	E53	Optimality conditions.
L4.	Mon	Apr 13	15-17	D42	Unconstrained optimization. (pdf)
L5.	Wed	Apr 15	15-17	E33	Unconstrained optimization, cont. (pdf)
L6.	Fri	Apr 17	15-17	D42	Equality-constrained quadratic programming. (pdf)
E2.	Mon	Apr 20	15-17	D42	Unconstrained optimization.
E3.	Wed	Apr 22	15-17	E33	Equality-constrained quadratic programming.
L7.	Thu	Apr 23	15-17	E53	Inequality-constrained quadratic programming. (pdf)
L8.	Mon	Apr 27	15-17	D32	Inequality-constrained quadratic programming, cont. (pdf)
P3.	Tue	Apr 28	10-12	D42	Presentation of project assignment 1.
E4.	Wed	Apr 29	15-17	E33	Inequality-constrained quadratic programming.
L9.	Mon	May 4	15-17	D42	Sequential quadratic programming. (pdf)
E5.	Wed	May 6	15-17	E33	Sequential quadratic programming.
L10.	Fri	May 8	13-15	D32	Interior methods for nonlinear programming. (pdf)
E6.	Mon	May 11	15-17	D42	Interior methods for nonlinear programming.
L11.	Tue	May 12	15-17	E33	Interior methods for nonlinear programming, cont. Semidefinite programming. (pdf)
L12.	Wed	May 13	8-10	E33	Semidefinite programming, cont.
E7.	Mon	May 18	15-17	D42	Semidefinite programming.
P4.	Tue	May 19	13-15	E33	Presentation of project assignment 2.
E8.	Thu	May 21	15-17	E32	Selected topics.

Overview of course contents

- **Unconstrained optimization**
  Fundamental theory, in particular optimality conditions.
  Linesearch algorithms, steepest descent, Newton's method.
  Conjugate directions and the conjugate gradient method.
  Quasi-Newton methods.
  (Chapters 11, 12.1-12.3 and 13.1-13.2 in Griva, Nash and Sofer.)
- **Constrained nonlinear optimization**
  Fundamental theory, optimality conditions, Lagrange multipliers and sensitivity analysis.
  Quadratic programming.
  Primal methods, in particular active-set methods.
  Penalty and barrier methods, in particular primal-dual interior methods.
  Dulal methods, local duality, separable problems.
  Lagrange methods, in particular sequential quadratic programming.
  (Chapters 3, 14.1-14.7, 14.8.1, 15.1-15.5, 16.1-16.3 and 16.7 in Griva, Nash and Sofer.)
- **Semidefinite programming**
  Fundamental theory.
  (Chapter 16.8 in Griva, Nash and Sofer. Separate article in the supplementary course material. Fundamental concepts only.)

Welcome to the course!

Course web page: http://www.math.kth.se/optsyst/grundutbildning/kurser/SF2822/.