Course memo 2022

The latest news can be found on Canvas (canvas.kth.se). It is also possible to contact the involved teachers:

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Assistance with administrative matters, such as course and exam registration are managed by the student service desk:

- **Web**: KTH | EECS | Contact | Student service desk
  https://www.kth.se/en/eecs/studentsupport
- **Service Center Borggården:** Lindstedtsvägen 3, floor 4 (open Mo-Fr 9:00–15:00)
- **Service Center Q:** Malvinas väg 10, entrance hall (open Mo-Fr 9:00–15:00)

Learning Outcomes

The course provides an introduction to electricity markets and electricity pricing. The course also includes models and methods to simulate electricity markets focusing on carbon dioxide emissions.

To pass the course, the students should show that they are able to

- explain how the balance between generation and consumption is maintained in an electric power system, calculate how the frequency is affected by various events in the power system and design the frequency control so that there are sufficient margins in the power system,
- describe the principles of how electricity markets can be designed including regulatory framework to limit carbon dioxide emissions from electricity generation and to promote carbon dioxide free electricity generation,
- perform rough estimations of electricity prices as well as analyse factors that have a large importance for the electricity pricing and carbon dioxide emissions, and to indicate how these factors affect for example producers and consumers,
- apply Monte Carlo simulation to simulate an electricity market and use the simulation results to analyse the consequences of different measures,
- give a short oral presentation of the solution to a problem in electricity pricing and emissions.

Course Registration

In order to access the course on Canvas you need to be registered on the course. Most students can register themselves through their personal KTH menu. Contact student service if there is any problem.

Table 1 Schedule for the lectures.

Lecture	Time and place	Topics	Compendium
Introduction	Monday 29 August, 13–15, V12	Course organisation	–
L1	Thursday 1 September, 13–15, D35	Frequency control	2
L2	Friday 2 September, 8–10, B26	Frequency control	2
L3	Monday 5 September, 13–15, B21	Frequency control Presentation techniques	2
L4	Thursday 8 September, 13–15, B26	Electricity markets	3
L5	Friday 9 September, 8–10, B21	Electricity markets	3
Reserve	Monday 12 September, 13–15, B21		–
L6	Tuesday 13 September, 8–10, E36	Electricity markets	3
L7	Monday 19 September, 10–12, V12	Electricity pricing	4
L8	Friday 23 September, 8–10, B24	Electricity pricing	4
L9	Monday 26 September, 8–10, B24	CO_2 emissions	5
L10	Wednesday 28 September, 13–15, U51	CO_2 emissions	5
L11	Monday 3 October, 10–12, B25	CO_2 emissions	5
L12	Friday 7 October, 8–10, B24	CO_2 emissions	5
Reserve	Monday 10 October, 10–12, V01		–
L13	Monday 31 October, 13–15, V01	Monte Carlo simulation	9
L14	Thursday 3 November, 13–15, E33	Monte Carlo simulation	9
L15	Monday 7 November, 14–16, B26	Monte Carlo simulation	9
Reserve	Wednesday 9 November, 14–16, B26		–

Learning Activities

In order to fulfil the learning objectives of the course, students will have to put some effort into their studies. You can to a large extent decide yourself how to organise your studies, but it is of course important that you plan your work so that you can complete the examination (see below) on the available times.

The following learning activities are offered in the course:

- **Lectures.** The lectures present the most important theory as well as practical examples. There are also ready-made lecture notes for most of the lectures as well as recorded lectures.[1] Lecture notes and recorded lectures are found on the course web page.

  Please notice that lectures marked “Reserve” will not be used unless another occasion has been cancelled. Information about changes in the schedule can be found on the course web page.

- **Lecture assignments.** The lecture assignments are small problems that are solved during the lectures. The idea behind these assignments are that you should get an opportunity to master the basic definitions and calculation methods that are required to pass the course. What is important is therefore not to answer these questions correctly, but to learn something from them (preferably in cooperation with your fellow students). The lecture assignments are therefore not part of the examination in the course.

- **Self-study.** The most important literature in this course are the lecture slides. In addition to the slides, there is also some additional reading on the course web page and an exercise booklet.

1. Please notice that the recordings will be uploaded after the in-class lecture.

Support for Students with Disabilities

Students at KTH with a permanent disability can get support during studies from Funka (see https://www.kth.se/en/student/stod/studier/funktionsnedsattning/funka). Please inform the course coordinator if you have special needs not related to the written exam, and show your certificate from Funka.

- Support measures under code R (i.e. adjustments related to space, time, and physical circumstances, e.g. longer writing time) are always granted.
- Support measures under code P (pedagogical measures) may be granted or rejected by the examiner after you have applied for this in accordance with KTH rules. Support measures under code P are usually always granted for courses given at EECS.

Examination

The examination of this course is divided in multiple parts: seminars (SEM1), written exam (TEN1) and project assignments (PRO1 and PRO2). Students are required to have a Pass grade on the seminars and the exam for the final grade E. Students who have passed the seminars and exam and also pass one of the two optional project assignments will receive the highest grade from the project assignments as the final grade.

The examination includes two types of problems:

- **Basic problems.** The problem text is relatively short and there is a direct question. The problems may include calculations, short theoretical questions and multiple choice questions.
- **Advanced problems.** The problem text is relatively long. The student will have to identify the problem from the text, choose an appropriate solution method and be able to discuss the conclusion of the results.

The grading criteria are shown in table 2. Familiar problems refers to problems that have been explained in lectures, course literature or seminars. New problems refers to problems that can be solved using methods explained in the course, but which have not yet appeared in the course. Moreover, new advanced problem may require that the students have to adjust models and methods in order to apply them on the problem and that they can see the connection between different topics of the course, for example by when running a Monte Carlo simulation to study the impact on CO_2 emissions. Advanced problems may also intentionally be formulated so that there are more than one possible solution; thus, not only the solution itself but also the motivation for the chosen solution will be evaluated.

Table 2 Grading criteria.

Grade	Requirement	Examination
E	• Ability to determine if statements on electricity markets are true or false. • Ability to solve basic problems on frequency control, pricing and emissions as well as Monte Carlo simulation. • Ability to give a short oral presentation of problems in electricity pricing and emissions and to discuss the solutions with other students.	Exam Exam Seminars
D	As for E, as well as *ability to solve advanced but **familiar** problems* on frequency control, pricing and emissions as well as Monte Carlo simulation.	Project assignment I (Project assignment II)
C	As for E, as well as ***very good** ability to solve advanced but **familiar** problems* on frequency control, pricing and emissions as well as Monte Carlo simulation.	Project assignment I (Project assignment II)
B	As for E, as well as *ability to solve **new** advanced problems* on frequency control, pricing and emissions as well as Monte Carlo simulation.	Project assignment II
A	As for E, as well as ***very good** ability to solve **new** advanced problems* on frequency control, pricing and emissions as well as Monte Carlo simulation.	Project assignment II

Seminars

There will be three seminars during the course. There is one problem (with multiple questions) for each

seminar. The questions include a mix of familiar basic and advanced problems on frequency control, pricing and emissions as well as Monte Carlo simulation.

The total score for the seminars is 50 and you need at least 45 points to pass. The points are valid until the re-exam. If you have not completed the seminars by then, you will have to redo them from the beginning next academic year. Hence, if you are at the end your studies and want to get your degree later this academic year then it is important that you plan your studies so that you can complete the seminars in time.

The rules for the seminars are as follows:

- **Group.** The problems may be solved in groups of up to four students. Students may choose themselves who to work with and you do not need to register your group in Canvas.
- **Solution.** The problems should be solved according to the EECS code of honour (see https://www.kth.se/en/eecs/utbildning/hederskodex/inledning).
- **Preparation.** The solution should be explained in slides. The slides do not need to be submitted in advance. The front page of the solution should state the name of all group members, the course code (EG2230) and the date when the report was prepared. The text, figures and table in the slides must include sufficient detail that the argument and calculations can be easily followed also for someone who is not attending the presentation. The principles of calculations that are performed in Matlab or any other software must be described in the slides.
- **Presentation.** The solutions are presented in seminars. The schedule for the seminars are shown in table 3. The number of seats is limited in each seminar; therefore, each student has to sign up for the seminars in advance using the calendar function in Canvas. All group members do not need to attend the same seminar.
- **Score.** Students get points for the questions which they are prepared to present in the seminar. It should be noted that the presented solution does not have to be completely correct. To pass a presentation it is sufficient that the student shows that he or she is able to discuss the solution with other students and the teaching assistant. This means that the student must be able to explain why he or she decided to solve the problem in a particular way and to explain all details in the solution, such as for example how input values have been chosen or why a particular formula has been used. The student should also be able to compare his or her solution to alternative solution methods suggested by the other participants and discuss which method that should be used.

Table 3 Schedule for the seminars

Seminar	Problem	Time and place
Ordinary	1	Wednesday 14 September, 8:15–10:00, Rinman Wednesday 14 September, 15:15–17:00, Rinman Thursday 15 September, 8:15–10:00, Rinman Thursday 15 September, 10:15–12:00, Rinman
Ordinary	2	Tuesday 11 October, 13:15–16:00, Hjärne Wednesday 12 October, 9:15–12:00, M23 Thursday 13 October, 9:15–12:00, K53 Thursday 13 October, 13:15–16:00, K53
Ordinary	3	Tuesday 15 November, 13:15–15:00, Rinman Tuesday 15 November, 15:15–17:00, Rinman Wednesday 16 November, 8:15–10:00, Hjärne Thursday 17 November, 8:15–10:00, B24
Repetition	1–3	Will be decided according to the need

At the beginning of the seminar each student states which questions he or she is ready to present. The ordinary seminars comprises a given selection of questions, as shown in the schedule above. For each question, the course assistant chooses[2] which student that is giving his or her presentation. If there is time left, several students may present the same question. The repetition occasions can be used to present those questions that the student has been skipped earlier or have failed to present. For each partici-

2. The selection is done almost, but not quite entirely, randomly.

pating student, the course assistant then chooses[3] one or more questions to present.

If a student has passed all presentations during a seminar (or if the student is not selected to present) then points will be rewarded for all questions that the student was prepared to present. However, if a student fails at least one oral presentation, no points at all will be rewarded for this seminar, regardless of which other questions that the student have been prepared to present!

Exam

The exam can be completed either by participating in partial exams during the course or by writing the final exam. In both cases the students will be given a mix of familiar and new basic problems on frequency control, electricity markets, pricing and emissions as well as Monte Carlo simulation.

In order to attend partial exams and the final exam, students must register in advance. Please contact student service if you have difficulties registering.

The following aids are allowed at the exams and partial exams:

- Calculator without information relevant to the course.
- One **handwritten**, **single-sided** A4-page with **your own** notes (original, not a copy), which should be handed in together with the exam.

Please notice that if you are about to finalise your studies and want to get your degree then it is important that you plan your studies so that you can pass the exam during the course (partial exams) or in one of the two occasions for the final exam that are offered. However, according to KTH Guideline on course syllabus, grading system and examination at education on all cycles (section 7.2)[4] students have the right to demand an extra exam if there is a proper cause; in short, it is required that you have failed the last two exams and that this course is the only course that is left before you can get your degree. If you are granted an extra exam, you will agree upon a date for the exam with the examiner. If you for some reason cannot prepare to the extent that you would desire (for example due to a new employment) then it is important that you contact the examiner and reschedule the exam, because if you fail an exam that you have requested yourself then you will have to wait for the next scheduled exam in order to make another attempt.

Partial exams

There will be three partial exams during the course, which together correspond to the final exam. The schedule of the partial exams is shown in table 4. The maximal score of the three partial exams is 60 points, and you need to have at least 48 points to pass.

Table 4 Schedule for partial exams.

Partial exam	Time and place	Problems
KS1	Friday 16 September, 8–9, V22	Frequency control Electricity markets
KS2	Friday 14 October, 8–9, V34	Pricing and emissions
KS3	Friday 18 November, 8–9, B23, B24	Monte Carlo simulation

The partial exams are one hour each and the same rules applies as for an exam. This means that students must arrive no later than 30 minutes after the start of the partial exam and nobody may leave the room until 60 minutes have passed (i.e., all students have to remain in the room until the end of the partial exam).

There is no complementary test for the partial exams, i.e., students who get less than 48 points in total on the three partial exams will have to write the complete final exam instead.

Final exam

The final exam is three hours long. The maximal score is 60 points, and you need to have at least 48 points to pass. Examinees who have failed the exam but are close to the requirement for passing (i.e., 46 or 47 points) may write a complementary test. If the result of this test is approved, the student

3. This selection is also done almost, but not quite entirely, randomly.
4. Available at https://intra.kth.se/en/styrning/styrdokument/regler/utbildning.

will pass the exam. The date of the extra test is decided by the course coordinator after consulting the concerned students. However, the student must notify his or her intention to write the complementary test no later than one month after the exam.

Project assignment I

The first project assignment is voluntary and can yield the grades C or D if completed successfully. The problems are familiar advanced problems on frequency control, electricity pricing and emissions as well as Monte Carlo simulation.

The total score of project assignment I is 50. Students who receive at least 40 points will get the grade C and students who receive at least 30 points will receive the grade D.

The rules for project assignment I are as follows:

- **Group.** The problems may be solved individually or by a group of two students. Students may choose themselves who to work with, but students are requested to set up their group in Canvas using the "People" section.
- **Solution.** The problems should be solved according to the EECS code of honour (see https://www.kth.se/en/eecs/utbildning/hederskodex/inledning).
- **Preparation.** The solution should be explained in slides. The slides should be uploaded in Canvas using the "Assignments" section. There are two Canvas assignments for each problem: one for the slides themselves and one for additional program code. The deadlines for submission are shown in table 5.

  The front page of the solution should state the name of all group members, the course code (EG2230) and the date when the report was prepared. The text, figures and table in the slides must include sufficient detail that the argument and calculations can be easily followed *without an oral explanation*. The principles of calculations that are performed in Matlab or any other software must be described in the slides.
- **Defence.** Each group member must orally defend the group's solution. Sign up for a defence time using the calendar function in Canvas. Notice that you sign up as a group, but that each group member will have to explain the solution individually (while the other group member is waiting).
- **Score.** The solutions will be marked in Canvas. There will be a score reduction for errors in the presented solutions. However, students will not receive any score for a problem if they did not attend the defence or if they cannot respond well enough to the course assistant's questions about how they have solved the problem.

Table 5 Schedule for project assignment I.

Problems	Release date	Deadline for submission
1	Friday 16 September	Friday 23 September, 8:00 am.
2	Friday 14 October	Tuesday 25 October, 8:00 am.
3	Friday 18 November	Tuesday 29 November, 8:00 am.

Project assignment II

The second project assignment is voluntary and can yield the grades A to D if completed successfully. The total score of the project assignment II is 50. Students who receive at least 40 points will get the grade A and students who receive at least 30 points will receive the grade B. Students who do not get at least 30 points in project assignment II can get the grades C or D by combining the results from both project assignments. For each problem, the student may count the best score from project assignments I and II respectively. If this sum is at least 40 points then the student will get the grade C and students who receive at least 30 points will receive the grade D.

The rules for project assignment II are as follows:

- **Group.** The problems may be solved individually or by a group of two students. Students may choose themselves who to work with, but students are requested to set up their group in Canvas using the "People" section.
- **Solution.** The problems should be solved according to the EECS code of honour (see

https://www.kth.se/en/eecs/utbildning/hederskodex/inledning).

- **Preparation.** The solution should be explained in slides. The slides should be uploaded in Canvas using the "Assignments" section. There are two Canvas assignments for this project assignment: one for the slides themselves and one for additional program code. The deadline for submission is Thursday 15 December, 8:00.

  The front page of the solution should state the name of all group members, the course code (EG2230) and the date when the report was prepared. The text, figures and table in the slides must include sufficient detail that the argument and calculations can be easily followed *without an oral explanation*. The principles of calculations that are performed in Matlab or any other software must be described in the slides.
- **Defence.** Each group member must orally defend the group's solution. Sign up for a defence time using the calendar function in Canvas. Notice that you sign up as a group, but that each group member will have to explain the solution individually (while the other group member is waiting).
- **Score.** The solutions will be marked in Canvas. There will be a score reduction for errors in the presented solutions. However, students will not receive any score for a problem if they did not attend the defence or if they cannot respond well enough to the course assistant's questions about how they have solved the problem.

Course Evaluation Committee

To evaluate and improve the course, we need a few students who are willing to participate in the course evaluation committee. The committee is meeting shortly after the ordinary exam. In connection with this meeting, the Division of Electric Power and Energy Systems will treat the participants to lunch. Students who are interested in participating can contact the course coordinator by e-mail or in connection to a lecture.