Course memo spring 2022

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

Mikael Amelin (examiner, lecturer)
Tel.: 08 - 790 7755
E-mail: amelin@kth.se

Lennart Söder (lecturer)
Tel.: 08 - 790 8906
E-mail: lsod@kth.se

Assistance with administrational 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 10:00–14:00)
- **Service Center Q:** Malvinas väg 10, entrance hall
  (open Mo–Fr 10:00–14:00)

Learning Outcomes

The aim of the course is that the students learn how renewable power generation affects operation and planning of electric power systems, and how the design of the electricity market can be adjusted when the amount of varying, renewable generation (for example wind power or solar energy) is increasing. The course is also considering additional markets that support renewable generation, for example markets for green certificates and emission trading. The course comprises theory, computation methods (in particular optimisation theory) as well as examples from reality.

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

- describe the principles of how an electricity market and other related markets can be organised, and analyse how the design of these markets affect renewable generation,
- formulate planning problems of hydro-thermal power systems in electricity markets with large volumes of varying renewable generation,
- analyse how the grid regulation affects the development of renewable generation,
- describe and explain the challenges in a power system with very large volumes of varying renewable generation,
- give a short oral presentation of the solution to a problem within power generation, environment and markets.

Table 1 Schedule for the lectures.

Lecture	Time and place	Topics
Intro	Monday 21 March, 8–10, B21	Course organisation.
L1–3	Recorded lectures, Canvas	Externalities.
L4	Thursday 24 March, 13–15, D32	Externalities.
L5	Friday 25 March, 10–12, B25	Externalities.
L6	Tuesday 29 March, 13–15, B21	Externalities.
L7	Wednesday 30 March, 10–12, B21	Externalities.
L8	Thursday 31 March, 13–15, D34	Externalities.
Reserve	Friday 1 April, 10–12, B23	
L9	Wednesday 6 April, 15–17, D42	Short-term planning.
L10	Thursday 7 April, 13–15, D42	Short-term planning.
L11	Friday 8 April, 10–12, D32	Short-term planning.
L12	Friday 8 April, 13–15, E35	Short-term planning.
Reserve	Monday 11 April, 8–10, B21	
L13	Tuesday 26 April, 13–15, B21	Grid regulation.
L14	Wednesday 27 April, 10–12, B21	Grid regulation.
Reserve	Thursday 28 April, 8–10, B21	
L15	Friday 29 April, 10–12, B22	Grid regulation
L16	Wednesday 4 May, 13–15, B23	Future power systems.
L17	Thursday 5 May, 10–12, B21	Future power systems.
L18	Friday 6 May, 10–12, B22	Future power systems.
L19	Monday 9 May, 8–10, B21	Future power systems.
L20	Tuesday 10 May, 13–15, B21	Future power systems.
Reserve	Wednesday 11 May, 10–12, B22	

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 desk if there is any problem.

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. Before the lectures you should preferably prepare yourself by reading lecture notes for the lectures, which will be made available 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 lecture. 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 im-

portant is therefore not to answer these questions correctly, but to learn something from them (preferably in cooperation with your fellow students).

- **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.

Support for Students with Disabilities

Students at KTH with a permanent disability can get support during studies from Funka (see https://www.kth.se/student/studentliv/funktionsnedsattning). 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.

Code of Honour

In this course, the EECS code of honor applies, see: http://www.kth.se/en/eecs/utbildning/hederskodex.

Examination

The examination of this course is divided in two parts: exam (TEN1) and project assignments (PRO1). Students have to complete both these parts to receive their final grade. The grading scale of the exam is just pass or fail and the final grade of the course is therefore equal to the grade of the project assignments. There are several ways to complete each of the two parts of the examination. Further details are provided below.

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 to the new problem and that they can see the connection between the different topics of the course, for example by formulating an optimisation problem to solve a problem on frequency control. 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.

Exam

The exam can be completed either by participating in partial exams during the course or by writing the final exam. n both cases the students will be given a mix of familiar and new basic problems on externalities, short-term planning, grid regulation and future power systems.

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.

Table 2 Grading criteria.

Grade	Requirement	Examination
E	• Ability to solve basic problems on externalities, short-term planning, grid regulation and future power systems. • Ability to give a short oral presentation of problems in power generation, environment and markets and to discuss the solutions with other students.	Exam Project assignments
D	As for E, as well as *ability to solve advanced but **familiar** problems* on externalities, short-term planning and grid regulation.	Project assignment CD
C	As for E, as well as ***very good** ability to solve advanced but **familiar** problems* on externalities, short-term planning and grid regulation.	Project assignment CD
B	As for E, as well as *ability to solve **new** advanced problems* on externalities, short-term planning and grid regulation.	Project assignment AB
A	As for E, as well as ***very good** ability to solve **new** advanced problems* on externalities, short-term planning and grid regulation.	Project assignment AB

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)[1] 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 3. The maximal score of the three partial exams is 60 points, and you need to have at least 48 points to pass.

Table 3 Schedule for partial exams.

Partial exam	Time and place	Problems
KS1	Wednesday 6 April, 13–14, Q33	Externalities.
KS2	Wednesday 13 April, 13–14, Q33	Short-term planning.
KS3	Monday 16 May, 8–9, V22	Grid regulation. Future power systems.

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).

Final exam

The final exam is four 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 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.

1. Available at https://intra.kth.se/en/styrning/styrdokument/regler/utbildning-overgripande-1.660834.

Project Assignments

The project assignments are divided in three parts: AB, CD and E. Only project assignment E is mandatory. Students who participate in the other assignments have the possibility to improve their grade to A–D. Each assignment includes several problems, which are to be solved individually or in a small group. Except for problem E4, students may choose who to work with themselves. It is not necessary to work with the same students for each problem, i.e., students may work in one group for problem E1 and in another for problem E2, etc.

Project assignment E

This assignment is mandatory for all students. The problems are a mix of familiar basic and advanced problems concerning externalities, short-term planning, grid regulation and future power systems.

The total score of the project assignment E is 60 and you need at least 54 points to pass. The points are valid until the re-exam. If you have not completed the seminar assignments 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 all assignments in time.

The procedure for this assignment is as follows:

- **Group.** Problems E1–3 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. Problem E4 is solved in groups of three or more students and the groups are decided by the teachers. You can see in Canvas to which group you have been assigned.
- **Solution.** The problems should be solved according to the EECS code of honor (see https://www.kth.se/en/eecs/utbildning/hederskodex).
- **Preparation.** The solution should be explained in slides. The slides for problems E1–3 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 (EG2220) 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, GAMS, Excel or any other software must be described in the slides.

  The slides for problem E4 should be uploaded in Canvas using the “Assignments” section. The deadline for submitting the presentation is Thursday 12 May at 8:00.
- **Presentation.** The solutions are presented in seminars. The schedule for the seminars are shown in table 4. The number of participants 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 for problem E1–3. I

  In seminar E4, students sign up as groups. The number of groups that can present in each seminar is limited; therefore each group has to sign up for the seminar in advance using the calendar function in Canvas. All group members are expected to participate in the same presentation; however, if there are special circumstances that prevent a student from attending then it is also possible to present the work alone in a repetition 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.

  Please notice that group members who are not active during the presentation of problem E4 will not receive any points.

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

Table 4 Schedule for the seminars

Seminar	Assignments	Time and venue
Ordinary	E1	Tuesday 5 April, 8:15–10:00, Zoom Tuesday 5 April, 10:15–12:00, Zoom
Ordinary	E2	Monday 11 April, 10:15–12:00, Zoom Tuesday 12 April, 13:15–15:00, Zoom
Ordinary	E3	Tuesday 3 May, 13:15–15:00, Zoom Wednesday 4 May, 10:15–12:00, Zoom
Ordinary	E4	Friday 13 May, 10:15–12:00, B21 Friday 13 May, 13:15–15:00, B21
Repetition	E1–4	Tuesday 17 May, 10:15–12:00, Zoom

time left, several students may present the same assignment. The repetition occasions can be used to present those assignments that the student has been skipped earlier or have failed to present. For each participating student, the course assistant then chooses[3] one or more assignments 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 assignments that the student have been prepared to present!

Project assignment CD

This assignment is voluntary and can yield a higher final grade in the course. The problems are familiar advanced problems on externalities, short-term planning and grid regulation.

The total score of the project assignment CD is 52. The points are valid until the re-exam. If you have not completed the project assignments by then, you will have to redo them from the beginning next academic year. Students who receive at least 42 points will get the grade C and students who receive at least 32 points will receive the grade D. The score for project assignment CD may include results from project assignment AB, if that score should be higher than the score of the corresponding problem in project assignment CD, i.e., a student's score from problem AB1 can replace the score from problem CD1, the score of AB2 can replace CD2, etc.

The procedure for this project assignment is 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).
- **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 front page of the solution should state the name of all group members, the course code (EG2220) and the date when the report was prepared. The text, figures and tables 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, GAMS, Excel 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

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

attend the defence or if they cannot explain well enough how they have solved the problem.

Table 5 Schedule for project assignment CD.

Problem	Release date	Deadline for submission
CD1	Wednesday 6 April	Wednesday 13 April, 8:00 am.
CD2	Wednesday 13 April	Wednesday 27 April, 8:00 am.
CD3	Monday 16 May	Monday 23 May, 8:00 am.

Project assignment AB

This assignment is voluntary and can yield a higher final grade in the course. The problems are new advanced problems on externalities, short-term planning and grid regulation.

The total score of the project assignment AB is 52. The points are valid until the re-exam. If you have not completed the seminar assignments by then, you will have to redo them from the beginning next academic year. Students who receive at least 42 points will get the grade A and students who receive at least 32 points will receive the grade B.

The procedure for this project assignment is 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).
- **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 deadline for submission is Tuesday 26 May.

  The front page of the solution should state the name of all group members, the course code (EG2220) and the date when the report was prepared. The text, figures and tables 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, GAMS, Excel 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 explain well enough 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.