

ENERGY AND FUSION RESEARCH

Course PM Spring 2019

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Course home page: <https://kth.instructure.com/courses/7543>
(see also www.kth.se/social/course/ED2200)

COURSE SUBJECT

In earlier days, the question "For how long will the fossil fuels last?" was often raised, but the development during the last decades rather imply the question "When can we free ourselves from the dependence on fossil fuels?".

In this course, a background is given to the problems concerning future energy production that we are realizing today and that will become critical towards the mid-century unless new energy sources are developed. We will also discuss the alternative energy sources that are known today. Within fusion research, the goal is to produce a sustainable energy source for large scale generation of electricity. By using the surplus energy that is released in fusion reactions, as light atomic nuclei merge, the final benefit comes from an enduring, affordable and environmentally friendly "Sun on earth".

The Alfvén Laboratory at KTH collaborates internationally in this field. This introductory course will provide the physical and technological basics and give a picture of the state of present day fusion research. Development in fusion has now reached a state where we may say, with some confidence, that fusion power will indeed be realized. In the course, different solutions to this "the greatest technological challenge ever pursued by man" will be presented.

COURSE LITERATURE

- *Fusion Physics – introduction to the physics behind fusion energy*, J. Scheffel and P. Brunsell
- *Exercises with solutions*, J. Scheffel and P. Brunsell

Course book and exercises are freely available as pdf:s. Physical course book cost is 200 kr.

ABOUT TEACHING AND LEARNING IN THIS COURSE

Lectures (Le) provide an overview of the energy provision problem and the development of fusion research, as well as an understanding for important problems in fusion research. Some course book material will be taught as home assignments, being distributed at each lecture.

Home assignments provide credits for the course examination.

Class exercises (Ex) develop skills to solve formal problems within fusion research and an opportunity to discuss questions encountered during the studies. Normally a few problems are solved on the blackboard, whereafter the students solve a given problem as a group exercise. Protocols from each group are handed in at the end of the session, as part of the examination.

Disability - Support via Funka

If you have a disability, you may receive support from Funka.

<https://www.kth.se/en/student/studentliv/funktionsnedsattning>

Inform the teacher regarding any need you may have. Funka does not automatically inform the teacher.

EXAMINATION

Continual examination, based on a credit point system, is used.

The grades “pass” (P) or “fail” (F) are determined by the total number of credit points accumulated during the course. Maximum 42 credit points are available. A minimum of 30 credit points is required for grade “pass”. Students achieving 26-29.5 credit points may be awarded “pass” grade after completing an additional exam within 6 weeks after the course.

Course activities required for examination:

HOME ASSIGNMENTS are six in total and provide a total maximum of 30 credit points.

They are handed out each week, and should be handed in at the first lecture the week after.

The first five assignments cover the subjects presented in the lectures the same week. Each assignment give maximally 4 credit points.

The *second and sixth assignments* contain surveys on the Canvas course platform as first questions. These *must* be answered for receiving credit points from assignments two and six.

The *first part* of the *sixth assignment* covers last week’s lectures and can give 4 credit points while the *second part* of the sixth assignment covers the whole course and can give maximally 6 credit points.

- Note that your individual understanding is in focus; you are free to cooperate with other students during the solution of the problems, but your answers *must be formulated from your personal understanding*. Measures will be taken in cases of plagiarism!

GROUP WORK SESSIONS during class exercises may provide 12 credit points in total. Handed in protocols for each session are graded “pass” or “fail”. Constructive participation is a minimum requirement for the “pass” grade. Protocols graded “pass” in 4-6 sessions give 12 credit points while protocols graded “pass” in 2-3 sessions give 6 credit points.

COURSE PROGRAM

Week	Day	Date	Time	Place	Le/Ex	Topic
12	Mon	18 Mar	10-12	E33	Le 1	Fusion in nature, future energy needs, energy alternatives (Ch 1.1).
	Wed	20 Mar	15-17	E32	Le 2	Energy alternatives, cont’d., fusion reactions, brief fusion history (Ch 1.2).
	Thu	21 Mar	10-12	E32	Ex 1	Le 1, 2
13	Mon	25 Mar	10-12	E32	Le 3	Lawson criterion, quality parameters of the fusion plasma (Ch 1.2, 2).
	Wed	27 Mar	15-18	E32	Le 4	Plasma models; particle, kinetic and fluid models (Ch 2).
	Thu	28 Mar	10-12	E32	Ex 2	Le 3, 4
14	Mon	1 Apr	10-12	D35	Le 5	Equilibrium, plasma waves (Ch 3, 4).
	Wed	3 Apr	15-18	E32	Le 6	Stability (Ch 4).
	Thu	4 Apr	10-12	D35	Ex 3	Le 5, 6
15	Mon	8 Apr	10-12	E32	Le 7	Transport (Ch 5).
	Wed	10 Apr	15-17	E32	Le 8	Transport cont’d (Ch 5).
	Thu	11 Apr	10-12	D35	Ex 4	Le 7, 8
17	Wed	24 Apr	15-17	E32	Le 9	Radiation, boundary, heating (Ch 6).
	Thu	25 Apr	10-12	E33	Le 10	Diagnostics (Ch 7). Visit to the Alfvén laboratory.
18	Mon	29 Apr	10-12	D35	Ex 5	Le 9, 10
19	Tue	7 May	15-17	E32	Le 11	Alternative concepts, inertial confinement fusion (Ch 8).
	Wed	8 May	15-17	E32	Le 12	Reactor, safety, environment (Ch 9).
	Thu	9 May	10-12	E32	Ex 6	Le 11, 12