ED2200 ENERGY AND FUSION RESEARCH
Course PM 2023

Course teacher: Per Brunsell
Email: brunsell@kth.se, phone: 790 6246
Division of Electromagnetic Engineering and Fusion Science, EECS
Visiting address: Teknikringen 31, KTH
Course home page: https://canvas.kth.se/courses/38988
(https://www.kth.se/kursutveckling/ED2200 for course development)

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 endurable, affordable and environmentally friendly ”Sun on earth”.

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 on the course home pages as PDF files.

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.
Home assignments provide credits for the course examination.
Class exercises and group work (Ex) develop skills to solve problems within fusion research and an opportunity to discuss questions encountered during the studies. A few problems are solved by the teacher on the blackboard during the first hour, where after the students solve a given problem in the classroom as a group exercise the second hour.

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.

HOME ASSIGNMENTS are 6 in total and provide a total maximum of 30 credit points to the examination. They are posted on the course web at the first lecture each week, and should be uploaded on Canvas before the first lecture in the following week.

Home assignments must be uploaded as PDF files. Handwritten assignments scanned with SwiftScan is ok.

- *The first five assignments* cover the subject presented in the lectures the same week. Each assignment gives maximally 4 credit points to the examination.
- 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 an additional 6 credit points. NOTE: 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 (see above) are 6 in total and provide a total maximum of 12 credit points to the examination. Group work is carried out during the second hour of Exercise (Ex) sessions. Protocols from each group of typically three students are handed in at the end of the session. Each group work give maximally 2 credit points to the examination.

COURSE PROGRAM 2023

Week	Day	Date	Time	Place	Le/Ex	Topic
12	Mon	20 Mar	15-17	E51	Le 1	Fusion in nature, future energy needs, energy alternatives (Ch 1.1).
	Tue	21 Mar	10-12	W37	Le 2	Energy alternatives (cont'd), fusion reactions, brief fusion history (Ch 1.2).
	Thu	23 Mar	10-12	E35	Ex 1	Le 1, 2
13	Mon	27 Mar	15-17	E51	Le 3	Lawson criterion, quality parameters of the fusion plasma (Ch 1.2, 2).
	Tue	28 Mar	10-12	E52	Le 4	Plasma models; particle, kinetic and fluid models (Ch 2).
	Thu	30 Mar	10-12	E52	Ex 2	Le 3, 4
14	Mon	3 Apr	15-17	E51	Le 5	Equilibrium, plasma waves (Ch 3, 4).
	Tue	4 Apr	10-12	E35	Le 6	Stability (Ch 4).
	Thu	6 Apr	10-12	E51	Ex 3	Le 5, 6
16	Mon	17 Apr	15-17	E51	Le 7	Transport (Ch 5).
	Wed	19 Apr	13-15	W37	Le 8	Transport cont'd (Ch 5).
	Thu	20 Apr	10-12	E35	Ex 4	Le 7, 8
17	Mon	24 Apr	15-17	E51	Le 9	Radiation, boundary, heating (Ch 6).
	Wed	26 Apr	13-15	E35	Le 10	Diagnostics (Ch 7). Visit to the Alfvén laboratory.
	Thu	27 Apr	10-12	E51	Ex 5	Le 9, 10
19	Tue	2 May	15-17	D34	Le 11	Alternative concepts, inertial confinement fusion (Ch 8).
	Wed	3 May	13-15	W37	Le 12	Reactor, safety, environment (Ch 9).
	Thu	4 May	10-12	E51	Ex 6	Le 11, 12

Disability

If you have a disability, you may receive support from Funka, KTH's coordinator for students with disabilities, see https://www.kth.se/en/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) are generally granted by the examiner.
- 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. Normally, support measures under code P will be granted.