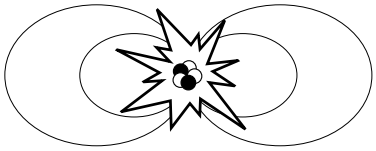

FUSION PLASMA PHYSICS
School of Electrical Engineering
KTH
Jan Scheffel and Per Brunsell

ENERGY AND FUSION RESEARCH

Spring 2014

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Course home page: **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 experiences during the last decades have given us reasons to instead ask 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 provision 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 an energy source for large scale generation of electricity. By using the surplus energy that is released when light atomic nuclei merge (fusion), the final benefit comes from an endurable and environmentally friendly ”Sun on earth”. The Alfvén Laboratory at KTH is part of the international collaboration 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. The development 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 literature cost: 250 kr.

ABOUT TEACHING AND LEARNING IN THIS COURSE

The lectures 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. **The home assignments** provide credits for the course examination. **The class exercises** 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, where after 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.

EXAMINATION

Continuous 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. A maximum of 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 the grade "pass" after completing an additional oral exam within 6 weeks after the course.

The course activities required for **examination** are as follows:

- ***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 and each assignment give maximally 4 credit points. The first part of the *sixth assignment* covers the 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 individually formulated*!
- ***Group work sessions*** at the 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
13	Tue	25 Mar	10-12	E32	Le 1	Fusion in nature, future energy needs, energy alternatives (Ch 1.1).
	Thu	27 Mar	10-12	E31	Le 2	Energy alternatives cont'd., fusion reactions, brief fusion history (Ch 1.2).
	Thu	27 Mar	13-15	E31	Ex 1	Le 1, 2
14	Mon	31 Mar	10-12	D34	Le 3	Lawson criterion, quality parameters of the fusion plasma (Ch 1.2, 2).
	Thu	3 Apr	09-12	E31	Le 4	Plasma models; particle, kinetic and fluid models (Ch 2).
	Fri	4 Apr	10-12	E36	Ex 2	Le 3, 4
15	Mon	7 Apr	13-15	E35	Le 5	Equilibrium, plasma waves (Ch 3, 4).
	Tue	8 Apr	13-16	E36	Le 6	Stability (Ch 4).
	Thur	10 Apr	10-12	D34	Ex 3	Le 5, 6
16	Mon	14 Apr	10-12	D41	Le 7	Transport (Ch 5).
	Tue	15 Apr	13-15	E36	Le 8	Transport cont'd (Ch 5).
	Thu	17 Apr	10-12	E32	Ex 4	Le 7, 8
17	Wed	23 Apr	10-12	E36	Le 9	Radiation, boundary, heating (Ch 6).
	Thu	24 Apr	10-12	D34	Le 10	Diagnostics (Ch 7). Visit to the Alfvén laboratory.
	Fri	25 Apr	13-15	E36	Ex 5	Le 9, 10
19	Mon	5 May	13-15	E32	Le 11	Alternative concepts, inertial confinement fusion (Ch 8).
	Wed	7 May	13-15	E32	Le 12	Reactor, safety, environment (Ch 9).
	Fri	9 May	13-15	E36	Ex 6	Le 11, 12