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

ENERGY AND FUSION RESEARCH

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COURSE SUBJECT

In earlier days, the question ”For how long will the fossil fuels last?” was often raised, but experiences during the last decade 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
The course literature cost is 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 grade is determined by the total number of credit points accumulated during the course. The grades are "pass" (P) or "fail" (F). A maximum of 42 credit points are available. A minimum of 30 credit points are 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:

- *Answering pre-knowledge test questions, g*iven at the start of the course together with the first home assignment. Answering all of the pre-knowledge test questions is a requirement for receiving credit points for the first home assignment but the pre-knowledge test questions are not marked and will not give any credit points themselves. It is important that these questions are answered without any use of books or the internet!
- *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.
- *Active participation in problem solving group work sessions* at the class exercises provide 12 credit points in total for active participation in at least 4 sessions or alternatively 6 credit points for active participation in 2-3 sessions.

PROGRAM

Week	Day	Date	Time	Place	Le/Ex	Topic
12	Mon	22 Mar	13-15	D34	Le 1	Fusion in nature, future energy needs, energy alternatives (Ch.1.1).
	Tue	23 Mar	13-15	V32	Le 2	Energy alternatives cont'd., fusion reactions, brief fusion history (Ch 1.2).
	Fri	26 Mar	10-12	E36	Ex 1	Le 1, 2
13	Mon	29 Mar	13-15	D34	Le 3	Lawson criterion, quality parameters of the fusion plasma (Ch. 1.2, 2).
	Tue	30 Mar	13-16	V32	Le 4	Plasma models; particle, kinetic and fluid models (Ch. 2).
	Thu	1 Apr	15-17	E36	Ex 2	Le 3, 4
15	Mon	12 Apr	13-15	D34	Le 5	Equilibrium, plasma waves (Ch. 3, 4).
	Tue	13 Apr	13-16	V32	Le 6	Stability (Ch. 4).
	Thu	15 Apr	15-17	D41	Ex 3	Le 5, 6
16	Mon	19 Apr	13-15	D34	Le 7	Transport (Ch 5).
	Tue	20 Apr	13-15	V32	Le 8	Transport cont'd (Ch 5).
	Fri	23 Apr	10-12	E36	Ex 4	Le 7, 8
17	Mon	26 Apr	13-15	D34	Le 9	Radiation, boundary, heating (Ch. 6).
	Tue	27 Apr	13-15	V32	Le 10	Diagnostics (Ch 7). Visit to the Alfvén laboratory.
	Fri	30 Apr	10-12	E36	Ex 5	Le 9, 10
18	Mon	3 May	13-15	D34	Le 11	Alternative concepts, inertial confinement fusion (Ch. 8).
	Tue	4 May	13-15	V32	Le 12	Reactor, safety, environment (Ch. 9).
	Fri	7 May	10-12	E36	Ex 6	Le 11, 12