FED3320 Fusion Research 8.0 credits

Fusionsforskning

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for FED3320 valid from Spring 2012

Grading scale

Education cycle

Third cycle

Specific prerequisites

Courses FED3210 and FED3230 (or corresponding) are prerequisites.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

When completing the course, the student should be able to

- Give an account of fusion reactions and conditions for fusion energy production
- Explain different experimental approaches to fusion
- Discuss reactor power balance and thermal stability
- Derive and discuss MHD tokamak instabilities from the Energy principle
- Give an account of current stability issues for tokamaks
- Assess confinement and experimental confinement scalings
- Discuss limits of operations for magnetic fusion devices
- Discuss the value of non-tokamak aproaches to magnetic fusion
- Give an account of important experiments around the world
- Explain the basic principles of inertial fusion and the status of research
- Give an account of the safety and environmental aspects of fusion
- Discuss the motivation for fusion energy research in a global perspective

Course contents

Fusion reactions. Fusion in nature. Future energy demands. Energy alternatives. Fusion history. Different approaches to fusion. The Lawson criterion. Breakeven, ignition. Quality parameters of the fusion plasma. Fusion reactor power balance and thermal stability. Heating of fusion plasmas. The Energy principle applied to different configurations. Tokamak stability; MHD and non-MHD modes. Resistive instabilities. Resistive wall modes and feedback control. Density and beta limits. Edge localized mode (ELM), multi-faceted asymmetric radiation from the edge (MARFE). Fishbones. Disruptions. Confinement modes and energy confinement scaling laws. Reversed shear scenarios. Characteristics of different magnetic confinement schemes. Spherical and compact tokamaks. RFP and stellarator stability. Reactor design and reactor studies. ITER design. Magnetized target fusion. Inertial fusion; direct and indirect drive, fast ignition, the large experiments NIF and LMJ. Safety and environmental aspects of fusion. Fusion research at KTH and at different experiments in the world.

Disposition

Discussion meetings.

Course literature

Parts of the following literature, or similar:

- J. Scheffel and P. Brunsell, Fusion Physics, KTH 2007.
- J. P. Freidberg, Plasma Physics and Fusion Energy,
- Cambridge University Press 2007.
- J. Wesson, Tokamaks, Oxford University Press 2004.
- W. M. Stacey, Fusion Plasma Physics, Wiley 2005.

- A. A. Harms et.al., Principles of Fusion Energy, World Scientific, 2000.
- S. Pfalzner, An Introduction to Inertial Confinement Fusion, Taylor and Francis 2006.

Examination

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Final oral exam.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.