PX438-7.5 Physics for Fusion Power

22/23

Department
Physics
Level
Undergraduate Level 4
Module leader
Ben McMillan
Credit value
7.5
Module duration
5 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module discusses the physics of thermonuclear fusion, which is a candidate solution for the energy demands of our society. Nuclear fusion is promising due to the unlimited amount of fuel, the fact that it is CO2 neutral, the limited amount of long-lived radioactive waste, and the inherent safety of the approach. As a 'minor' drawback, one could mention that a working concept for this approach still needs to be demonstrated!

For reasons we will discuss, the construction of a working fusion reactor is hindered by several, in themselves rather interesting, physics phenomena. The module discusses the two main approaches: inertial confinement and magnetic confinement, with the emphasis on the latter since it is further developed. The module will deal with both the physics phenomena as well as with the boundary conditions that must be satisfied for a working reactor. At the end of the module you should have an understanding of the concepts in the field and the reasons behind the choices made in the current experimental designs.

Module web page

Module aims

To discuss aspects of nuclear fusion and advanced plasma physics relevant to the construction of fusion power stations

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

The fusion process in stellar interiors

The density/temperature/confinement time triple product for energy breakeven in a fusion reactor

Magnetic confinement fusion: equilibrium: flux surfaces, toroidal geometry; stability: the energy principle, current limits, beta limits; heating: Ohmic heating limitations, neutral beams and radio waves; collisional and turbulent transport of particles and energy

Inertial confinement fusion: Rayleigh-Taylor instability and implications for implosion symmetry; direct and indirect drive; parametric instabilities and laser reflectivity

Environmental and socio-economic aspects of fusion power

Learning outcomes

By the end of the module, students should be able to:

- Explain how plasma physics defines the design parameters of fusion power plants
- Explain the physics of fusion power plasma heating, confinement and stability
- Start postgraduate research in either fusion or plasma physics

Indicative reading list

K. Miyamoto, Controlled Fusion and Plasma Physics, Taylor & Francis Ltd (2006); R. J. Goldston and P. H. Rutherford, Introduction to Plasma Physics, IoP (1995)

View reading list on Talis Aspire

Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking.

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	15 sessions of 1 hour (20%)
Private study	60 hours (80%)
Total	75 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on past exam papers

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B2

	Weighting	Study time
In-person Examination	100%	
Answer two questions		

Feedback on assessment

Personal tutor, group feedback

[Past exam papers for PX438]

Availability

Courses

This module is Optional for:

- Year 4 of UPXA-F303 Undergraduate Physics (MPhys)

This module is Option list B for:

- Year 4 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)

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