

## **Engineering Tripos Part IIB, 4I11: Advanced Fission and Fusion System, 2022-23**

### **Module Leader**

[Dr E Shwageraus](#) [1]

### **Lecturers**

[Dr N Read and Dr E Shwageraus](#) [2]

### **Timing and Structure**

Lent Term. 16 lectures, 4 examples papers, 2 examples classes in support of coursework. Assessment: 100% coursework

### **Prerequisites**

4M16

### **Aims**

The aims of the course are to:

- provide an understanding of advanced systems, why they are being pursued, what their advantages are and their difficulties in becoming commercially viable designs.

### **Content**

Further aims:

- What are the factors that are driving the development of advanced systems?
- Overview of fast reactor development & Generation IV reactor systems, including accelerator driven sub-critical reactors;
- Introduce the principles of fusion energy physics and the current status of research;
- Explain how the principles of fusion energy are to be applied for the design of future fusion energy systems;
- Re-cycle fuel studies, including reprocessing and re-fabrication;
- Status, issues and what would be needed to bring advanced reactor systems to a commercial standard with safety and economics as good as current Generation III+ designs

#### **Fission Systems**

- Design objectives, drivers & alternatives (2L)
- Advanced thermal systems – example high temperature gas-cooled reactor (2L)
- Fast spectrum reactor systems – including external lecturer A Judd (4L)
- Transmutation and advanced fuel cycles (2L)

#### **Fusion Systems**

Introduction & Physics of Fusion Systems - CCFE (2L)

- Fusion reactions: cross-sections and reactivity
- Magnetic and inertial approaches to fusion
- Equilibrium, transport, instabilities and power balance

Physics & Materials - CCFE (2L)

- Heating systems and current drive
- Layout of a fusion power plant
- Fusion reactor components and materials requirements

Performance Safety and Design - CCFE (2L)

- Safety of a fusion reactor
- Radiological hazards and waste products
- Fusion in the market and timescale to commercial fusion plant
- Designing a fusion power plant

**Examples papers**

- Thermal Reactor Systems (High Temperature Gas-cooled Reactors)
- Fast Reactors
- Fusion: Plasma Physics and Reactor Engineering

**Coursework**

Coursework #1

Group project (3-4 students) researching into a particular advanced reactor design.

This part will be assessed by a group presentation to the rest of the class.

The presentations will be scheduled at a convenient time outside the normal lectures schedule.

Learning objective:

- Research in depth one of the advanced reactor systems
- Become familiar with a broad range of advanced systems, their strengths and weaknesses

Coursework #2

Fast reactor transient analysis using provided computer models.

This part of the coursework will be preceded by an examples class, where these models will be introduced and demonstrated.

Learning objective:

- Understand fundamentals of fast reactor transient behaviour and safety

Coursework #3

Problem set on advanced fission reactors, plasma physics and fusion technology.

Learning objective:

- Understand fundamentals of fusion power systems physics and engineering

### Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

### Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [3].

Last modified: 16/02/2023 15:35

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### Links

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