Engineering Tripos Part IIB, 4I11: Advanced Fission and Fusion System, 2017-18

Module Leader

Dr E Shwageraus [1]

Lecturers

Dr E Shwageraus, Mr A Roulstone

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 are their advantages 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 & Gen 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 reactor(2l)
- Fast Spectrum Reactor systems – including external Dr A Judd(4l)
- Transmutation and Advanced Fuel cycles (2l)

Fusion Systems

Introduction & Physics of fusion systems - Dr C. Roach CCFE (2l)

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

Physics & Materials - Dr M. Fleming CCFE (2l)

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

Performance Safety and Design Dr M. Fleming CCFE (2l)

- Safety of a fusion
- Radiological hazards and waste products
- Fusion in the market and timescale to fusion
- 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 • Familiarise with a broad range of advanced systems, their strengths and weaknesses
Coursework #2 Fast reactor transient analysis using provided computer models. This part of coursework will be preceded by an examples class, where these models will be introduced and demonstrated. Learning objective: • Understand fundamentals of fast reactors 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 see the Booklist for Group I Courses [2] for references for this module.

Examination Guidelines

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

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