Engineering Tripos Part IIB, 4M16: Nuclear Power Engineering (shared with IIA), 2024-25

Module Leader

Dr Paul Cosgrove [1]

Lecturers

Dr Paul Cosgrove, Prof. Eugene Shwageraus and Mr Bob Skelton

Timing and Structure

Lent Term. 12 lectures + 2 examples classes + 2 in-lecture demonstrations. Assessment: 100% exam. Lectures will be recorded.

Aims

The aims of the course are to:

- give the student an introduction to and appreciation of nuclear power engineering and the UK nuclear industry

Objectives

As specific objectives, by the end of the course students should be able to:

- appreciate the nature of neutron-nucleus interactions
- classify ionising radiation by physical nature and health hazard
- conduct safely a simple experiment involving radiation
- understand the principles of radiation detection and shielding
- understand the principles of operation of UK nuclear reactors
- apply elementary models of neutron behaviour in reactors
- compute simple power distributions in reactors
- compute simple temperature distributions in reactors and appreciate their consequences
- appreciate the significance of delayed neutrons and xenon-135 to the control and operation of reactors
- appreciate the advantages and disadvantages of on-load and off-load refuelling
- perform simple calculations to predict the refuelling requirements of reactors
- explain the operation of enrichment plant
- appreciate the problems of radioactive waste management
- appreciate the range of activities of the UK nuclear industry

Content

This module aims to give the student an introduction to and appreciation of nuclear power engineering and the UK nuclear industry, particularly the technology used in the production of electricity in nuclear power stations, the preparation and subsequent treatment of the fuel and its by-products, and the detection of ionising radiation and the protection of workers within the nuclear industry and the general public from it.

Basic Principles and Health Physics (2L, Prof. E. Shwageraus)

- Principles of nuclear reactions;
- Radioactivity and the effects of ionising radiation;
- Introduction to health physics and shielding.

Reactor Physics (3L, Dr P.M. Cosgrove)

- The fission chain process;
- Interactions of neutrons with matter;
- Models for neutron distributions in space and energy.

Reactor Design & Operation (4L, Dr P.M. Cosgrove)

- Simple reactor design;
- Heat transfer and temperature distributions in commercial reactors;
- Time-dependent aspects of reactor operations; delayed neutrons and xenon poisoning;
- In-core and out-of-core fuel cycles.

Fuel Processing (3L, Mr R.L. Skelton)

- Enrichment and reprocessing;
- The treatment, containment and disposal of radioactive wastes.

Demonstrations (2L, Dr P.M.Cosgrove)

Demonstration of the use of Geiger-Muller and scintillation counters for detecting ionising radiation (1 hour in-lecture time).

Demonstration of the detection and shielding of fast and thermal neutrons using a 37 GBq Americium-Beryllium source (1 hour in-lecture time).

Booklists

Please refer to the Booklist for references to this module. This can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

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Links
[1] mailto:pmc55@cam.ac.uk
[2] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations