SH2702 – Nuclear Reactor Technology: 8 ECTS

Course PM

Course objectives

The purpose of the course is to provide general knowledge on the technological solution applied in nuclear power engineering. In particular, students will learn the principles of design of reactors and nuclear power plant components. In addition, the details of the primary systems and balance of plant will be analyzed, including a thorough investigation of the performance of key components of a nuclear power plant under normal and off-normal operation conditions. Principles of design and operation of the advanced reactors such as supercritical water, liquid metal reactor, molten salt reactor, gas cooled reactor and fast breeder reactor will be discussed.

After completion of the present course, students will be able to:

ILO1: Define key elements of the nuclear power plant design and safety features,
ILO2: Explain the principles of nuclear reactor operation and control,
ILO3: Develop simplified design and perform analysis of (a) nuclear reactor core, (b) primary systems, (c) balance of plant.
ILO4: Reflect on nuclear core design constraints in terms of limiting important operating parameters such as (a) Critical Heat Flux (CHF), (b) maximum cladding and fuel pellet temperature.

Course prerequisites

- Completed course “Reactor Physics” - SH2600 or equivalent.
- Completed course “Sustainable Energy Transformation Technologies” – SH2706 or equivalent.

Course language

The course is taught in English.

Course staff

Teacher and examiner:	Associate Professor Pavel Kudinov (PK), email: pkudinov@kth.se
Teacher:	Dr. Haipeng Li (HL), email: haipengl@kth.se
Teacher:	Dr. Dmitry Grishchenko (DG), dmitrygr@kth.se
Course responsible:	PK

Course contents

The course contains the following topics:

- Primary systems in nuclear power plants with light water reactors.
- Balance of plant systems in nuclear power plants with light water reactors.
- Auxiliary and safety systems in light water reactors.
- Elements of the thermal-hydraulic design of fuel assemblies in light water reactors.
- Principles of design and operation of various advanced reactor types.
- Safety margin evaluations in nuclear reactors.

Course literature

The basic literature consists of the compendium (H. Anglart, *Nuclear Reactor Technology*, KTH, 2018) and lecture handouts. Compulsory self-reading, on which the examination and the project

work are based, consists of all handouts and compendium chapters 2 and 5, and sections 7.2, 7.3, and 8.5. Only selected parts of the self-reading material will be discussed during lectures.

Activities

The course consists of the following activities:

- lectures given by the teacher,
- exercises demonstrated by the teacher and solved by students,
- project work and oral presentations given by students,
- peer review of the project work done by other students,
- final written exam.

Course schedule

The current course schedule is provided in Canvas

Project work and presentations given by students

Project work will be performed by students organized in teams of 2 people. Each team will choose from the list below a specific reactor type to work with:

1. Design, operation and safety features of NuSCALE.
2. Design, operation and safety features of ABWR.
3. Design, operation and safety features of ESBWR.
4. Design, operation and safety features of EPR.
5. Design, operation and safety features of AP1000.

The project work will be presented in oral presentations (seminars) and as a written report (one draft version and one final report per team). The first presentation (Tasks 1 to 3) will be based on literature search and will be concerned with a general description of the nuclear power plant with the selected reactor type. The focus should be on the main features that make this particular reactor type so special and different from other reactor types. The last three presentations (Tasks 4 to 6) will be concerned with reactor core calculations. A detailed description of the content of all six tasks is provided in a separate document “Project work description”.

The topics of the oral presentations are as follows:

1. Reactor design overview
   i) General design specification of the nuclear power plant with the selected reactor type (Task 1).
   ii) Operation principles of the nuclear power plant with the selected reactor type (Task 2).
   iii) Safety features of the nuclear power plant with the selected reactor type (Task 3).
2. Results of calculation of selected core parameters (Task 4).
3. Results of calculation of CHF margins in hot channel (Task 5).
4. Results of calculation of the maximum cladding and fuel temperature (Task 6).

It is important that all team members participate equally in the preparation and delivery of the presentations. The presentations will be graded (0 to 5 points, where 0 points is very bad and 5 points is very good).

The draft written reports will be anonymously peer-reviewed by other students using a special form as given in a separate schedule. The peer review should include specific suggestions for improvement of the report. Revised final report should include an appendix with response to the peer-reviewers’ comments and suggestions.

NOTE: presence is compulsory during all presentations given by students. Impossibility of participation in a student presentation should be reported to the teacher in advance. In addition, own review of the missed presentations should be prepared and submitted to the teacher before the end of the course. The review should contain:

- **short summary of the presentation**
- **highlights and strengths of the presentation**
- **weaknesses of the presentation**
- **suggestions for improvements**

One review has to be written for each missed presentation.

Course grading and requirements

For passing the course a student should fulfill following requirements:

- Attend all seminars with presentations of the group project work is required,
- Receive at least 35 points for the project work (i.e. presentations, report and peer review),
- Receive at least 15 points at the final written exam.

The total maximum number of points that can be earned in the course is shown in the table below.

Activity	**Points**
Project work including in-class presentation, report, peer review	70
Final written exam	30
Total	100

The final grading in the course follows the rules shown in the table below.

Total point interval	**Grade**
Less than 40	F
From 40 and less than 50	Fx
From 50 and less than 60	E
From 60 and less than 70	D
From 70 and less than 80	C
From 80 and less than 90	B
More than 90	A