

# Environmental Protection and Power Engineering

This course provides PhD students in nuclear science and engineering with a rigorous foundation in the fundamental principles governing nuclear reactor technology. It develops both conceptual understanding and practical analytical skills essential for evaluating existing reactor systems and contributing to the design of next-generation nuclear power plants. Lectures, exercises, and case studies work together to bridge theory and practice, emphasizing efficiency, safety, and scientific rigor.

## Learning objectives

After completing this course, students will be able to:

- Explain the physical principles underlying reactor physics, reactor kinetics, thermal-hydraulics, and fuel behavior.
- Describe major reactor types, their design philosophies, and their operational characteristics.
- Understand the regulatory, environmental, and safety frameworks that guide reactor design and operation.
- Apply analytical and computational methods to evaluate reactor performance.
- Perform simplified design calculations for core physics, thermal limits, and safety margins.
- Assess strengths and limitations of existing reactor technologies.
- Formulate proposals for improving reactor efficiency, safety, or sustainability.

## Course contents

The following topics are included:

- Overview of nuclear technology in science and engineering
- Overview of components and systems in light water reactor (LWR) power plants
- Overview of components and systems in fast breeder reactor (FBR) power plants
- Introduction to nuclear reactor physics
- Nuclear reactor kinetics, dynamics, and stability
- Nuclear power plant operation and control
- Introduction to thermodynamics of nuclear energy systems
- Introduction to thermal-hydraulics of nuclear energy systems
- Nuclear and thermal-hydraulic design of reactor cores
- Principles of nuclear power sustainability, environmental protection, and safety

## Course structure

The course is organized into short, intensive modules combining lectures, exercises, and seminars. The following time-frames for the modules are set:

- Days from 10/4 to 14/4
- Days from 28/4 to 8/5
- Days from 19/5 to 29/5
- Days 9-10/6

The first meeting will be held on April 10 at 10:00 in Świerk, room 3/232, building PNT. The remaining meetings follow the course schedule. All lectures, exercises, and seminars are planned to take place on site. Online meetings will be arranged only if in-person sessions become impossible.

## Teaching methods

- Lectures introducing theoretical foundations
- Problem-solving sessions
- Seminars during which each student presents current status for a selected Gen IV or SMR reactor concept

## Assessment, examination and grading

- Oral seminar presentation (30%)
- Case study report (30%)
- Final oral examination (40%)

Oral student seminars will be held during the final course module, on June 9 and 10. The oral exam will be scheduled individually with each student and will take place in Świerk between June 15 and June 17.

Final grading: 5, 4, 3, 2

## Prerequisites

- Undergraduate-level physics, thermodynamics, fluid mechanics, solid mechanics, and heat transfer
- Familiarity with differential equations and numerical methods
- Basic programming skills (Python, MATLAB, or similar)

## Course literature

Selected chapters in the following books:

H. Anglart, *Applied Reactor Technology* (PDF available)

H. Anglart, *Thermal-Hydraulics in Nuclear Systems* (PDF available)

H. Anglart, *Nuclear Reactor Dynamics and Stability* (PDF available)

H. Anglart, *Introduction to Sustainable Energy Transformation*, CRC Press, ISBN 978-0-367-47861-2

H. Anglart, *Thermal Safety Margins in Nuclear Reactors*, CRC Press, ISBN 978-1-032-17106-0