

PHYS-443

**Physics of nuclear reactors**

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Cursus	Sem.	Type
Nuclear engineering	MA1	Obl.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Oral
Workload	180h
Weeks	14
<b>Hours</b>	<b>6 weekly</b>
Courses	4 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

In this course, one acquires an understanding of the basic neutronics interactions occurring in a nuclear fission reactor as well as the conditions for establishing and controlling a nuclear chain reaction.

**Content**

- **Brief review of nuclear physics**
  - Historical: Constitution of the nucleus and discovery of the neutron
  - Nuclear reactions and radioactivity
  - Cross sections
  - Differences between fusion and fission.
- **Nuclear fission**
  - Characteristics - Nuclear fuel - Introductory elements of neutronics.
  - Fissile and fertile materials.
- **Element of reactor design**
  - flux and heat source distribution; properties of different coolants and technological consequences
- **LWR reactors technology**
  - overview of the functional scheme of PWR and BWRs; fuel elements; compensation of excess reactivity in PWRs and BWRs (boron, etc.)
- **Neutron diffusion and slowing down**
  - Monoenergetic neutrons - Angular and scalar flux
  - Diffusion theory as simplified case of transport theory - Neutron slowing down through elastic scattering.
- **Multiplying media (reactors)**
  - Multiplication factors - Criticality condition in simple cases.
  - Thermal reactors - Neutron spectra - Multizone reactors - Multigroup theory and general criticality condition - Heterogeneous reactors.
- **Reactor kinetics**
  - Point reactor model: prompt and delayed transients - Practical applications.
- **Reactivity variations and control**
  - Short, medium and long term reactivity changes. Different means of control.
- **Advanced reactor designs**
  - Breeding and transmutation; introduction into Gen-IV reactors

**Learning Outcomes**

By the end of the course, the student must be able to:

- Elaborate on neutron diffusion equation
- Formulate approximations to solving the diffusion equation for simple systems
- Classify nuclear reaction cross sections
- Develop for a nuclear reactor

### **Transversal skills**

- Access and evaluate appropriate sources of information.
- Collect data.
- Use both general and domain specific IT resources and tools
- Write a scientific or technical report.

### **Teaching methods**

Lectures, numerical exercises

### **Assessment methods**

oral exam (50%)  
group project (50%)

### **Resources**

#### **Moodle Link**

- <https://go.epfl.ch/PHYS-443>