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
Hours	**6 weekly**
Courses	4 weekly
Exercises	2 weekly
Number of positions	

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 - 25min closed book (50%)
project - coding exercise (50%)

Resources

Moodle Link

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