THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Wprowadzenie do energetyki jądrowej**				
	English	**An introduction to nuclear power engineering**				
Type of the course	**Specialized course**					
Course coordinator	**Karol Frydrych, PhD., Eng.**		Course teacher	**Karol Frydrych, PhD., Eng.**		
Implementing unit	**ZMM**	Scientific discipline / disciplines	**Mechanical engineering Materials engineering**			
Level of education	**doctoral studies**	Semester	**summer or winter**			
Language of the course	**English or Polish**					
Type of assessment	**exam**	Number of hours in a semester	**45**	ECTS credits	**4**	

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**	**1**	**0**	**0**	**0**
	in a semester	**30**	**15**	**0**	**0**	**0**

1. Prerequisites

Knowledge of mathematics and physics within the scope of higher technical studies.

2. Course objectives

The objective of the course is to provide the audience with a basic understanding on how the nuclear power systems work. During the course it will be explained why the nuclear power systems are essential in order to fulfil rapid decarbonisation goals. The students will have the opportunity to understand how the nuclear power systems work, what kind of radiation is present inside the reactor and how the radiation interacts with the structural components of the nuclear power plants. Some possibilities on how to model the irradiation effects will be also discussed.

3. Course content (separate for each type of classes)

Lecture

Main topics:

1. The importance of nuclear power systems
2. Basics of nuclear physics
3. Interaction of radiation with matter
4. Basics of nuclear reactor physics
5. Overview of nuclear power reactor types
6. Materials for nuclear power systems
7. Impact of radiation on the properties of structural materials

Auditory classes

During the auditory classes, topics covered in the lectures are illustrated by specific examples.

4. Learning outcomes			
Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate acquires basic knowledge of the fundamentals of nuclear physics necessary to understand the principles of operation of nuclear reactors.	P8S_WG	oral exam
2	The graduate acquires basic knowledge of nuclear energy technologies and the principles of their operation.	P8S_WG	oral exam
3	The graduate acquires basic knowledge of materials used in nuclear energy and the specific impact of environmental factors on their performance.	P8S_WG	oral exam
4	The graduate understands the essence of the problems of modern power engineering, which has to ensure stable availability of electricity at the lowest possible cost while reducing carbon dioxide emissions.	P8S_WK	active participation during classes
Skills			
1	The graduate is able to critically analyze and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge, in particular to assess the usefulness and possibility of using the results of theoretical work in practice.	P8S_UW	active participation during classes
Communication			
1	The graduate is able to communicate on specialist topics relevant to the represented scientific discipline, to a degree that enables active participation in the national and international scientific community, including within international consortia of research universities.	P8S_UK	presentation evaluation
Social competences			
1	The graduate is ready to critically evaluate his/her own contribution to the development of the represented scientific discipline.	P8S_KK	presentation evaluation
2	The graduate is ready to recognize the importance of knowledge and scientific achievements in solving cognitive and practical problems.	P8S_KK	active participation during classes
3	The graduate is ready to initiate activities for the public interest.	P8S_KO	active participation during classes

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Assessment of activity during classes (including auditory exercises), assessment of the presentation based on own scientific research or literature review and the result of the exam.

6. Literature
Primary references:
[1] H. Anglart, "Applied Reactor Technology", Politechnika Warszawska, 2013,
[2] C. Tucker „How to drive a nuclear reactor", Springer Nature Switzerland AG, 2019,
[3] E. Skrzypczak, Z. Szefliński: „Wstęp do fizyki jądra atomowego i cząstek elementarnych", Wydawnictwo Naukowe PWN, Warszawa 2012,
[4] E. De Sanctis, S. Monti, M. Ripani: Energy from Nuclear Fission, Springer International Publishing Switzerland 2016,
[5] W. Hoffelner, "Materials for Nuclear Plants", Springer-Verlag London Limited, 2013,
[6] G. S. Was, Fundamentals of Radiation Materials Science. Metals and Alloys, Springer, New York, 2017.
Secondary references:
[1] C. D. Gregg King, „Nuclear Power Systems", The Macmillan Company, New York, 1964,
[2] R. L. Murray, "Nuclear Energy", Pergamon Press, 1980,
[3] D. H. Perkins: „Introduction to high energy physics", Press Syndicate of the University of Cambridge, Cambridge, 2000,
[4] M. Kiełkiewicz, „Teoria reaktorów jądrowych", PWN, Warszawa, 1987,
[5] K. Jeleń, Z. Rau, „Energetyka jądrowa w Polsce", Wolters Kluwer Polska Sp. z o. o., Warszawa, 2012,
[6] M. Pawlik, F. Strzelczyk, „Elektrownie", Wydawnictwo WNT, Warszawa, 2016,
[7] Z. Celiński, A. Strupczewski, „Podstawy energetyki jądrowej", Wydawnictwa Naukowo-Techniczne, Warszawa, 1984,
[8] J. T. Adrian Roberts, „Structural Materials in Nuclear Power Systems", Plenum Press, New York, 1981,
[9] P. Cohen, "Water coolant technology of power plants", American Nuclear Society, 1985,
[10] A. E. Waltar, A. B. Reynolds, "Fast breeder reactors", Pergamon Press, 1981.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the lecturer in the classroom	**45**
2	Hours of consultations with the lecturer, exams, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**20**
4	Amount of time devoted to the preparation for exams, test, assessments	**20**
	Total number of hours	**100**
	ECTS credits	**4**

** 1 ECTS = 25–30 hours of the PhD students work (2 ECTS ≈ 60 hours; 4 ECTS ≈ 110 hours, etc.)