GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Passive cooling systems in nuclear power systems, PG_00065901						
Field of study	Nuclear Engineering						
Date of commencement of studies	February 2027		Academic year of realisation of subject	2027/2028			
Education level	second-cycle studies		Subject group	Specialty subject group Subject group related to scientific research in the field of study			
Mode of study	Full-time studies		Mode of delivery	at the university			
Year of study	1		Language of instruction	Polish			
Semester of study	2		ECTS credits	3.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Division of Thermal Power Systems -> Institute of Energy -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Paweł Szymański				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM	
	Number of study hours	30		8.0	37.0	75	
Subject objectives	The aim of the course is to familiarise students with the principles of operation, design and operation of passive cooling systems in nuclear power plants. Students learn about the mechanisms of passive heat and mass transport under normal and emergency conditions, learn to identify, select and design appropriate passive technologies (heat pipes, thermosyphons, phase change materials, etc.), and analyse their efficiency and operational safety. In doing so, they acquire the competences necessary to work on nuclear reactor safety projects and the development of modern cooling solutions.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U04] creatively designs or modifies, either entirely or at least in part, nulear power systems, considering both technical and non-technical aspects, estimating costs and utilizing design techniques appropriate for tasks within the scope of Nuclear Power Technologies	The student is able to creatively design or modify a selected component of a passive cooling system (e.g. a set of heat pipes, thermosyphons), taking into account the given technical specifications and limitations resulting from safety regulations. Is able to carry out a preliminary cost analysis for the implementation of a passive cooling system in a nuclear power plant, taking into account, among other things, the choice of materials, complexity of the installation or operating costs. Uses appropriate design and simulation techniques (e.g. numerical calculations) to optimise cooling solutions in the context of various criteria (e.g. efficiency, reliability, safety). Is able to present a proposed concept for the implementation or modification of a passive cooling system, taking into account technical and non-technical (environmental, economic, social) arguments.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
[K7_U03] identifies and formulates task specifications in the scope of energy processes and systems including non-standard problems and taking into consideration their non-technical aspects.	The student is able to identify and define the design tasks necessary for the specification or modification of a passive cooling system in a nuclear power plant, taking into account both technical aspects (e.g. thermodynamic parameters, material selection) and nuclear safety constraints. He/she is able to formulate detailed design requirements for new and unusual applications (e.g. small modular reactors, hybrid cooling systems) using knowledge of the specifics of passive systems and their role in the heat removal process under different operating conditions.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[K7_W03] demonstrates structured and theory supported knowledge encompassing key issues in the field of Nuclear Power Technologies, enabling design of energy processes and systems	The student knows and understands the basic principles of passive cooling systems in nuclear power plants, including their role in reactor safety and their impact on the overall efficiency of energy processes. Can characterise the main passive technologies (heat pipes, thermosyphons, phase change materials, etc.) and explain their application in the context of different reactor types. Knows the key material requirements and design criteria necessary for the selection and implementation of passive cooling systems.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation

Course outcome	Subject outcome	Method of verification
[K7_U15] evaluates the feasibility of advanced methods and tools for solving complex engineering tasks of a practical nature, characteristic of the field of study, and selects and applies appropriate methods and tools for this purpose	The student is able to properly select advanced design and simulation tools (e.g. engineering software) to solve specific problems related to passive cooling systems in nuclear power plants, taking into account the complexity of phenomena (heat and mass transport, phase change, natural convection). Is able to interpret and critically evaluate the results obtained from the methods used (e.g. numerical, experimental), comparing them with available literature data or industry standards. Is able to prepare appropriate assumptions and simplifications of the model (preserving the relevant physical aspects of the phenomena) and justify their influence on the final evaluation of the effectiveness of the passive cooling system.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

Subject contents

Course content – lecture

Lecture:

1. Introduction to cooling systems in nuclear power plants.
2. Types of cooling systems.
3. Passive cooling systems - principle of operation.
4. Cooling systems under failure conditions.
5. Analysis and design of passive cooling systems using heat pipes as an example.
6. Future of passive cooling systems.

Project:

1. Design analysis of a selected passive cooling system for nuclear power plant equipment.

Prerequisites and co-requisites

Knowledge of basic mathematics, physics, thermodynamics, materials science, fluid mechanics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
	56.0%	50.0%
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Recommended reading

Basic literature	Bahman Zohuri "Heat Pipe Applications in Fission Driven Nuclear Power Plants"
Supplementary literature	Hussam Jouhara, David Reay, Ryan McGlen, Peter Kew, Jonathan McDonough "Heat Pipes: Theory, Design and Applications"
eResources addresses	

Example issues/ example questions/ tasks being completed

1. Classification and theoretical background
2. Passive system technologies and principle of operation
3. Design and analysis of passive systems
4. Emergency conditions and nuclear safety
5. Examples of implementation and new technologies
6. Problem / practical tasks.

Practical activites within the subject

Not applicable

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