COURSE DESCRIPTION CARD - SYLLABUS

Course name
Basics of thermal power engineering [N1Energ2>PEC]

Course

Field of study
Power Engineering

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other
20	10	0
Tutorials	Projects/seminars	
10	0	

Number of credit points

5,00

Coordinators

dr hab. inż. Damian Joachimiak prof. PP
damian.joachimiak@put.poznan.pl

Lecturers

Prerequisites

- Basic knowledge of the basics of thermodynamics, fluid mechanics - Aware of the need to expand his competence and willingness to cooperate within the team. Awareness of the need to expand one's competence in the field of engineering work.

Course objective

Familiarise yourself with the systems operating in the thermal power industry and develop the assumptions necessary for the design or modernisation of systems in the thermal power industry area. This includes such equipment as turbines, compressors, heat exchangers, and RES systems. Practical familiarisation with the construction of heat engines and individual systems in power generation systems.

Course-related learning outcomes

Knowledge:
1. Has theoretically underpinned knowledge including mechanics, thermodynamics, fluid mechanics. Including the knowledge necessary to understand complex methods and technologies of energy generation, storage and supply including unstable sources.
2. Has a systematized knowledge of energy sources, including renewable sources of wind, water, solar,

biomass and geothermal energy, knows and understands the phenomena, processes and factors that allow the conversion of energy from renewable sources to electricity and heat, as well as the impact of their use on the environment.
3. He knows and understands the principles and regulations of construction, correct operation, assembly and disassembly of machinery, equipment of installations and energy networks, as well as the processes occurring in the life cycle of energy equipment, through which he knows how to plan the necessary changes in the scope of applicable standards and legal acts.
4. Has advanced knowledge of selected facts, objects, and phenomena, as well as the methods and theories concerning them that explain the complex interrelationships between them, constituting basic knowledge of the fundamentals of electric power engineering, and knows and understands how the national power system functions.

Skills:
1. Is able to obtain information from literature, databases, and other sources and integrate the obtained information, interpret, evaluate, critically analyse, and synthesise it in order to make appropriate conclusions and formulate and issue opinions determining the conditions and technologies of assembly of both typical and atypical power equipment and installations.
2. Is able to develop assumptions and documentation for the implementation of prototypes of power equipment and installations or other engineering tasks using appropriate methods and tools; Is able to prepare a text containing an analysis and discussion of the results obtained from the implementation of this task.
3. Is able to use the learned analytical, simulation and experimental methods, as well as mathematical models and computer simulations, to analyze and evaluate the performance of power components and systems, as well as to develop plans to ensure the continuity of power generation in various operating states of power equipment and installations and energy security.
4. Is able to select the technology, design, and implement the energy supply system (according to the set specification taking into account the parameters of operation of equipment, installations and energy networks) in a way that minimizes the negative impact on the environment, as well as to compare the proposed design solution due to the set utility and economic criteria with alternative solutions; is able to critically analyze the functioning of existing technical solutions and evaluate these solutions.

Social competences:
1. Is aware of the importance of knowledge in solving cognitive and practical problems, understands the need for continuous training and improving professional, personal, and social competencies, consults experts in case of difficulties in solving the problem independently, and accepts responsibility for decisions related to work in the energy profession, including safety and the effects on the environment.
2. He is aware of the responsibility for his own work and is ready to submit to the principles of teamwork and bear the responsibility of his professional role in jointly carried out activities for the improvement of safety and quality of work, improvement of the quality of manufactured products and provided services and tasks performed in the processes related to energy.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

- The knowledge acquired in the lecture is verified by a final exam lasting about 90 minutes, consisting of two parts each of 3 to 4 questions scored differently depending on their difficulty. For a passing grade, it is necessary to obtain 50% of the points from each part of the credit.
Skills acquired in exercise classes are verified on the basis of a credit colloquium, consisting of 3 to 4 tasks variously scored depending on their degree of difficulty. The passing threshold: 50% of the points.
Skills acquired in laboratory classes are verified on the basis of class reports and interviews (short input colloquia are possible). Credit threshold: 50% of the points. Issues are discussed first on the blackboard and then implemented in groups - practical exercises.

Programme content

a1) Introduction to thermal power and characteristics of energy systems,
- Characteristics of operating factors used in thermal power circuits
a2) Heat flow: concepts, laws, equations, thermodynamic properties of materials,
(b) Application of similarity theory to describe heat flow phenomena, criterion numbers ,
(c) Types of heat exchangers, phenomena in heat exchangers, methods of calculation,

(d) Heat turbines (general characteristics, division, principle of operation),
(e) Analysis of cycle efficiency:
- effect of the change of p, T at characteristic points;
- Effect of: regenerative heating, number of exchangers, interstage superheating on the efficiency of the circuit;
- investment costs, capital costs;
- turbine efficiency, dependence of circuit efficiency on turbine efficiency.
(f) Steam power plant circuits, cogeneration and trigeneration;
(g) Turbine-gas circuits: methods of increasing the efficiency of turbo-gas circuits;
(b) Industrial boilers: division, construction, principle of operation, auxiliary equipment,
(c) Renewable energy sources: general characteristics, application, advantages, disadvantages,
d) Environmental aspects of investments in the power industry: environmental decision, integrated permit, construction permit,
e) Environmental protection in the power industry, legal acts: IED, MCP, BAT conclusions, RMŚ,

Course topics

1 Heat transfer: concepts, laws, equations, thermodynamic properties of materials
2. application of similarity theory to describe heat transfer phenomena
3. types of heat exchangers, phenomena in heat exchangers, methods of calculation
4. turbines (general characteristics, division, principle of operation).
5 The effect of changing the thermodynamic parameters of steam on the efficiency of the circulation with the assumptions:
- The effect of changing p1, T1 and p2 on the efficiency of the circuit.
- Effect of regenerative heating on the efficiency of the circuit
- Effect of number of exchangers on efficiency
- Investment costs, capital costs
- Effect of interstage superheat on efficiency of the circuit
- Turbine efficiency, dependence of cycle efficiency on turbine efficiency
6. gas turbine circuits
- Methods of increasing the efficiency of T-G circuits

Teaching methods

1. Lecture: blackboard with multimedia presentation.
2. Exercises: solving tasks on the board.
3. Laboratory classes: discussing the theory and assumptions for classes on the board and performing tasks given by the teacher.

Bibliography

Basic:
1. S. Perycz - Turbiny parowe i gazowe, Wyd. Pol. Gdańskiej,1982
2. J. Szargut, A. Ziębik: Podstawy energetyki cieplnej, PWN, Warszawa 1998;
3. T. Chmielniak - Technologie energetyczne, Wyd. Pol. Śląskiej, 2004
4. R. Domański: Magazynowanie energii cieplnej, PWN, Warszawa, 1990.
5. R. Janiczek - Eksploatacja elektrowni parowych, WNT W-wa 1980,
6. S. Wiśniewski, Termodynamika Techniczna
7. S. Wiśniewski, Wymiana ciepła

Additional:
1. T. Chmielniak - Turbiny cieplne, Wyd. Pol. Śląskiej, 2004
2. S. Kruczek: Kotły. Konstrukcja i obliczenia, Wydawnictwo Politechniki Wrocławskiej. Wrocław 2001;
3. P. Orłowski, Kotły parowe w energetyce przemysłowej. Zagadnienia eksploatacyjne, WNT, Warszawa 1976;
4. G. Wielgosiński, R. Zarzycki - Technologie i procesy ochrony powietrza, PWN, 2018.
5. Analysis of heat flow in a tube bank of a condenser considering the influence of air / Magda Joachimiak (WMRiT), Damian Joachimiak (WMRiT), Piotr Krzyślak (WMRiT) // Archives of Thermodynamics - 2017, vol. 32, no. 3, s. 119-134
6. Novel Method of the Seal Aerodynamic Design to Reduce Leakage by Matching the Seal Geometry to Flow Conditions / Damian Joachimiak (WIŚiE) // Energies - 2021, vol. 14, no. 23, s. 7880-1-7880-16

7. Uszczelnienia bezdotykowe - badania, modelowanie i optymalizacja / Damian Joachimiak (WIŚiE) / red. Anna Liberek (WPP) - Poznań, Polska : Wydawnictwo Politechniki Poznańskiej, 2021 - 172 s.
8. Experimental and numerical analysis of the gas flow in the axisymmetric radial clearance / Damian Joachimiak (WIŚiE), Andrzej Frąckowiak (WIŚiE) // Energies - 2020, vol. 13, no. 21, s. 5794-1-5794-13
9. Thermodynamic Analysis of Gas Turbine Systems Fueled by a CH_4/H_2 Mixture; Laith Mustafa, Rafał Ślefarski, Radosław Jankowski; Sustainability; 2024, vol. 16, iss. 2, s. 1-15

Breakdown of average student's workload

	Hours	ECTS
Total workload	142	5,00
Classes requiring direct contact with the teacher	42	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	100	3,50