GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Technical Thermodynamics 1, PG_00042038		
Field of study	Power Engineering, Power Engineering		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2022/2023
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	2	Language of instruction	English
Semester of study	3	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Energy and Industrial Apparatus -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Dariusz Mikielewicz	
	Teachers	dr inż. Marcin Jewartowski dr hab. inż. Michał Klugmann dr inż. Waldemar Targański mgr inż. Michał Pysz dr inż. Paweł Dąbrowski prof. dr hab. inż. Dariusz Mikielewicz	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	15.0	0.0	0.0	60
	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	60	10.0	80.0	150

Subject objectives	Presentation of fundamental mechanisms and laws governing the thermodynamics. Familiarisation with approaches to the analysis of processes. Analysis of examples of thermodynamic cycles and their description. Introduction to the analysis of exergy

Learning outcomes	<table><tr><th>Course outcome</th><th>Subject outcome</th><th>Method of verification</th></tr><tr><td>[K6_U05] is able to formulate and carry out energy balances in devices and energy systems, also perform an energy audit of a simple building object, is able to perform a preliminary profitability analysis of a planned energy investment</td><td></td><td></td></tr><tr><td>[K6_W15] knows and understands the basic quantities characteristic methods for thermodynamics, fluid mechanics and hydraulics, hydrology; knows the calculation methods and IT tools necessary to analyse the results of laboratory and field work</td><td></td><td></td></tr><tr><td>[K6_U06] is able to use the basic knowledge on the operation of energy equipment in the field of thermal power plants, thermal and energy and heating systems, combustion engines, compressors and rotating machines to assess the technical condition of the system</td><td></td><td></td></tr><tr><td>[K6_W02] has a basic knowledge of physics (including optics, electricity and magnetism), chemistry, technical thermodynamics, fluid mechanics and general mechanics needed to understand and describe the basic phenomena occurring in devices and systems, energy plants and transmission networks and their environment</td><td>Student acquire basic knowledge of thermodynamics in the dimension of theory and practice. Student explains the principles of thermodynamics, heat-flow processes and issues related to energy conversion in technical applications.</td><td>[SW1] Assessment of factual knowledge</td></tr></table>
Subject contents	LECTURE: Basic concepts. The first law of thermodynamics. Ideal gas model. Properties of ideal, semi-ideal and real gases. Gas laws, thermal and caloric equation of state. Characteristic processes of ideal gas. Gas mixtures. Thermodynamic gas cycles. The second law of thermodynamics and its consequences. Isobaric evaporation process. Properties of steam. Properties of superheated steam. Characteristic processes of steam. Thermodynamic steam cycles. EXERCISES: Simple conversion of energy, heat, work. The balances of power of open or closed thermodynamics systems. State and functions of state of ideal and semi-ideal gases and gas mixtures. Characteristic processes of gases. Gas thermodynamic cycles. Characteristic changes of steam. Calculations thermodynamic steam cycles. LABORATORIES: Measurements of thermodynamic parameters: temperature and pressure. Determination of mass flow rate. Determination of air and water enthalpy. Energy balance of piston engine and heat pump.
Prerequisites and co-requisites	thermodynamics, fluid mechanics, mathematics, physics
Assessment methods and criteria	<table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Tutorial test</td><td>60.0%</td><td>50.0%</td></tr><tr><td>written exam</td><td>60.0%</td><td>50.0%</td></tr></table>
Recommended reading	<table><tr><td>Basic literature</td><td>**1. M.J. Moran, H.N. Shapiro, D.D. Boettner, M.B. Bailey, Fundamentals of Engineering Thermodynamics 8th Ed., Wiley, 2014** **2. Y. Cengel, M. Boles, Thermodynamics An Engineering Approach, 8th Edition, Wiley, 2014**</td></tr><tr><td>Supplementary literature</td><td>Any textbook on engineering thermodynamics</td></tr><tr><td>eResources addresses</td><td></td></tr></table>

Example issues/ example questions/ tasks being completed	1. Definition of work and heat; units of heat and rate of heat, work and power; graphical interpretation of work (absolute and technical). 2. What is the closed and open system (name differences, schematic of the systems) 3. What is a thermodynamic cycle?.Draw a sample cycle in p-v and T-s coordinates. 4. Definition of extensive and intensive properties (examples) 5. Pressure (definition, units, atmospheric pressure, absolute pressure, gauge pressure, vacuum pressure), pressure measurement by U-tube manometer 6. Zeroeth Law of Thermodynamics 7. Definition of quality, Schematic p-v, T-s diagram for wet steam, mark one example of quality line. 8. Describe the procedure for evaluation of a state property in the wet vapour region. 9. Describe the process of isobaric heating of water from liquid state to superheated vapour. 10. Ideal gas equation, specific heat at constant pressure and constant volume, exponent of adiabate. Assumptions for the ideal gas. 11. Van der Waals equation of state. Properties of real gas. 12. Describe the isovolumetric, isobaric, isothermal, isenthalpic and adiabatic process. Derive expressions describing the heat, work and technical work for the process. Present processes in p-v and T-s diagrams. 13. First Law of Thermodynamics for closed and open systems in the differential form, rate form and integrated forms. Explain the terms. 14. Second Law of Thermodynamics. Give two verbal definitions of the cycle. 15. Reversible and irreversible processes. 16. Present the way of calculation of entropy change for ideal gas. 17. Exergy definition. Explain the difference between energy and exergy. 18. Definition of efficiency of heat engines. 19. Incorporation of First Law of Thermodynamics into the Second Law of Thermodynamics. Derive the relation for the individual gas constant expressed in term of specific heat at constant pressure and constant volume. 20. Application of 1^{st} Law of Thermodynamics for open systems to compressor, heat exchanger, turbine. 21. The Carnot cycle (2 isotherms, 2 isentropes). Draw the cycle in p-v and T-s diagrams. Define efficiency of the cycle for its operation as engine cycle. 22. The Clausius Rankine cycle discuss the constituent elements of the cycle, draw the processes in T-s, p-v and h-s diagram, write the expression for the efficiency of the cycle, name three ways of increasing the cycle efficiency. 23. Criteria for selection of working fluids for the organic Rankine cycle. Explain the difference between wet, dry and isentropic fluid. 24. The Brayton turbine cycle (2 isentropes, 2 isobars). Draw the cycle in p-v and T-s diagrams. Define efficiency of the cycle. What is understood by the cycle regeneration? 25. The heat pump Linde cycle draw the cycle and processes in T-s, p-h diagram, define the coefficient of performance of the cycle. Name two ways of increasing COP. 26. The refrigeration Linde cycle draw the cycle and processes in T-s, p-h diagram, define the coefficient of performance of the cycle. Name two ways of increasing COP. 27. Principle of operation of absorption refrigeration cycle. 28. Criteria for selection of the working fluid for the refrigeration/heat pump cycle.
Work placement	Not applicable