COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S1-ME-707**
	part-time programme:	
Course title in Polish	**Termodynamika II**	
Course title in English	**Thermodynamics II**	
Valid from (academic year)	**2024/2025**	

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**first-cycle**
Type of education	**academic**
Mode of study	**full-time programme**
Specialism	**all**
Department responsible	**Department of Mechanics and Heat Transfer**
Course leader	**dr hab. Robert Pastuszko, prof. PŚk**
Approved by	**dr hab. Jakub Takosoglu, prof. PŚk, Dean of the Faculty of Mechatronics and Mechanical Engineering**

COURSE OVERVIEW

Course type		**programme-specific**
Course status		**compulsory**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester VII**
	part-time programme	
Pre-requisites		**Thermodynamics I**
Examination required (YES/NO)		**YES**
ECTS value		**3**

Mode of instruction		**lecture**	**class**	**laboratory**	**project**	**seminar**
No. of hours per semester	full-time programme	**15**		**15**		
	part-time programme					

LEARNING OUTCOMES

Category of outcome	**Outcome code**	**Course learning outcomes**	**Corresponding programme outcome code**
Knowledge	W01	On completion of the course, students will have knowledge of the application of the second law of thermodynamics to energy conversion systems.	MiBM1_W02 MiBM1_W16
	W02	Students will have knowledge of the properties of gas mixtures, humid air and its transformations.	MiBM1_W02 MiBM1_W16

	W03	Students will have fundamental knowledge about heat engines and refrigeration cycles, and the formulas expressing their efficiency, understand the basic theory of refrigeration systems	MiBM1_W02 MiBM1_W16
	W04	Students will have basic knowledge of the combustion of solid, liquid and gaseous fuels.	MiBM1_W02 MiBM1_W16
	W05	Students will have basic knowledge of heat transfer.	MiBM1_W02 MiBM1_W16
	W06	On completion of the course, students will have the skills to use procedures for energy balancing and methods of energy transport between systems.	MiBM1_W02 MiBM1_W16
Skills	U01	Students will be able to use mathematical tools to solve problems relating to the laws of thermodynamics.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U02	Students will have basic skills related to operating an infrared camera and will be able to use basic heat transfer mechanisms.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U03	Students will be able to determine the parameters of the humid air and the coefficients COP/EER.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U04	On completion of the course, students will have knowledge of the application of the second law of thermodynamics to energy conversion systems.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
Competence	K01	On completion of the course, students will be aware of the impact on the natural environment of the way energy is generated and the operation of energy generating devices (heat engines, etc.) and refrigeration devices	MiBM1_K02 MiBM1_K03 MiBM1_K06
	K02	Students are aware of the need to follow the rules of teamwork.	MiBM1_K02 MiBM1_K03 MiBM1_K06

COURSE CONTENT

Type of instruction lecture	Topics covered

lecture	Application of the second law of thermodynamics to energy conversion systems. Thermal efficiency of heat engines, coefficient of performance of heat pumps and energy efficiency rating of refrigerators and air conditioners. Examples of gas power cycles. Compressors. Heat pipes. Refrigeration cycles and refrigerators. Heat pumps. Properties of refrigerants, fluorinated greenhouse gases, *p-h* chart, refrigerant saturation tables, and chart of a single-stage compressor refrigeration system. Basic components of a refrigeration system. Gas mixtures. Van der Waals equation. The Clapeyron equation and the Maxwell relations. Dry and atmospheric air. Specific and relative humidity. Mollier diagram. Examples of air conditioning processes. Basic information on heat transfer (conduction, convection, radiation, overall heat transfer), thermal resistance concept. Basic information about fuels and combustion.
laboratory	Temperature measurement. Determination of the temperature field using the IR method. Pressure measurement. Heat pipe. Boyle - Mariotte law (isothermal process). Isochoric process. Dependence of the state of matter on temperature and pressure. Determination of the calorimeter constant. Determination of the heat pump's coefficient of performance (COP) and/or the refrigerator/air conditioner's energy efficiency ratio (EER).

ASSESSMENT METHODS

Outcome code	Methods of assessment *(Mark with an X where applicable)*					
	Oral examination	Written examination	Test	Project	Report	Other
W01		x				
W02		x				
W03		x				
W04		x				
W05		x				
W06		x				
U01		x				
U02		x			x	
U03		x			x	
U04		x			x	
K01						x
K02						x

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	examination assessment	Examination in the form of an open-ended question test. The overall mark for the course is dependent on the number of points obtained for the coursework assignments. The pass mark is a minimum of 51 points. The highest mark ‘very good’ is awarded for 90-100 points.
laboratory	non-examination assessment	The pass mark is the post-lab reports

OVERALL STUDENT WORKLOAD

ECTS weighting												
No.	**Activity type**	**Student workload**										**Unit**
		full-time programme					**part-time programme**					
1.	Scheduled contact hours	L	C	Lb	P	S	L	C	Lb	P	S	h
		15		15								
2.	Other contact hours (office hours, examination)	4		2								h
3.	**Total number of contact hours**	**36**										h
4.	**Number of ECTS credits for contact hours**	**1,4**										ECTS
5.	**Number of independent study hours**	**39**										h
6.	**Number of ECTS credits for independent study hours**	**1,6**										ECTS
7.	**Number of practical hours**	**38**										h
8.	**Number of ECTS credits for practical hours**	**1,5**										ECTS
9.	**Total study time**	**75**										h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**3**										ECTS

READING LIST

1. Whaley P.B., Basic Engineering Thermodynamics, Oxford Science Publications, Oxford 1999
2. Logan E., Jr., Thermodynamics and Applications, Marcel Dekker, Inc., 1999
3. Cengel Y.A., Boles M.A.: Thermodynamics – an Engineering Approach, McGraw-Hill, 2015
4. van Wylen G., Sonntag R., Borgnakke C., Fundamentals of Classical Thermodynamics, IV ed., John Wiley & Sons, 1993
5. Bayazitoglu, Y. Ozisik, Necati M.: Elements of Heat Transfer . McGraw-Hill Book Company, New York, 1988
6. Howell, J. R. : Fundamentals of engineering thermodynamics, New York McGraw-Hill Book Company, 1987
7. Moran M. J., Shapiro H. N.: Fundamentals of engineering thermodynamics, John Wiley & Sons, 1998