

## **LEARNING OUTCOMES FOR THE FIELD OF STUDY**

(Assumed educational effects)

**Faculty: Mechanical and Power Engineering**

**Field of study: MECHANICAL ENGINEERING AND MACHINE BUILDING (MBM)**

**Specialization: Power Engineering Machines and Devices (MUE)**

**Level of study: II (post-graduate)**

The area of study:

Field of study Mechanical Engineering and Machine Building belongs to the domain of technical sciences and is related to such majors as Energy, Environmental Engineering, Electrical Engineering, Process Engineering and Aerospace Engineering.

Concept of the post-graduate studies and their relation to the undergraduate studies

An applicant for the admission to the Master's degree in Mechanical Engineering and Machine Building must have undergraduate degree and possess competencies to continue education at post-graduate level in this field of study. The candidate should have in particular the following abilities:

- knowledge of mathematics, physics and chemistry that enable understanding of the fundamentals of mechanics, material sciences and principles of machinery construction,
- knowledge of mechanics, strength of materials and the foundations of machine construction that enable understanding and design of the basic machine elements,
- ability to use analytical methods, simulation and experiment to formulate and solve engineering problems,
- knowledge on the flows of fluids, including all thermal processes,
- knowledge of 2D and 3D CAD design,
- ability to communicate in English, document and present experimental results, document and present the outcomes of a project,
- knowledge on thermal processes such as refrigeration, cryogenics, and incineration.

Explanation of symbols:

**K** – learning outcomes for the field of study

**S** – learning outcomes for specialization

**W** – category of knowledge

**U** – category of skill

**K** (after the underscore) – category of social competencies

**T** – the area of study in the field of technical sciences

**2** – post-graduate studies,

**A** – general profile

Learning outcome for post-graduate studies in the field of study: MBM Specialization MUE	DESCRIPTION OF THE MAIN LEARNING OUTCOMES  After completion of the post-graduate studies in the field of <i>Mechanical Engineering and Machine Building</i> in specialization <i>Power Engineering Machines and Devices</i> the graduate:	Reference to learning outcomes for the area of technical sciences (T)
<b>KNOWLEDGE</b>		
K2MBM_W01	has structured, theoretically founded knowledge of the theory and application of microprocessor electronics to control electromechanical and pneumatic systems; distinguishes microcontrollers and microprocessors and explains principles of their programming and coupling to the components of mechatronic systems that are used in modern industrial machinery and power plants	T2A_W03
K2MBM_W02	has extended knowledge on shaping of the structure of modern engineering materials; describes phase equilibrium systems and phase transitions; can list selection principles of structural materials and their use in modern machine construction	T2A_W01 T2A_W03 T2A_W05
K2MBM_W03	has knowledge on mathematical description of the dynamics of mechanical systems represented by a finite number of material points; understands variation principles, invariants integral and the issues of small vibrations; recognizes canonical transformations and Hamilton-Jacobi equation; distinguishes stable and unstable equilibrium in mechanical systems and describes systems using cyclic coordinates	T2A_W01 T2A_W02 T2A_W04
K2MBM_W04	has knowledge of the structure of multidimensional real space and activities in this space; knows the theoretical basis of dimensional analysis as well as the rules for its use in the construction of mathematical models and moving the scale; understands the nature of optimization problems and the operation of certain optimization algorithms for functions of one and several variables	T2A_W01 T2A_W03 T2A_W07
K2MBM_W05	knows basic tools for failure analysis; has basic understanding of the causes and consequences of failures in machinery	T2A_W03 T2A_W06
K2MBM_W06	has knowledge of basic production processes and the engineering platform that integrates business activities (CIM) from concept, through the design processes, production planning, manufacturing, resource management and recycling	T2A_W03 T2A_W06
K2MBM_W07	has knowledge needed to understand the social, economic, legal and other non-technical considerations of engineering activities	T2A_W08 T2A_W09
K2MBM_W08	knowledgeable about processes of business management	T2A_W09 T2A_W11
S2MUE_W01	explains the structure and function of the main components of the boiler and associated equipment; describes solutions used in the modern boiler technology; describes the principle of agent circulation in evaporators of steam boilers;	T2A_W04

	formulates heat transfer equations for engineering calculations of heat exchangers in the boiler; identifies and characterizes the advantages and disadvantages of renewable and alternative fuels in power boilers	
S2MUE_W02	describes and explains the principles of construction, operation and maintenance of burners and furnaces (gas-fueled, liquid and solid); knows the rules of safe operation of burners and furnaces; describes and explains the technology of clean combustion; is able to identify specific ways to help reduce emissions during combustion of fuels	T2A_W04
S2MUE_W03	is familiar with the construction and operation of specialty pumps; is able to perform basic calculations of selected specialty pumps (e.g. frictional, circulatory, a water ring, centrifugal pumps with a small number of blades, with the free movement); knows specifics of pumps used in selected industries; is able to define requirements for seals and the drive	T2A_W03
S2MUE_W04	knows the general requirements and tests for piping and the role of pipelines in power plants; can list and describe heat losses and pressure drops during compressible flow in pipes; knows the basic types and grades of steel for pipelines; has basic knowledge of the stresses in the pipe wall due to temperature and yielded by external loads; is able to describe the principles of compensation of thermal expansion of pipeline and pipeline suspension; knows fittings and has knowledge of the principles of operation of pipelines, possible interferences and failures	T2A_W03
S2MUE_W05	describes the characteristics and use of reciprocating internal combustion engines and external combustion; is familiar with the requirements and properties of motor fuels and knows the rules of the combustible mixture formation and combustion properties of the spark-ignition engines; has maximum working knowledge of any circuit of the internal combustion engine; describes the exchange of charge and timing in 4-stroke engines, as well as goals, solutions and trends in the regulation and control of these engines; explains the cooling of engines and knows computational and design problems related thereto; knows characteristics of internal combustion engines; describes the principles and limitations of boost engines and design solutions of engine components	T2A_W02
S2MUE_W06	is familiar with the basic theoretical principles and the basic structures of steam and gas turbines; knows basic theory of turbine stage, the elements and components of a steam and gas turbine and the principles of their operation	T2A_W04
S2MUE_W07	is familiar with the basic construction of turbines and hydrology; knows basis for the construction of reaction turbines; knows types and specificity of hydropower plants; can choose parameters basic types of hydroelectric plants	T2A_W04
S2MUE_W08	has knowledge of the transport pipeline of granular materials (ash, ore concentrates, etc.) and hydraulic transport machinery; describes the hydro-mixtures flow patterns in pipes; knows rheological properties of mixtures and their classification; explains the methods and algorithms for calculation of hydraulic transport systems; knows economic issues of hydro-transport; describes principles of operation and the importance of hydro-transport for the protection of environment	T2A_W04
S2MUE_W09	describes the operation of hydraulic machines and the specificity of their research; knows measuring methods (simple and high-tech)	T2A_W04
S2MUE_W10	describes the principle of operation and construction of a power blocks; knows the rules governing the legal and technical exploitation of machinery and power equipment	T2A_W03
S2MUE_W11	knows the purpose and design features of special-purpose turbines e.g. for district heating, with unregulated and regulated	T2A_W03

	vents, for marine, for transportation, etc.; characterizes gas turbines - of airplanes, air, turbo systems, etc. and describes the trends of contemporary design steam and gas turbines	
S2MUE_W12	has knowledge of the and low-power energy power stations and boilers used in the energy industry and the municipal sector; knows trends associated with the implementation of a new generation of biofuel-fired boilers, waste, explains the use of related and associated hybrid systems; knows conditions for the design, collection and operation of boilers and low-power stations	T2A_W04
S2MUE_W13	has structured knowledge of mechanical and pneumatic transport, in particular systems used in power generation	T2A_W03
<b>SKILLS</b>		
K2MBM_U01	can build mechatronic systems that base on programmable controllers and incorporate electric and electro-pneumatic actuators; can write and run programs for programmable controllers using ladder language, is able to create and test programs with microcontroller development kits; can couple microcontrollers with the elements of mechatronic system	T2A_U08 T2A_U12
K2MBM_U02	is able to prepare samples of construction materials for testing, perform examinations and use results to identify characteristics and qualities of modern construction materials	T2A_U08 T2A_U18
K2MBM_U03	can build mathematical and physical models of processes; knows how to formulate objective functions and set up constraints in engineering optimization problems; is able to use numerical optimization methods to determine model parameters and the optimal process conditions	T2A_U07 T2A_U09 T2A_U10 T2A_U11 T2A_U16
K2MBM_U04	can perform deductive process directed at finding the cause of failure of the machine on the basis of failure reports and other sources of knowledge	T2A_U01 T2A_U10 T2A_U11 T2A_U13 T2A_U15
K2MBM_U05	can carry out engineering activities, ranging from initial design, through the stage of manufacturing process simulation, using integrated engineering environment such as CATIA.	T2A_U07 T2A_U09 T2A_U10 T2A_U17 T2A_U19
K2MBM_U06	has the ability to perform oral presentations on specific issues in the field of studied engineering discipline	T2A_U04 T2A_U05
K2MBM_U07	is able to prepare coherent report on the carried out work	T2A_U03 T2A_U05
K2MBM_U08	has language skills in the fields of science and scientific disciplines relevant to the Power Engineering in accordance with the requirements for level B2+ and possibly for level C1+ of the European Framework of Reference for Languages	T2A_U06

K2MBM_U09	has language skills in the fields of science and scientific disciplines relevant to the <i>Power Engineering</i> in accordance with the requirements for level A1 or A2 or B1 of the European Framework of Reference for Languages	T2A_U02
S2MUE_U01	can independently conduct research used on the example of a comprehensive energy measurements of various types of pumps	T2A_U08
S2MUE_U02	analyzes successive stages of starting the power unit from cold state and hot state; analyzes successive stages of withdrawal to the reserve power unit (hot or cold state) or for the maintenance	T2A_U10 T2A_U11
S2MUE_U03	developing flow characteristics of a steam turbine and two adjustable vents; conducts heat and mass flow calculations for microturbines and radial turbines	T2A_U08
S2MUE_U04	carries out calculations for stoichiometric combustion, thermal of the boiler, flow and the flow resistance; selects burners; selects the boiler and boiler equipment; prepare the heat balance of the boiler	T2A_U08 T2A_U12
S2MUE_U05	selects designs and performs basic calculations movement of selected types of conveyors	T2A_U08
S2MUE_U06	calculates the heat transfer performance of the boiler when changing fuel; analyzes the impact of co-firing heat transfer in the boiler; evaluate the economic aspect of the use of renewable and alternative fuels to produce heat and electricity	T2A_U10 T2A_U14 T2A_U16 T2A_U19
S2MUE_U07	perform basic design calculations of gas and dust burner and low-emission hearth	T2A_U09
S2MUE_U08	presents selected issues related to heat engines	T2A_U03
S2MUE_U09	calculates flow parameters at the Bendemann nozzle and at the de Laval nozzle; runs flow calculations with specified degree of reactivity; calculates energy losses	T2A_U09 T2A_U10
S2MUE_U10	adjusts parameters of the installed run-of-the-river power plants; selects water turbines for a particular installation conditions; calculates the desired Kaplan type rotor turbine; calculates reaction turbine wheel	T2A_U09 T2A_U10 T2A_U19
S2MUE_U11	performs sieve analysis of the bulk material; prepares the thermal performance of a centrifugal pump for hydraulic transport; prepares the thermal performance of a positive displacement pump for hydraulic transport	T2A_U09
<b>SOCIAL COMPETENCIES</b>		
K2MBM_K01	understands the need to improve professional, personal and social skills; identifies and resolves dilemmas associated with his profession	T2A_K01 T2A_K05
K2MBM_K02	is aware of the importance of non-technical aspects and impacts of social engineering and the role of university graduates	T2A_K02 T2A_K07
K2MBM_K03	is able to work in a group and assume different roles	T2A_K03
K2MBM_K04	can properly identify priorities for implementation of self-defined or appointed tasks	T2A_K04
K2MBM_K05	is able to think and act in entrepreneurial manner	T2A_K06
K2MBM_K06	is aware of the necessity of individual and group activities that go beyond the activities of engineering	T2A_K02 T2A_K03

**MATRIX OF CORRELATION BETWEEN EDUCATIONAL OUTCOMES/ EFFECTS IN THE FIELD OF TECHNICAL SCIENCES  
AND EDUCATIONAL EFFECTS  
for 2<sup>nd</sup> level, main field of study *MECHANICAL ENGINEERING AND MACHINE BUILDING*  
in specialization *POWER ENGINEERING MACHINES AND DEVICES*  
general academic profile**

Symbol of the educational outcome in the field of technical sciences	Description of the educational outcomes/ effects in the field of technical sciences	Reference to educational outcomes for 2 <sup>nd</sup> level main field of study	
		main field of study <i>Mechanical Engineering and Machine Building</i>	specialization <i>Power Engineering Machines and Devices</i>
<b>KNOWLEDGE</b>			
<b>T2A_W01</b>	has expanded and broadened knowledge of mathematics, physics and chemistry and other areas related to the studied discipline necessary to formulate and solve complex tasks in the field of the studied discipline	K2MBM_W02 K2MBM_W03 K2MBM_W04	
<b>T2A_W02</b>	has detailed knowledge in the field of study related to the studied discipline	K2MBM_W03	S2MUE_W05
<b>T2A_W03</b>	has organized, general knowledge and theoretical grounding including key issues related to the studied discipline	K2MBM_W01 K2MBM_W02 K2MBM_W04 K2MBM_W05 K2MBM_W06	S2MUE_W03 S2MUE_W04 S2MUE_W10 S2MUE_W11 S2MUE_W13
<b>T2A_W04</b>	has detailed knowledge and theoretical grounding connected with the chosen issues in the field of the studied discipline	K2MBM_W03	S2MUE_W01 S2MUE_W02 S2MUE_W06 S2MUE_W07 S2MUE_W08 S2MUE_W09 S2MUE_W12
<b>T2A_W05</b>	has knowledge of trends in development and the most crucial and newest achievements in scientific disciplines and fields of study related to the studied discipline and other related scientific disciplines	K2MBM_W02	
<b>T2A_W06</b>	has fundamental knowledge of the lifecycle of devices, objects and technical systems	K2MBM_W05 K2MBM_W06	
<b>T2A_W07</b>	knows fundamental methods, techniques, tools and materials used for solving simple engineering tasks	K2MBM_W01	

	in the field of the studied discipline		
<b>T2A_W08</b>	has fundamental knowledge necessary to understand social, economical ,legal and other non-technical factors of engineering activities as well as taking them into consideration in engineering practice	K2MBM_W07	
<b>T2A_W09</b>	has fundamental knowledge of management, including quality management and running a business	K2MBM_W07 K2MBM_W08	
<b>T2A_W10</b>	knows and understands basic concepts and rules related to industrial property protection and copyright laws and knows the necessity of these laws and rules in managing intellectual property resources; is able to use patent information resources		
<b>T2A_W11</b>	knows general rules related to establishing and developing individual entrepreneurial activity, using knowledge of scientific disciplines and fields of study related to the studied discipline	K2MBM_W08	
<b>SKILLS</b>			
<b>T2A_U01</b>	is able to obtain information from literature, databases and other properly selected sources, either in English or another foreign language regarded as a language for international communication in the studied discipline ; is able to integrate obtained information, interpret and critically evaluate it, draw conclusions, formulate and justify opinions in full	K2MBM_U04	
<b>T2A_U02</b>	is able to communicate in their professional environment and other environments using various techniques, either in English or another foreign language regarded as a language for international communication in the studied discipline	K2MBM_U09	
<b>T2A_U03</b>	is able to prepare a scientific study in Polish language and also a short scientific report, with the results of own research, in a foreign language regarded as a basic one in the scientific disciplines and fields of study related to the studied discipline	K2MBM_U07	S2MUE_U08
<b>T2A_U04</b>	is able to prepare and give an oral presentation concerning detailed issues in the field of the studied discipline both in Polish and a foreign language	K2MBM_U06	
<b>T2A_U05</b>	is able to establish directions of further education and follow the process of self-learning	K2MBM_U06 K2MBM_U07	
<b>T2A_U06</b>	has language skills in scientific disciplines and fields of study related to the studied discipline according to CEFR requirements for B2+ level	K2MBM_U08	
<b>T2A_U07</b>	is able to use information and communication technologies necessary to perform tasks typical of engineering activities	K2MBM_U03 K2MBM_U05	
<b>T2A_U08</b>	is able to plan and run experiments including measurements and computer simulations, interpret results and draw conclusions	K2MBM_U01 K2MBM_U02	S2MUE_U01 S2MUE_U03 S2MUE_U04 S2MUE_U05
<b>T2A_U09</b>	is able to use analytical, simulation and experimental methods to formulate and solve engineering tasks	K2MBM_U03	S2MUE_U07



	as well as simple research problems	K2MBM_U05	S2MUE_U09 S2MUE_U10 S2MUE_U11
<b>T2A_U10</b>	is able to formulate and test hypotheses connected with engineering problems and simple research problems	K2MBM_U03 K2MBM_U04 K2MBM_U05	S2MUE_U02 S2MUE_U06 S2MUE_U09 S2MUE_U10
<b>T2A_U11</b>	is able to formulate and test hypotheses connected with engineering problems and simple research problems	K2MBM_U03 K2MBM_U04	S2MUE_U02
<b>T2A_U12</b>	is able to assess the usefulness and possibilities of new achievements (technological and technical) in the field of the studied discipline	K2MBM_U01	S2MUE_U04
<b>T2A_U13</b>	is prepared to work in an industry environment and knows safety rules in the workplace	K2MBM_U04	
<b>T2A_U14</b>	is able to carry out primary economic analysis of undertaken engineering activities		S2MUE_U06
<b>T2A_U15</b>	is able to carry out critical analysis of functioning and also assess – particularly in reference to the studied discipline- existing technical solutions, in particular devices, objects, systems, processes, and services	K2MBM_U04	
<b>T2A_U16</b>	is able to plan improvements in existing technical solutions	K2MBM_U03	S2MUE_U06
<b>T2A_U17</b>	is able to identify and formulate specifications of complex engineering tasks specific for the studied discipline including untypical tasks considering their non-technical aspects	K2MBM_U05	
<b>T2A_U18</b>	is able to assess the usefulness of methods and tools for solving an engineering task specific for the studied discipline, and notice limitations of these methods and tools; is able – by applying conceptually new methods- to solve complex engineering tasks specific for the studied discipline, including untypical tasks and tasks with a research component	K2MBM_U02	
<b>T2A_U19</b>	is able – according to a given specification which considers non –technical aspects- to design a complex device, object, system or process specific for the studied discipline and complete this project – at least partially- using appropriate methods, techniques and tools, adapting already existing tools or by creating new tools	K2MBM_U05	S2MUE_U06 S2MUE_U10
<b>SOCIAL COMPETENCES</b>			
<b>T2A_K01</b>	understands the necessity of a lifetime learning process; is able to inspire and organize the process of learning for others	K2MBM_K01	
<b>T2A_K02</b>	realizes the significance and understands non-technical aspects and consequences of engineering activity and especially its influence on the natural environment and the related responsibility for decisions	K2MBM_K02 K2MBM_K06	

<b>T2A_K03</b>	is able to cooperate and work in a group, taking up different roles	K2MBM_K03 K2MBM_K06	
<b>T2A_K04</b>	is able to set clear priorities leading to the realization tasks set by himself or others	K2MBM_K04	
<b>T2A_K05</b>	identifies correctly and solves dilemmas connected with the profession	K2MBM_K01	
<b>T2A_K06</b>	is able to think and act in an entrepreneurial way	K2MBM_K05	
<b>T2A_K07</b>	realizes the social role of technical university graduates and especially understands the need to formulate information and share it with society, e.g. through mass media, in relation to achievements in environmental engineering and other aspects of engineering activity; makes attempts at sharing such information and opinions in an understandable way	K2MBM_K02	