Attachement no. 1 to Programme of Education
(for studies beginning in the year 2015/2016))

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: Process Systems Engineering (IAP)
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 IAP	**DESCRIPTION OF THE MAIN LEARNING OUTCOMES** **After completion of the post-graduate studies in the field of *Mechanical Engineering and Machine Building*, in specialization *Process Systems Engineering* the graduate:**	**Reference to learning outcomes for the area of technical sciences (T)**
KNOWLEDGE		
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
S2IAP_W01	has extended, theoretically founded knowledge of the dynamics of unit operations in process engineering; understands their progression and knows defining relations; knows equipment and its applicability to implement dynamic unit	T2A_W01 T2A_W03

	operations in the industry	T2A_W07
S2IAP_W02	has knowledge on construction of process equipment components such as shells, bottoms, lids, legs, supports, flange connections, grills, rotating drums and high-pressure apparatus components; has knowledge on use of these elements in constructing the entire apparatus; knows methods of their calculation and the rules of selection; has expertise in the selection of parameters of the process equipment and necessary equipment to ensure trouble-free and safe operation	T2A_W02 T2A_W03 T2A_W07
S2IAP_W03	has knowledge of procedures for selecting the optimal solution for the project and preparation of scientific and technical documentation; knows the specialized software supporting calculations as well monitoring and process control operations	T2A_W01 T2A_W03 T2A_W04
S2IAP_W04	has basic knowledge on thermodynamic transformations and phase equilibriums	T2A_W01 T2A_W03
S2IAP_W05	has structured and theoretically founded knowledge in the field of heat transfer and methods of increasing the concentration of solutions by evaporation of the liquid; knows basic constructions of heat exchangers and evaporators; understands principles of heat and mass balances in evaporation	T2A_W04 T2A_W07
S2IAP_W06	has extended knowledge on static and kinetic aspects of crystallization; knows in detail the methods of industrial crystallization, apparatus to implement them as well as procedures for their proper selection to achieve high quality crystalline product while reducing energy consumption; has structured knowledge on mathematical modeling and design of crystallizers	T2A_W04 T2A_W07
S2IAP_W07	has detailed knowledge of processes of thermal diffusion separation of substances; has in-depth knowledge on the design of apparatus for thermal diffusion separation of substances; knows methods of their design, mathematical modeling and operation; knows the applicability of thermal diffusion processes in selected industries and for environmental protection	T2A_W02 T2A_W03 T2A_W07
S2IAP_W08	has basic understanding on how to develop the concept of technological process as well as on its balancing; knows rules for drawing process diagrams; has structured knowledge on the selection of apparatus, control and measuring equipment for the implementation of technological process; knows the basis of economic assessment and has expertise in scaling up processes	T2A_W01 T2A_W04 T2A_W07
S2IAP_W09	has extended, theoretically founded knowledge of the physical, chemical, structural and mechanical properties of solutions, suspensions, granular and porous materials; has basic knowledge on rheology and multiphase flows; understands and can explain the methods of measurement using image analysis; knows in detail the methods for measuring selected properties of solutions, suspensions and particulate and porous materials	T2A_W04 T2A_W07
S2IAP_W10	has extended and in-depth knowledge of the industrial methods of separation of solid particles suspended in liquids and gases; knows allocation methods and knows how to select proper method for separation of individual suspensions; has expertise in combining and optimization of different separation methods; knows apparatus for separation; explains the operation of separation nodes	T2A_W04 T2A_W07
SKILLS		
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	T2A_U08 T2A_U12

	programs with microcontroller development kits; can couple microcontrollers with the elements of mechatronic system	
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 *Power Engineering* in accordance with the requirements for level A1 or A2 or B1 of the European Framework of Reference for Languages	T2A_U02
S2IAP_U01	is able to analyze and measure basic parameters of unit operations in process engineering; knows how to calculate and select operating parameters for high performance equipment operatio; is able to analyze and compare the experimental results with calculated theoretical results	T2A_U07 T2A_U09 T2A_U18
S2IAP_U02	can perform calculations, manufacturing drawings and assembly drawing of the selected apparatus of the process, knows how to select components based on equipment standards and manufacturers' catalogs; is able to use the device to ensure safe operation of the apparatus and to develop a method of its exploitation	T2A_U15 T2A_U16
S2IAP_U03	is able to plan in detail the engineering project and outline its critical components; is able to define and assign resources necessary for effective its implementation; is able to use specialized software to carry out design calculations and presentations; can prepare initial economic evaluation	T2A_U09 T2A_U10 T2A_U14

S2IAP_U04	Is able to resolve issues and problems associated with phase transitions and interfacial equilibrium	T2A_U10 T2A_U17
S2IAP_U05	is able to do the project of the selected type mixer including detailed calculations of hydraulics and hydrodynamics, mixing, stirring power, thermal and endurance calculations; knows how to perform assembly drawing and manufacturing drawings of the mixer and its components	T2A_U01 T2A_U15 T2A_U19
S2IAP_U06	is able to prepare and give a presentation on such topics as: construction and operation of mixing equipment, liquid velocity distributions in mixers, hydraulic mixing of heterogeneous systems, mixing of granular materials, mixing in flow apparatus, mixing power and the exchange of heat and mass transfer in mixing vessels	T1A_U01 T1A_U04
S2IAP_U07	is able to determine experimentally heat transfer coefficients is apparatus submitted to varying operating conditions; is able to present results in numerical and graphical form, and perform comparative analysis of experimentally and theoretically obtained coefficients	T2A_U08 T2A_U09
S2IAP_U08	knows how to perform mass, energy and population balance in the mold based on the experimental data; is able to determine kinetic parameters of the crystallization process in intermittent and continuously operating crystallizer; is able to select the operating parameters of the batch crystallizer in order to obtain high quality crystalline product	T2A_U07 T2A_U08 T2A_U09
S2IAP_U09	Is able to experimentally determine mass transfer coefficients and calculate the efficiency of mass transfer process and to determine the amount of filling for the rectification column; is able to analyze and compare the experimental results with theoretical calculations	T2A_U07 T2A_U08 T2A_U09
S2IAP_U10	is able to perform detailed calculations of selected thermal diffusion processes aimed at the selection and design of equipment; knows how to use mathematical models of these processes and their equilibrium data	T2A_U01 T2A_U15 T2A_U19
S2IAP_U11	can make installation project for the selected technological process with specified production capacity, including: the material and energy balance of the installation, selection of devices and equipment, detailed design calculations and assumptions for apparatus that require individual construction, technological schematics of apparatus, spatial planning of measurement equipment and apparatus	T2A_U01 T2A_U10 T2A_U15
S2IAP_U12	is able to experimentally determine concentration of solutions, choose proper method and analyze the particle size distribution; knows how to calculate the strength parameters of granular material and how to make measurements of the structural properties of sediments	T2A_U08 T2A_U09 T2A_U18
S2IAP_U13	is able to identify and describe a method for separating of suspensions required by the specific process conditions; is able to estimate process parameters and the efficiency of the methods of separation; is able to define basic dimensions of machinery and apparatus for separation of suspensions in given process conditions; can make a preliminary economic analysis of the separation process	T2A_U07 T2A_U15 T2A_U14
SOCIAL COMPETENCIES		
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 2nd level, main field of study *MECHANICAL ENGINEERING AND MACHINE BUILDING*
in specialization *PROCESS SYSTEMS ENGINEERING*
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 2nd level main field of study	
		main field of study *Mechanical Engineering and Machine Building*	specialization *Process Systems Engineering*
KNOWLEDGE			
T2A_W01	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	S2IAP_W01 S2IAP_W03 S2IAP_W04 S2IAP_W08
T2A_W02	has detailed knowledge in the field of study related to the studied discipline	K2MBM_W03	S2IAP_W02 S2IAP_W07
T2A_W03	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	S2IAP_W01 S2IAP_W02 S2IAP_W03 S2IAP_W04 S2IAP_W07
T2A_W04	has detailed knowledge and theoretical grounding connected with the chosen issues in the field of the studied discipline	K2MBM_W03	S2IAP_W03 S2IAP_W05 S2IAP_W06 S2IAP_W08 S2IAP_W09 S2IAP_W10
T2A_W05	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	
T2A_W06	has fundamental knowledge of the lifecycle of devices, objects and technical systems	K2MBM_W05	

		K2MBM_W06	
T2A_W07	knows fundamental methods, techniques, tools and materials used for solving simple engineering tasks in the field of the studied discipline	K2MBM_W01	S2IAP_W01 S2IAP_W02 S2IAP_W05 S2IAP_W06 S2IAP_W07 S2IAP_W08 S2IAP_W09 S2IAP_W10
T2A_W08	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	
T2A_W09	has fundamental knowledge of management, including quality management and running a business	K2MBM_W07 K2MBM_W08	
T2A_W10	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		
T2A_W11	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	
SKILLS			
T2A_U01	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	S2IAP_U05 S2IAP_U10 S2IAP_U11
T2A_U02	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	
T2A_U03	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	
T2A_U04	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	
T2A_U05	is able to establish directions of further education and follow the process of self-learning	K2MBM_U06 K2MBM_U07	
T2A_U06	has language skills in scientific disciplines and fields of study related to the studied discipline according to CEFR requirements for B2+ level	K2MBM_U08	

T2A_U07	is able to use information and communication technologies necessary to perform tasks typical of engineering activities	K2MBM_U03 K2MBM_U05	S2IAP_U01 S2IAP_U08 S2IAP_U09 S2IAP_U13
T2A_U08	is able to plan and run experiments including measurements and computer simulations, interpret results and draw conclusions	K2MBM_U01 K2MBM_U02	S2IAP_U07 S2IAP_U08 S2IAP_U09 S2IAP_U12
T2A_U09	is able to use analytical, simulation and experimental methods to formulate and solve engineering tasks as well as simple research problems	K2MBM_U03 K2MBM_U05	S2IAP_U01 S2IAP_U03 S2IAP_U07 S2IAP_U08 S2IAP_U09 S2IAP_U12
T2A_U10	is able - while formulating and solving engineering tasks- to integrate knowledge of scientific disciplines and fields of studies appropriate for the specialization and apply the system approach which also takes into account non- technical aspects	K2MBM_U03 K2MBM_U04 K2MBM_U05	S2IAP_U03 S2IAP_U04 S2IAP_U11
T2A_U11	is able to formulate and test hypotheses connected with engineering problems and simple research problems	K2MBM_U03 K2MBM_U04	
T2A_U12	is able to assess the usefulness and possibilities of new achievements (technological and technical) in the field of the studied discipline	K2MBM_U01	
T2A_U13	is prepared to work in an industry environment and knows safety rules in the workplace	K2MBM_U04	
T2A_U14	is able to carry out primary economic analysis of undertaken engineering activities		S2IAP_U03 S2IAP_U13
T2A_U15	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	S2IAP_U02 S2IAP_U05 S2IAP_U10 S2IAP_U11 S2IAP_U13
T2A_U16	is able to plan improvements in existing technical solutions	K2MBM_U03	S2IAP_U02
T2A_U17	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	S2IAP_U04
T2A_U18	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;	K2MBM_U02	S2IAP_U01 S2IAP_U12

	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		
T2A_U19	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	S2IAP_U05 S2IAP_U10
SOCIAL COMPETENCES			
T2A_K01	understands the necessity of a lifetime learning process; is able to inspire and organize the process of learning for others	K2MBM_K01	
T2A_K02	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	
T2A_K03	is able to cooperate and work in a group, taking up different roles	K2MBM_K03 K2MBM_K06	
T2A_K04	is able to set clear priorities leading to the realization tasks set by himself or others	K2MBM_K04	
T2A_K05	identifies correctly and solves dilemmas connected with the profession	K2MBM_K01	
T2A_K06	is able to think and act in an entrepreneurial way	K2MBM_K05	
T2A_K07	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	