**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: Engineering of Aviation (ILO)**
**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 ILO** | **DESCRIPTION OF THE MAIN LEARNING OUTCOMES**<br><br>**After completion of the post-graduate studies in the field of *Mechanical Engineering and Machine Building*, in specialization *Engineering of Aviation* 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<br>T2A_W03<br>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<br>T2A_W02<br>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<br>T2A_W03<br>T2A_W07 |
| K2MBM_W05 | knows basic tools for failure analysis; has basic understanding of the causes and consequences of failures in machinery | T2A_W03<br>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<br>T2A_W06 |
| K2MBM_W07 | has knowledge needed to understand the social, economic, legal and other non-technical considerations of engineering activities | T2A_W08<br>T2A_W09 |
| K2MBM_W08 | knowledgeable about processes of business management | T2A_W09<br>T2A_W11 |
| S2ILO_W01 | has basic knowledge of preliminary gas-dynamic calculations of turbine engines and their main components; has knowledge on the strength calculations of the basic structural components of gas turbine engines | T2A_W07 |

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| S2ILO_W02 | identifies the design features of aircrafts; explains the methodology for determining loads on components of aircrafts; describes the structure of components and systems of aircrafts | T2A_W03<br>T2A_W04 |
| S2ILO_W03 | defines types of vibrations and vibration characteristics of aircraft components; is able to identify methods of preventing vibrations in aircraft components | T2A_W01<br>T2A_W04 |
| S2ILO_W04 | characterizes advanced hydrodynamic phenomena occurring in flows; defines laws describing the flow around objects; explains methods for describing the turbulent flow; formulates the theory of boundary layer | T2A_W01<br>T2A_W03<br>T2A_W04 |
| S2ILO_W05 | describes how to derive the equations of motion for an aircraft; defines loads acting in flight; describes the aero-elasticity of the aircraft; identifies the impact of aero-elasticity effects on the dynamics of motion of the aircraft and the flight safety | T2A_W01<br>T2A_W04 |
| S2ILO_W06 | lists the main documents underlying the regulation of aviation; explains concepts in the field of aviation law | T2A_W03<br>T2A_W08 |
| S2ILO_W07 | has knowledge of the life and reliability of the aircraft; is able to identify the determinants of the level of reliability of the aircraft; is able to describe the principles of forecasting the reliability in the exploitation | T2A_W04<br>T2A_W06 |
| S2ILO_W08 | lists the purpose and tasks of the energy systems of the aircraft; describes their design, explains the methodology of calculation of the energy systems of the aircraft | T2A_W03<br>T2A_W04<br>T2A_W06 |
| S2ILO_W09 | explains the equations of motion of the helicopter; interprets helicopter flight from the equations of motion | T2A_W03<br>T2A_W04 |
| S2ILO_W10 | lists the main concepts of aviation safety; describes the methodology of accident investigation and explains ways to improve air safety | T2A_W04<br>T2A_W06 |
| S2ILO_W11 | has ordered knowledge of the mathematical formulas used in the finite element method, knows the rules of use of FEM software in structural design | 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 programs with microcontroller development kits; can couple microcontrollers with the elements of mechatronic system | T2A_U08<br>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<br>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<br>T2A_U09<br>T2A_U10<br>T2A_U11<br>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 | T2A_U01 |

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| | other sources of knowledge | T2A_U10<br>T2A_U11<br>T2A_U13<br>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<br>T2A_U09<br>T2A_U10<br>T2A_U17<br>T2A_U19 |
| K2MBM_U06 | has the ability to perform oral presentations on specific issues in the field of studied engineering discipline | T2A_U04<br>T2A_U05 |
| K2MBM_U07 | is able to prepare coherent report on the carried out work | T2A_U03<br>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 |
| S2ILO_U01 | can perform the calculation of parameters of the stream in the flow channel in the turbine engine and its main units | T2A_U09 |
| S2ILO_U02 | is able to select parameters of the engine cycle; can design the flow channel geometry for the turbine engine and carry out preliminary strength calculations of basic gas turbine engine components | T2A_U14<br>T2A_U15 |
| S2ILO_U03 | performs strength calculations of the main components of an aircraft | T2A_U07<br>T2A_U14 |
| S2ILO_U04 | carries out the design process of the selected energy system of an aircraft | T2A_U09<br>T2A_U15 |
| S2ILO_U05 | is able to identify the type of vibration on aircraft components and calculate the natural frequency of the selected aircraft components | T2A_U09 |
| S2ILO_U06 | solves problems related to the similarity of flows, apply laws of fluid mechanics to determine parameters of flow | T2A_U01<br>T2A_U09<br>T2A_U10 |
| S2ILO_U07 | analyzes and interprets velocity, pressure and temperature fields derived from commercial CFD software (Computational Fluid Dynamics); uses information provided by these programs | T2A_U08<br>T2A_U09<br>T2A_U12 |
| S2ILO_U08 | calculates aerodynamic derivatives and analyzes vibration on aircraft components; can determine the critical speed of | T2A_U09 |

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| | Flatter type vibration | |
| S2ILO_U09 | uses advanced software engineering MES in designing aircraft structures | T2A_U07<br>T2A_U16 |
| S2ILO_U10 | search, interpret and properly apply the rules of the air | T2A_U01<br>T2A_U03 |
| S2ILO_U11 | calculates helicopter flight parameters on the basis of equations of motion | T2A_U09 |
| S2ILO_U12 | perform a preliminary design of the drive system for helicopter | T2A_U07 |
| **SOCIAL COMPETENCIES** | | |
| K2MBM_K01 | understands the need to improve professional, personal and social skills; identifies and resolves dilemmas associated with his profession | T2A_K01<br>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<br>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<br>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 *ENGINEERING OF AVIATION***
**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 *Engineering of Aviation* |
| **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<br>K2MBM_W03<br>K2MBM_W04 | S2ILO_W03<br>S2ILO_W04<br>S2ILO_W05 |
| **T2A_W02** | has detailed knowledge in the field of study related to the studied discipline | K2MBM_W03 | |
| **T2A_W03** | has organized, general knowledge and theoretical grounding including key issues related to the studied discipline | K2MBM_W01<br>K2MBM_W02<br>K2MBM_W04<br>K2MBM_W05<br>K2MBM_W06 | S2ILO_W02<br>S2ILO_W04<br>S2ILO_W06<br>S2ILO_W08<br>S2ILO_W09 |
| **T2A_W04** | has detailed knowledge and theoretical grounding connected with the chosen issues in the field of the studied discipline | K2MBM_W03 | S2ILO_W02<br>S2ILO_W03<br>S2ILO_W04<br>S2ILO_W05<br>S2ILO_W07<br>S2ILO_W08<br>S2ILO_W09<br>S2ILO_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<br>K2MBM_W06 | S2ILO_W07<br>S2ILO_W08<br>S2ILO_W10 |

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| **T2A_W07** | knows fundamental methods, techniques, tools and materials used for solving simple engineering tasks in the field of the studied discipline | K2MBM_W01 | S2ILO_W01<br>S2ILO_W11 |
| **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 | S2ILO_W06 |
| **T2A_W09** | has fundamental knowledge of management, including quality management and running a business | K2MBM_W07<br>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 | S2ILO_U06<br>S2ILO_U10 |
| **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 | S2ILO_U10 |
| **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<br>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<br>K2MBM_U05 | S2ILO_U03<br>S2ILO_U09<br>S2ILO_U12 |
| **T2A_U08** | is able to plan and run experiments including measurements and computer simulations, interpret results and draw conclusions | K2MBM_U01<br>K2MBM_U02 | S2ILO_U07 |

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| **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<br>K2MBM_U05 | S2ILO_U01<br>S2ILO_U04<br>S2ILO_U05<br>S2ILO_U06<br>S2ILO_U07<br>S2ILO_U08<br>S2ILO_U11 |
| **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<br>K2MBM_U04<br>K2MBM_U05 | S2ILO_U06 |
| **T2A_U11** | is able to formulate and test hypotheses connected with engineering problems and simple research problems | K2MBM_U03<br>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 | S2ILO_U07 |
| **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 | | S2ILO_U02<br>S2ILO_U03 |
| **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 | S2ILO_U02<br>S2ILO_U04 |
| **T2A_U16** | is able to plan improvements in existing technical solutions | K2MBM_U03 | S2ILO_U09 |
| **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 | |
| **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;<br>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 | |
| **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 | |
| **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 | |

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| **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<br>K2MBM_K06 | |
| **T2A_K03** | is able to cooperate and work in a group, taking up different roles | K2MBM_K03<br>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 | |