Wojskowa Akademia Techniczna

**Uchwała**
**Senatu Wojskowej Akademii Technicznej**
**im. Jarosława Dąbrowskiego**

**nr 34/WAT/ 2021 z dnia 27 maja 2021 r.**

**w sprawie ustalenia programów studiów pierwszego stopnia dla kierunków studiów: „lotnictwo i kosmonautyka", „mechatronika", „inżynieria bezpieczeństwa", „inżynieria systemów bezzałogowych"**

Na podstawie art. 28 ust. 1 pkt. 11 Ustawy z dnia 20 lipca 2018 r. - Prawo o szkolnictwie wyższym i nauce (Dz. U. z 2021 r., poz. 478, z późn. zm.), oraz § 21ust. 1 pkt 21 i § 81 ust 10 i 11 Statutu WAT stanowiącego załącznik do uchwały Senatu WAT nr 16/WAT/ 2019 z dnia 25 kwietnia 2019 r., w sprawie uchwalenia Statutu Wojskowej Akademii technicznej im. Jarosława Dąbrowskiego (tj. obwieszczenie Rektora WAT nr 2/WAT/2019 z dnia 9 października 2019 r.), po zasięgnięciu opinii samorządu studenckiego uchwala się, co następuje:

§ 1

Ustala się programy studiów pierwszego stopnia o profilu ogólnoakademickim , rozpoczynających się od roku akademickiego 2021/2022, dla następujących kierunków studiów:

1) „lotnictwo i kosmonautyka" – w języku polskim i angielskim stanowiący załącznik nr 1 do uchwały;
2) „mechatronika" – w języku polskim i angielskim stanowiący załącznik nr 2 do uchwały;
3) „inżynieria bezpieczeństwa" – stanowiący załącznik nr 3 do uchwały;
4) „inżynieria systemów bezzałogowych"- stanowiący załącznik nr 4 do uchwały.

§ 2

Uchwała wchodzi w życie z dniem podjęcia.

**Przewodniczący Senatu**

**(-) płk prof. dr hab. inż. Przemysław WACHULAK**

Annex 1
To the resolution of the Senate of the MUT No. 34/WAT/2021
Dated: 27 maja 2021

# MILITARY UNIVERSITY OF TECHNOLOGY named after Jarosław Dąbrowski

# CURRICULUM

## Level of education: first cycle programme

**Field of study: Aeronautics and Astronautics**

***Resolution of the Senate of the Military University of Technology named after Jarosław Dąbrowski No 34/WAT/2021 of. 27 maja 2021 r. on the establishment of a curriculum for the field of study " Aeronautics and Astronautics".***

***Effective from the academic year 2021/2022***

*Warsaw*

*2021*

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**CURRICULUM**

**for the field of study "Aeronautics and Astronautics”**

**Level of education:** first-cycle programme

**Profile of study:** general academic

**Mode(s) of study:** full-time programme

**Qualification and title conferred on graduates:** engineer

**Polish Qualification Framework level:** 6

**Field of study is assigned to:**

| | |
|---|---|
| **Field of science** | engineering and technology |
| **Scientific discipline** | mechanical engineering, 70% ECTS credits |
| **Field of science** | engineering and technology |
| **Scientific discipline** | automation, electronics and electrical engineering, 30% ECTS credits |

**Leading discipline[5]:** mechanical engineering

**Language of instruction:** English

**Number of semesters:** 7

**Total number of hours:**

| | |
|---|---|
| Avionics: | 2424 |
| Aircrafts and helicopters: | 2458 |
| Aeronautical propulsion systems: | 2488 |

**Number of ECTS credits required to graduate:** 210

**Total number of ECTS credits a student is required to obtain for the course:**

**- conducted with direct participation of academic staff or other instructors:**

| | |
|---|---|
| Avionics | 124.5 |
| Aircrafts and helicopters | 125.0 |
| Aeronautical propulsion systems | 126.5 |

**- in the humanities and social sciences[6]:** 20

*[5] In case of assigning the field of study to more than one scientific discipline*

*[6] does not apply to fields of study which are assigned to disciplines within the disciplines of humanities or social sciences respectively*

**Dimension, number of ECTS credits, rules and form of apprenticeship:** 4 weeks, 4 ECTS

As a part of an apprenticeship carried out after the 6th semester (credit is awarded in the 7th semester) in a didactic dimensions of 4 weeks, students should obtain 4 ECTS credits. The aim of an apprenticeship is to verify in practice the knowledge, skills and social competences acquired by students during their studies and to prepare them to carry out a final thesis. Students complete their apprenticeship in national economy enterprises. Apprenticeship in representative and appropriate for a given field of study national economy enterprises is carried out on based on a bilateral agreement on student apprenticeships and apprenticeships programme. An apprenticeship may also be completed in the form of an individual project of a student under the direction of an academic teacher during the course of studies. A didactic and educational supervision over apprenticeship is exercised by an apprentice supervisor or a project manager.

**Description of the assumed learning outcomes takes into account:**

- a first-degree universal characteristics set out in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System
- a second-degree characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-degree characteristics of learning outcomes for qualifications at levels 6-8 of the Polish Qualification Framework, including those, which allow for acquiring engineering competence[7]

**and is included in three categories:**

- a **knowledge** category **(W)**, which specifies:
  - breadth and depth (**G**) - completeness of cognitive perspective and relationships,
  - context (**K**) - conditions, outcomes.
- a **skills** category **(U)**, which specifies:
  - in term of knowledge application (**W**) - problems solved and tasks performed,
  - in terms of communication (**K**) - receiving and creating statements, disseminating knowledge in a scientific environment and using a foreign language,
  - in terms of work organisation (**O**) - planning and teamwork,
  - in terms of learning (**U**) - planning one's own development and development of others.
- **a social competence** category **(K)** - which specifies:
  - in terms of assessments (**K**) - a critical approach,
  - in terms of responsibility (**O**) - fulfilling social obligations and acting in the public interest,
  - in relation to the professional role (**R**) - independence and ethos of development.

[7] *Applies to the fields of study, the graduates of which get a degree of inż., mgr inż*

Explanation of designations:
- in ***a symbol and outcome number*** column:
  - K – field-related learning outcomes;
  - W, U, K (after the underscore) - category - respectively: knowledge, skills, social competence;
  - 01, 02, 03 …. – a number of learning outcome.
- in *a* ***code of description component***[8] column - Inż[9]_P7S_WG – a code of description component of the second-degree characteristics for qualification at level 7 of the Polish Qualification Framework

| Symbol and outcome number | Description of the intended learning outcomes | Code of description component |
|---|---|---|
| **KNOWLEDGE** | **The graduate:** | |
| K_W01 | has knowledge of mathematics, encompassing algebra, elements of matrix calculus, mathematical analysis, including problems of differential and integral calculus of functions of many variables, elements of ordinary and partial differential equations, probability theory and elements of applied mathematics, necessary to:<br>5. describe and analyse the issues of general mechanics, including dynamics of material points and rigid bodies of constant and variable mass, and vibrating systems;<br>6. describe the state and motion of fluids, describe and analyse the fundamental physical phenomena in flows and drags, and analyse steady and transient flight issues;<br>7. describe the dynamics of mechanical, electrical and electronic components, systems and devices;<br>8. describing the strength issues and basic elasticity theory | P6S_WG |
| K_W02 | has knowledge of physics, encompassing mechanics, optics, electricity and electromagnetic waves, and solid state physics, including the knowledge necessary to understand the fundamental physical phenomena occurring in aircraft components, circuits, equipment, installations and systems, and their operational systems and environments | P6S_WG |
| K_W03 | has basic knowledge of electrical and electronic engineering covering relevant aeronautics and astronautics issues | P6S_WG<br>Inż_P6S_W |
| K_W04 | has well-structured and theoretically grounded knowledge of the fundamentals of control and automation, metrology of mechanical and electrical quantities and techniques of performing measurements | P6S_WG<br>Eng_P6S_WG |
| K_W05 | has well-structured knowledge of computer science, digital technology and the organisation, architecture and software of computers, including on-board computers | P6S_WG<br>Eng_P6S_WG |

[8] *6/7 keep the appropriate one*
[9] *In case of engineering competences*

| | | |
|---|---|---|
| K_W06 | has well-structured and theoretically grounded knowledge of general mechanics, including knowledge covering the key aspects of aircraft design and operation | P6S_WG<br>Eng_P6S_WG |
| K_W07 | has well-structured and theoretically grounded knowledge of the basics of machine design and strength of materials as well as engineering graphics and construction notation | P6S_WG<br>Eng_P6S_WG |
| K_W08 | has well-structured and theoretically grounded knowledge of the fluid and flight mechanics in relation to the key issues of aircraft design and operation | P6S_WG |
| K_W09 | has well-structured and theoretically grounded knowledge of the structural, technological and operational problems of machines, object evaluation criteria, reliability and safety and processes leading to failures of mechanical objects | P6S_WG<br>Eng_P6S_WG |
| K_W10 | has well-structured knowledge of aeronautic materials and aeronautic and astronautic technology | P6S_WG<br>Eng_P6S_WG |
| K_W11 | has well-structured knowledge of aerospace engine design and engineering thermodynamics, including thermodynamic circuits, heat transfer. | P6S_WG<br>Eng_P6S_WG |
| K_W12 | has well-structured knowledge of aircraft operations engineering and aircraft continuing airworthiness | P6S_WG<br>Eng_P6S_WG |
| K_W13 | has well-structured knowledge of aircraft and spacecraft construction and design, and of airborne equipment including airborne systems, circuits and installations | P6S_WG<br>Eng_P6S_WG |
| K_W14 | has detailed knowledge of aircraft operation, including knowledge necessary to understand the physical basis of operation of aircraft components, circuits, equipment, installations and systems | P6S_WG<br>Eng_P6S_WG |
| K_W15 | is familiar with the current status and latest development trends in aerospace technology | P6S_WK<br>Inż_P6S_WK |
| K_W16 | has basic knowledge of the life cycle of aircraft equipment and systems | P6S_WG<br>Eng_P6S_WG |
| K_W17 | has basic knowledge necessary to understand non-technical conditions of engineering activities, knows basic health and safety rules applicable in aviation | P6S_WK<br>Inż_P6S_WK |
| K_W18 | knows and understands the general principles for creating and developing forms of individual entrepreneurship, using the knowledge of aircraft construction and operation | P6S_WK<br>Inż_P6S_WK |
| K_W19 | has advanced knowledge of the selected facts about objects and phenomena and concerning the methods and theories which explain the complex interrelationships among them, constituting the basic general knowledge within the disciplines of mechanics, mechanical engineering and operation, electronics, electrical engineering, computer science | P6S_WG |
| K_W20 | has basic knowledge of economic, legal, social and humanistic aspects, including the basic concepts and principles of industrial property protection, intellectual property, copyright and patent law | P6S_WK |
| **SKILLS** | **The graduate:** | |

| | | |
|---|---|---|
| K_U01 | is able to obtain information from literature, databases and other sources, can integrate acquired information, interpret them and draw conclusions as well as formulate and justify opinions and identify and describe components, circuits, equipment, installations and systems of aircraft and spacecraft using information and communication technologies | P6S_UW |
| K_U02 | is able to communicate using a variety of techniques in professional and other environments | P6S_UK |
| K_U03 | is able to prepare documentation for the execution of an engineering task, can prepare a text describing the results of the task and give a short presentation of the results of the engineering task | P6S_UW<br>Eng._P6S_UW |
| K_U04 | Is able to self-educate, including with a view to improving professional competence | P6S_UU |
| K_U05 | has sufficient language skills corresponding to level B2 of the Common European Framework of Reference for Languages to be able to communicate and read technical texts with comprehension | P6S_UK |
| K_U06 | Is able to use properly the selected methods and equipment to plan and perform measurements of the principal characteristic quantities of aircraft components, circuits, equipment and installations | P6S_UW |
| K_U07 | Is able to determine basic parameters in an analytical manner and formulate simple mathematical models to simulate aircraft components, circuits, equipment, installations and systems, and additionally can use the appropriately selected computer tools - simulators and programming environments | P6S_UW<br>Eng._P6S_UW |
| K_U08 | Is able to develop an algorithm, use programming languages and appropriate computer tools to develop application software | P6S_UW<br>Eng._P6S_UW |
| K_U09 | Is able to use the known methods, measurement and computer techniques to analyse and evaluate the performance of aircraft components | P6S_UW<br>Eng._P6S_UW |
| K_U10 | Is able to design aircraft components, circuits, equipment, installations and simple systems, taking into account given performance and economic criteria, as well as safety regulations | P6S_UW<br>Eng._P6S_UW |
| K_U11 | Is able to compare the design solutions of aircraft systems, equipment and installations with regard to the type of mission and the given performance, economic and safety criteria, and solve technical tasks in the area of aircraft preliminary or conceptual design, airborne system, airborne installation design, proposal for technology of manufacturing, repair and operation procedure | P6S_UW<br>Eng._P6S_UW |
| K_U12 | Is able to operate aircraft subsystems in accordance with the required continuing airworthiness regulations, and is familiar with the safety rules applicable to such work | P6S_UW<br>Eng._P6S_UW |
| K_U13 | Is able to connect results of research work with engineering practice conditioning the improvement of functionality or modernity of solutions of airframe, power unit or particular sub-assemblies constituting the element of strength structure, control system or on-board equipment | P6S_UW<br>Eng._P6S_UW |

| | | |
|---|---|---|
| K_U14 | Is able to analyse conceptual and design solutions in relation to technological capabilities and operational conditions of aircrafts | P6S_UW<br>Eng._P6S_UW |
| K_U15 | Is able to make observations and interpretations of surrounding humanistic, legal and social phenomena | P6S_UW<br>Eng._P6S_UW |
| K_U16 | is able to plan and organise his/her individual and team work | P6S_UO |
| K_U17 | Is able at the identification and formulation of specifications of engineering tasks and their solution to:<br>• use analytical, simulation and experimental methods,<br>• recognise their systemic and non-technical aspects,<br>• make an initial economic assessment of proposed solutions and engineering actions undertaken | P6S_UW |
| K_U18 | is able to critically analyse how the existing technical solutions work and assess these solutions | P6S_UW |
| **SOCIAL COMPETENCES** | | **The graduate:** |
| K_K01 | is aware of the responsibility for his/her own work and is ready to follow the rules of teamwork and take responsibility for the tasks performed jointly, can think and act in an entrepreneurial manner | P6S_KO<br>P6S_KR |
| K_K02 | is able to define priorities in order to accomplish a task defined by him/herself or others | P6S_KK |
| K_K03 | is aware of the importance of acting in a professional manner, observing professional ethics and respecting diversity of opinion | P6S_KR |
| K_K04 | is aware of the social role of a technical university graduate, and in particular understands the need to formulate and convey to the society – among others through the mass media - information and opinions concerning aeronautical achievements and other aspects of aeronautical engineer's activity); undertakes efforts to convey such information and opinions objectively and in a commonly understood way | P6S_KO<br>P6S_KR |

## Groups of classes / subjects[15], their short descriptions (outline programs), ECTS credits allocated to them and learning outcomes (reference to the field-related outcomes)

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | **Group of content of general education<br>General subjects** | | | |
| A.1 | *Professional ethics:*<br>*General ethics, which constitute the basis for professional ethics: subject and divisions of ethics, basic ethical concepts and categories, ethical systems and directions. Professional ethics: essence and objectives of professional ethics, essence and functions of codes of ethics, traditional and contemporary codes of ethics and ethical requirements in technical professions* | **1.5** | **NS** | *K_W17, K_W20, K_U02, K_U15, K_U17, K_K01, K_K03, K_K04,* |
| A.2 | *Introduction to study::*<br>*The aim of the course is to familiarise a student with modern methods of studying and to enable a student to acquire the skills necessary for studying, such as the ability to learn independently, self-presentation, public speaking, scientific discussion, responsible teamwork, studying scientific literature, preparing research reports, initiating topics for study, developing a research and creative attitude, as well as managing his/her time and coping with stress - thus all those elements of knowledge and skills and competences that are required in the course of studying other subjects. The course is intended to help students to overcome difficulties they may encounter at the beginning of their studies in connection with the need to change the style of learning typical to school into the academic style of independent knowledge acquisition and the acquisition of skills and competences.* | **0.5** | **NS** | *K_U04*<br>*K_K01* |
| A.3 | *Basics of management and entrepreneurship:*<br>*The aim of the course is to provide theoretical and practical knowledge of the basics of management in contemporary companies. To introduce students to the basic issues of contemporary management and the mechanisms of organization functioning. To present the most important methods and tools for supporting entrepreneurship in Poland.* | **3.0** | **SNF** | *K_W17, K_W20, K_U01, K_U04, K_U15, K_U17, K_K01, K_K04* |
| A.4 | *Selected issues of law:*<br>*Basic knowledge of law and sources of law. Learning the basics of legal nomenclature necessary to understand the legal language, and elements of the law of the Republic of Poland in the field of constitutional, civil and economic law. The specificity of international law and European Union law.* | **1.5** | **NP** | *K_W17, K_W20, K_U02, K_U15, K_U17, K_K01, K_K03, K_K04* |
| A.5 | *Introduction to computer science:*<br>*Introduction to the architecture and functioning of contemporary computers. Basics of computer networks and the Internet. Windows and Linux operating systems. Standards, formats and computer software for electronic office documents. Text editors - selected functions and applications. Spreadsheets. Software for* | **3.0** | **ITT** | K_W05, K_W19, K_U08 |

*[15] course information sheets shall be drawn up and made available 30 days before the beginning of the semester in which the course is taught – template in Annex 4*
*[16] names of groups of classes / subjects*
*[17] the discipline code as set out in Annex 10*

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *multimedia presentations. Graphics processing packages. Basics of programming in high-level language programming.* | | | |
| A.6 | *Physical education:*<br>*Shaping of the desired behaviour and attitudes towards one's own health, awakening sports interests. Taking part in variety of sports and physical activities (outdoor athletics and Nordic walking, badminton, orienteering, gymnastics, bodybuilding, athletics, volleyball, football, basketball, combat sports, shooting, table tennis, rowing ergometer). Developing and improving the functional efficiency of the cardiorespiratory and muscular systems, stimulating the development of the musculoskeletal system.* | **0.0** | **-** | - |
| A.7 | *Foreign language:*<br>*Structural-grammatical material: revision, expansion and systematisation of the following topics: grammatical tenses/ tenses of narration; active/passive voice; de-pendent speech; conditionals; question formation; collocations; compound sentences; word order in a sentence; modal verbs; phrasal verbs. Conceptual-functional material: requests; suggestions; offers; ad-vice; consent/refusal; negations; agree/disagree; ex-pressing opinion, cause/effect; reason/purpose; wishes, apology; summary; choice of register/style, specialized language* | **8.0** | **J** | *K_U01,*<br>*K_U02,*<br>*K_U05,* |
| A.8 | *Poland history:*<br>*A history of Poland from the beginning of a Polish statehood to the turn of the 20th and 21st centuries: Poland of the Piasts, the Jagiellons, the elected monarchs, the era of partitions, regaining independence in 1918 and the history of the Polish state in the inter-war period, World War II and afterwards.* | **2.0** | **H** | *K_W20,*<br>*K_U15,*<br>*K_U18,* |
| A.9 | *Protection of intellectual property:*<br>*A history of industrial property protection in Poland and in the world. International organizations for protection of intellectual property. Patent protection, utility models and industrial designs. Trademarks, geographical indications, brand name and service marks. Topographies of integrated circuits. Proceedings before the Polish Pa-tent Office. Procedures, fees, registers. Law on Copyright and Related Rights* | **1.5** | **NP** | *K_W20*<br>*K_U01* |
| A.10 | *Occupational Health and Safety:*<br>*Occupational health and safety in the applicable law. Principles of occupational (academic) safety and health - rules of safe conduct, required in the performance of specific work (activities), resulting from scientific and technical requirements. Protection against threats to students' health and safety. Use of personal protective equipment during classes (exercises). Insurance against accidents. Behaviour in case of accidents and emergency situations. The principles of first aid.* | **0.0** | **-** | - |
| **Content group of basic education**<br>**Basic subjects** | | | | |
| B.1 | *Introduction to Metrology:*<br>*The place and role of metrology as an interdisciplinary area of knowledge in contemporary society. Definitions of basic concepts in metrology. The essence of basic measurement methods. The structure and purpose of basic standards and measurement instruments of physical quantities. Errors and uncertainty of measurement* | **2.0** | **AEE** | *K_W04,*<br>*K_W05,*<br>*K_U01,*<br>*K_U06,*<br>*K_U09,* |
| B.2 | *Mathematics 1:* | **6.0** | **M** | K_W01,<br>K_U07 |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *The course aims to provide students with knowledge and understanding of basic concepts and theorems of mathematics, particularly algebra with analytical geometry, and to master elementary calculus skills with a range of knowledge including: real numbers; elementary functions; complex numbers; matrices, determinants, systems of linear algebraic equations, vector spaces; lines, planes and surfaces of second degree in three-dimensional space..* | | | |
| B.3 | *Mathematics 2:*<br>*The course aims to provide students with knowledge and understanding of basic concepts and theorems of mathematics, particularly mathematical analysis, and to master elementary calculus skills with a range of knowledge including: real numbers, number sequences and number series; differential and integral calculus of functions of one real variable and ordinary differential equations..* | **6.0** | **M** | K_W01, K_U07 |
| B. 4 | *Basics of Engineering Graphics:*<br>*Basics of preparing and knowing how to read engineering technical documentation. Methods of representing geometric figures in the plane based on parallel and median projection. Standardization in the field of technical documentation. Learning about basic software supporting the process of developing technical documentation.* | **3.0** | **IM/AEE** | K_W09, K_W07; K_U01, K_U03 |
| B. 5 | *Mathematics 3:*<br>*The course aims to provide students with knowledge and understanding of basic concepts and theorems of mathematics, particularly mathematical analysis, and to master elementary calculus skills including: differential and integral calculus of real functions of many variables; vector analysis; calculus of probability and elements of mathematical statistics.* | **4.0** | **M** | K_W01, K_U07 |
| B.6 | *Physics 1:*<br>*Discussing the basic concepts and laws governing the motion of bodies for models of material point and rigid solid: finding equations of motion, applying principles of dynamics to rectilinear and curvilinear motion in inertial and non-inertial systems. Comparing the Newtonian and relativistic physics. Discussing classical theory of gravitation and quantities describing the gravitational field. Presenting the basic concepts and laws governing oscillatory and wave motion and phenomena characteristic for these movements. Discussing the fundamentals of classical thermodynamics. Discussing electrostatic interactions and the quantities describing this field.* | **6.0** | **NF** | K_W02, K_U07 |
| B. 7 | *Engineering Graphics:*<br>*CAD/CAM/CAE systems - organisation and structure. Performing 2D drawings. Modelling solids based on primitives and NURBS curves. Modelling solid assemblies using standards. Performing detailed drawings (2D) from solid components and assembly drawings (2D) from solid subassemblies. Introducing changes to 2D drawings and solids.* | **3.0** | **IM/AEE** | K_W09, K_W07; K_U01, K_U03 |
| B. 8 | *Computer Science:*<br>*Basic concepts of computer science. Algorithmisation of data processing objectives. Fundamentals of programming in a high-level language. Management support software using databases. Database functions. Data-base and database management system (DBMS). Relational data models. Structured query language SQL.*<br>*Architectures of DBMS. Computer networks and DBMS.* | **3.0** | **ITT** | K_W05, K_W19, K_U08 |
| B. 9 | *Materials Science:*<br>*Fundamentals of materials engineering. Principles of proper selection of materials and their impact on safety in operation of machines and technical equipment. Types of engineering materials. Methods* | **4.0** | **IMat** | K_W02, K_W07, K_W09, K_W10, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *of type designation according to EU standards. Relation between physical and functional properties of engineering materials and their chemical composition and state of processing.* | | | K_W19, K_U01, K_U06 |
| B.10 | *Manufacturing Engineering:*<br>*Basic knowledge of the cutting process. Materials used for cutting tools. Machining technology. Abrasive technology and other methods of reductive machining. Metal cutting machines - jigs and fixtures. Fundamentals of technology process design - components of the machining process, selection of semi-finished products. Technological aspects of powder metallurgy. Processing technologies applied to selected plastics. Fundamentals of welding. Welding methods and heat sealing. Welding methods of applying coatings.* | **3.0** | **IM** | K_W06, K_W07, K_W09, K_W19, K_U01, K_U02, K_U06, |
| B.11 | *Metrology 1:*<br>*Digital measurement technology - introduction. Analog and digital instruments for measuring electrical quantities. Analog vs. digital oscilloscope. Measuring transducers in mechatronic systems. Digital measurement systems. Metrology of geometric quantities.* | **3.0** | **AEE** | K_W04, K_U01, |
| B.12 | *Metrology 2:*<br>*Measurement of electrical quantities. Measurement of geometrical quantities Measurement of non-electrical quantities by electrical methods. Measurement of transducers in mechatronic systems.* | **2.0** | **AEE** | K_W04, K_U01, K_U06, K_U09, |
| B. 13 | *Physics 2:*<br>*Discussing the basic concepts and laws governing electric current. Introducing the concepts of magnetic field and the quantities describing it and comparing with electrostatic and gravitational fields. Discussing the electromagnetic field and its laws. Introducing the basic concepts of optics. Discussing the corpuscular-wave dualism of radiation. Discussing the structure of atom including quantum concepts. Introducing the concept of corpuscular-wave dualism of matter. Discussing the principle of laser construction and features of laser light. Learning the fundamentals of solid state physics, introducing a band model, discussing basic physical phenomena in semiconductors. Discussing the structure of the atomic nuclei, phenomena and laws of radioactivity and reactions of heavy nuclei fission and synthesis of light nuclei* | **4.0** | **NF** | K_W02, K_U07 |
| B.14 | *Electrical Engineering and Electronics:*<br>*Basic concepts and laws of electrical engineering, methods of analysis of DC and AC circuits. Basic electronic components and their application in circuits. Basics of construction and analysis of electrical circuits, necessary for synthesis and analysis of more complex electrical and mechatronic systems. DC and AC electric circuits. Methods of analysis and design and determination of basic parameters and characteristics. Principles of operation of selected DC and AC machines. Basic electronic components and systems, their parameters and characteristics.* | **6.0** | **AEE** | K_W01, K_W02, K_W03, K_W19, K_U01, K_U07, |
| B. 15 | *Engineering Mechanics:*<br>*Statics includes the concepts and principles of statics, reduction of force systems and equilibrium conditions, laws of friction and the calculation of centres of gravity. Strength of materials includes the basic concepts of strength of materials, tension, compression, bending, torsion and buckling, characterisation of multidimensional stress states, deflection calculations of beams and plane trusses. Kinematics includes the basic concepts and terms of kinematics, point kinematics, rigid body motion, compound point motion, plane motion, and spherical rigid body motion. Dynamics includes the basic concepts and definitions of dynamics, dynamics of a point and system of material points, dynamics of rotary motion and motion of* | **6.0** | **IM/AEE** | K_W01, K_W02, K_W06, K_W07, K_W09, K_W19, K_U01, K_U04, K_U07, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *a plane rigid body. Elements of analytical mechanics includes description of the dynamics model of a real object and definitions of special deformable elements with linear properties: It introduces an extended classification of bonds, definitions of the general equation of dynamics and La-grange's equation* | | | |
| B.16 | *Strength and Materials Science Laboratory:*<br>*Experimental determination of strain and stress in a selected section of a bending beam. Experimental verification of the formula determining the deflection line of a bending beam. Calculation of reactions of a statically indeterminate structure. Experimental determination of material constants, i.e. Young's modulus and Poisson's number of a metal sample. Experimental determination of critical force in a compression bar. Thermal analysis of alloys. Microscopic examination of the structure of steels, cast steels and cast irons. Microscopic examination of non-ferrous metal alloys. Dilatometric analysis of metals. Measurements of metal hardness. Examination of hardiness of steel. Precipitation strengthening of aluminium alloys. Density testing of porous materials and powders.* | **2.0** | **IM/IMat** | K_W06, K_W07, K_W09, K_W19, K_U01, K_U06, K_U16, K_U17, |
| **Content group of field-related education<br>Field-related subjects** | | | | |
| C.1 | *Mathematics 4:*<br>*Probability calculus. Basic probability distributions and their applications. Mathematical statistics and its application in experimental research. Using numerical methods in probability calculus and statistics.* | **5.0** | **IM/AEE** | K_W01, K_U07 |
| C. 2 | *Human Factor:*<br>*Necessity to consider human factors, incidents influenced by human factors/human error, Murphy's Law. Formation of executive processes and activities. The role of training and habits. Human capabilities and limitations. Vision, lighting, hearing, association and inference, concentration and perception, memory, claustrophobia and physical limitations, health hygiene, nutrition. Social psychology (sociology). Responsibility: individual and group, motivation and inhibition of motivation, group pressure on the individual, cultural background/influences, working in groups, management, supervision and leadership. Factors affecting the performance capabilities. Physical fitness/health, stress: domestic and work related, time pressure and deadlines, workload: excess and lack, sleep and fatigue, shift work, alcohol, medication, drugs. Surrounding environment. Noise and fumes, lighting, climate and temperature, movement and vibration, working conditions. Tasks/activities. Physical work, repetitive activities, visual inspection, complex systems. Communication. Communication within and between teams, work distribution and recording, updating, information circulation, sharing information (access levels). Human error. Models and theories of error, types of error in maintenance activities, consequences of errors (e.g. accidents), avoiding and controlling errors. Hazards in the workplace. Recognising and avoiding hazards, dealing with emergency situations.* | **1.0** | **IM/AEE** | K_W09, K_W17, K_W18, K_W20, K_K01, |
| C. 3 | *Aviation Law and Regulations:*<br>*General knowledge of law. Areas and branches of law. The system of law in Poland - basic legal acts. The European Union and Community law. Aviation law - basic concepts and subject matter. A history of aviation law. Applicable regulations of the national and international aviation law. Conventions and legal systems in international aviation law - International Civil Aviation Organisation (ICAO). Selected problems of law jurisdiction in the field of aviation law. The concept of common aviation regulations in the European Union and* | **2.0** | **NP** | K_W20, K_U01, K_U04, K_U15, K_U17, K_K01, K_K04 |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *the role and importance of EASA. National aviation law - the 'Aviation Law' Act. Relationship between 'civil' EASA Part and military Mil Part regulations. Principles and legal basis for the operation and management of continuing airworthiness of aircraft regulations: Part-M continuing airworthiness requirements. Part-145 regulations, approved maintenance organisations. Air transport regulations: Part OPS, Part-AWO, Part - MMEL and Part - MEL. ATA Maintenance Specifications 100/104. Applicable documentation and document specimens.* | | | |
| C. 4 | *Basics of Machine Constructions:*<br>*Basics of mechanical construction theory. Fatigue and shape strength of structural elements and assemblies. Inseparable and separable connections used in machine construction. Susceptible elements used in mechanical engineering. Mechanical transmissions – gear transmissions. Mechanical transmissions - friction gears and pulley-based transmissions. Mechanical clutches. Mechanical brakes. Tubular connections and valves. Fundamentals of hydrostatic propulsion. Modelling of design process. Elements of tribology.* | **5.0** | **IM/AEE** | K_W02,<br>K_W07,<br>K_W09,<br>K_W19,<br>K_U01,<br>K_U03,<br>K_U07,<br>K_U10,<br>K_U11, |
| C. 5 | *Basics of Automation:*<br>*Basic concepts of control theory. Types and structures of control systems. Structure of automatic control sys-tem. Elements of automation systems. Modelling of objects and elements of automatics. Operator transmittance, spectral, state space. Controllability and observability. Time and frequency characteristics. Stability - stability criteria. Quality of regulation processes - criteria of regulation quality. Types of correction and types of regulators. Synthesis of control systems by classical methods. Impulse control. Discrete transmittance of impulse control system. Digital control - basic structures. Logic and sequential control. Technology of automation systems: measuring devices (angle position sensors), regulators (controllers), and actuators (setting and executive elements). Automated and robotic systems. Structures of 1st, 2nd and 3rd generation robots. Simulation methods of dynamic systems study* | **4.0** | **AEE** | K_W01,<br>K_W04,<br>K_U01,<br>K_U06,<br>K_U07,<br>K_U16, |
| C. 6 | *Digital and microprocessor systems:*<br>*Counting systems and conversions. Binary codes. Fixed and floating point arithmetic. Basics of Boolean algebra. Logic gates and flip-flops. Basic combinatorial, sequential and arithmetic blocks. Programmable circuits. Classification and organisation of memory. Microprocessor architecture, command cycle, command list. Design and operation of microprocessors and microcontrollers. Microprocessor system organisation. Input-output (I/O) systems and embedded peripherals of microcontrollers. Introduction to microprocessor programming - languages and programming environments.* | **3.0** | **AEE** | K_W03,<br>K_W05,<br>K_U03,<br>K_U07,<br>K_U08,<br>K_U17, |
| C7 | *Basics of Modelling Physical Systems:*<br>*Basics of modelling. Introduction to Matlab-Simulink and LabView. Determination of mathematical models of complex mechatronic systems. Modelling of complex mechatronic systems in LabView and Matlab-Simulink. Data input to simulation. Basic data structures and their representation. Basic structures used in modelling. M-function and script files, VI and subVI. Presentation of simulation results. Graphical user interface in the process of modelling and testing complex mechatronic structures.* | **2.0** | **IM/AEE** | K_W06,<br>K_W07,<br>K_W19,<br>K_U01,<br>K_U04,<br>K_U07,<br>K_U08,<br>K_U10,<br>K_U11,<br>K_U17, |
| C. 8 | *Aircraft Materials:*<br>*Requirements for aircraft construction materials. Strength, technological (formability, heat treatment, joining methods) and* | **2.0** | **IMat** | K_W06,<br>K_W07,<br>K_W09, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *performance (heat resistance, corrosion resistance, fatigue life, abrasion resistance, erosion resistance, etc.) characteristics of the main groups of materials used in the construction of airframes and aircraft propulsion systems.* | | | K_W10, K_W15, K_W19, *K_U01, K_U14,* |
| C. 9 | *Aircraft Integrated Laboratory:*<br>*Health and safety rules applicable during aircraft maintenance. Current maintenance of aircrafts. Airframe assembly maintenance of aircraft and helicopter. Aircraft airborne equipment maintenance. Damage verification and replacement of airframe components. Controlling the main operating parameters of individual airframe systems. Operation of aircraft emergency systems and equipment. Analysis of operational parameters of an aircraft propulsion system based on an engine test.* | **5.0** | **IM/AEE** | K_W04, K_W09, K_W11, K_W12, K_W17, K_W18, K_U06, K_U09, K_U16, K_U17, K_U18, K_K01, K_K03, |
| C.10 | *Aircraft Maintenance Engineering:*<br>*Aircraft as an object of operation. Operation strategies. Organisation of aircraft operations. Standardisation of aircraft operation process. Probability of service in airworthiness. Operation definitions and methods. Major components of operation system structure and selection criteria. Structure of safe working life. Passenger aircraft operation. Operational safety factors of flights.* | **3.0** | **IM/AEE** | K_W06, K_W10, K_W12, K_W15, K_W16, K_W17, K_U01, K_U04, K_U17, K_U18, |
| C.11* | *Strength of Materials and Structures:*<br>*Introductory information. Experimental basis for the determination of mechanical properties of materials. Calculation of tensile and compressive strength of rods. Moments of inertia of plane figures. Internal forces in rods. Bending of a straight bar. Axis of deflection of a straight bar. Statically indeterminate bending beams. Stress state theory. Strain state theory. Relationships between deformation state and stress state. Stress hypotheses. Torsion of bars. Compound action of internal forces in simple rods. General energy theorems and their application. Curved rods. Stability of rods. Fundamentals of stress analysis, free torsion of rods of any cross-section. Non-free deformation of thin-walled rods of open cross-sections. Axially symmetric thin-walled tanks. Thin plates. Elements of dynamics of elastic systems. Stress of materials under periodically varying loads. Material creep.* | **7.0** | **IM/AEE** | K_W07, K_W19, K_U01, K_U03, K_U07, K_K03, |
| C.11** | *Aircraft construction and installation:*<br>*Aircraft requirements and classification. Forces on aircrafts and helicopters. Static and dynamic loads. Overload factor, disposable overload, limitations. Selection of layout and basic airframe parameters, statistical factors. Wing structure and its components. Work of girder, semi-shell, shell structures. Structure and work of the wing near the recess, nodes and connections. Wing mechanisation. Ailerons, empennage and control system. Fuselage and flight deck. Landing gear, characteristics and classification, landing gear requirements. Main and auxiliary landing gear design, suspension, airwheel design. Selection of layout and basic parameters of helicopter airframe. Lift rotor requirements; types and parameters* | **7.0** | **IM/AEE** | K_W06, K_W13, K_W15, K_U01, K_U04, K_U03, K_U11, K_U18, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *defining lift rotors. Characteristics of carrier rotor operating range, purpose of joints. Carrier rotor hub design. Control disc design, control system design. General principles of helicopter control: periodic, pitch and tail rotor control. Tail rotor design. Transmission systems, arrangement of engines in a helicopter. Fuselage and flight deck, constructional peculiarities. Helicopter landing gear. Development trends. Fire suppression and anti-icing systems. Aircraft engine ignition systems. Aircraft hydraulic and pneumatic systems.* | | | |
| C.12* | *Fluid mechanics:*<br>*Description of fluid state and motion, kinematics elements, velocity circulation. Local motion of a fluid element, deformation velocity tensor and stress tensor. Basic equations of fluid mechanics, Navier-Stokes equation, similarity of flows. Elements of hydrostatics - equilibrium equation, hydrostatic thrust and buoyancy, standard atmosphere. Euler's equation of motion, Bernoulli's equation, elements of applied hydraulics. Laminar and turbulent motion, boundary layer, Prandtl equation, Karman equation. Karman equation. "Well and badly" flowing bodies, issues of boundary layer detachment, effect of detachment on aerodynamic coefficients. Wave phenomena, effect of gas compressibility, isentropic flows.* | **4.0** | **IM/AEE** | K_W01, K_W08, K_W14, K_W19, K_U01, K_U07, K_U11 |
| C.12** | *Fluid Mechanics and Aerodynamics:*<br>*Description of fluid state and motion, local motion of a fluid element, deformation velocity tensor and stress tensor. Basic equations of fluid mechanics, similarity of flows. Equation of equilibrium of a fluid, standard atmosphere. Euler's equation of motion, Bernoulli's equation, boundary layer issues, boundary layer detachment. Determination of basic flow parameters. Wave phenomena, effects of gas compressibility.*<br>*Introduction to aerodynamics, aerodynamic objectives and research methods in aerodynamics. Airfoil theory: description of geometry, aerodynamic characteristics of the airfoil. Lifting surface: description of geometry, aerodynamic characteristics. Subcritical and supercritical airfoil and wing flow. Elements of high speed aerodynamics.* | **4.0** | **IM/AEE** | K_W01, K_W08, K_W14, K_W19, K_U01, K_U03, K_U07, K_U11 |
| C.13* | *Aerodynamics:*<br>*Introduction to aerodynamics, aerodynamic objectives and research methods in aerodynamics. Airfoil theory: description of geometry, pressure distribution over the airfoil, aerodynamic force coefficients, airfoil aerodynamic characteristics. Finite extension airfoil: description of geometry, rotary lifting line theory, induced drag, airfoil aerodynamic characteristics. Subcritical and supercritical airfoil and wing flow. Elements of high speed aerodynamic theory: small disturbance theory, sound barrier, densification and dilution waves, aerodynamic heating. Aerodynamic interference, supersonic air flow, elements of complete aircraft aerodynamics, experimental aerodynamic characteristics of model aircraft.* | **3.0** | **IM/AEE** | K_W01, K_W08, K_U01, K_U03, K_U11, |
| C.13** | *Basics of Flight Mechanics:*<br>*Flight mechanics objectves, forces acting on the aircraft. Dynamics of aircraft motion as a material point. Motion of aircraft on rectilinear trajectories inclined at any angle. Aircraft transient motions on rectilinear and curvilinear tracks in the vertical and horizontal plane and on space tracks. Issues of aircraft take-off and landing, aerodynamic characteristics in take-off and landing configurations. Dynamics of aircraft motion as a material solid. Aircraft equilibrium, static stability and longitudinal controllability. Equilibrium, static stability and lateral controllability, aircraft equilibrium curve. Moments* | **3.0** | **IM/AEE** | K_W01, K_W08, K_W14, K_U11 |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *acting on an aircraft in transient motion. Peculiarities of aircraft flight at large angles of attack. Suborbital and orbital flights of spacecraft.* | | | |
| C.14* | *Thermodynamics:*<br>*Thermodynamic state. The equations of state of perfect and real gases. Properties of gas mixtures. Principles of thermodynamics. Characteristic transformations. Thermodynamic circuits. Properties of single-component real substances. Phase transitions. Multicomponent systems. Equilibrium conditions of thermodynamic system. Combustion of liquid and solid fuels. Properties of combustion products. Fundamentals of thermodynamics of flows. Heat transfer: conduction, convection and radiation. External and internal heat sources heating a structure. Fundamentals of energy conversion from renewable sources.* | **4.0** | **IM/AEE** | K_W02, K_W11, K_W19, K_U01, K_U06, K_U14 |
| C.14** | *Basics of Propulsion Systems*<br>*Thermodynamic state. The equations of state of perfect and real gases. Properties of gas mixtures. Principles of thermodynamics. Characteristic transformations. Thermodynamic circuits. Fundamentals of flow thermodynamics. Heat transfer: conduction, convection and radiation. Theoretical fundamentals of piston engines. Theoretical fundamentals of single and dual flow turbine jet engines and propeller turbine engines. Theoretical fundamentals of jet engines. Fundamentals of aeroplane propulsion systems (jet, helicopter and propeller) with piston and turbine engines. Basic engine systems (oiling, power, starting and ignition). Hydromechanical and electronic control systems (FADEC). Engine parameter display systems.* | **4.0** | **IM/AEE** | K_W09, K_W11, K_W13, K_W14, K_W16, K_U01, K_U02, K_U04, K_U07, K_U11, K_U18, |
| **Content group of elective subjects<br>AVIONICS** | | | | |
| D1.1 | *Modelling of Avionic Systems:*<br>*Modelling of avionic systems and circuits in Matlab-Simulink environment. Basic principles of dynamic model creation based on the description using difference and differential equations to describe dynamic models. Modelling by finite element method of mechanical and electromagnetic processes in the Comsol Multiphysic environment. Software for virtual construction of measuring instruments in the LabView environment. Principles of integration of the Matlab-Simulink with Comsol Multiphysic and LabView.* | **3.0** | **IM/AEE** | K_W07, K_U02, K_U03, K_U07, K_U08, K_U10, K_U17 |
| D1.2 | *Aircraft Radioelectronic Systems:*<br>*Theoretical fundamentals of radioelectronic systems. Fundamentals of radioelectronics and radiolocation. Range of radioelectronic equipment and systems. Radioelectronic methods of measurement of navigation parameters. Distance measurement by impulse method - DME system. Distance measurement by the frequency method. Direction finding by a phase method - VOR system. Non-directional radio beacon and automatic radio compass. Aeronautical radio-communication equipment. Satellite communications. Aircraft rescue equipment and systems. Radioelectronic equipment for military air defence systems. Air traffic control equipment and systems. Principle of operation and use of secondary radar in aviation. Collision avoidance systems - TCAS. Low Altitude Flight Control Systems TAWS. Pulse Doppler Radar. Multi-role airborne radar - Principle of operation and use.* | **3.0** | **AEE** | K_W02, K_W03, K_W13, K_W14, K_W15, K_U01, K_U11, K_U18 |
| D1.3 | *Servoactuators and actuators:*<br>*General characteristics of actuators and servo systems. Basic requirements. Fluids - thermodynamic and flow properties. Flow losses. Pneumatic control and drive systems. Control and actuators elements. Mathematical model of pneumatic propulsion* | **3.0** | **IM/AEE** | K_W01, K_W03, K_W04, K_W08, K_W14, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *system. System characteristics. Structure and principle of operation of a hydraulic system. Assemblies of hydrostatic propulsion system. Throttle and displacement control. Hydraulic and electro-hydraulic amplifiers. Mathematical model of electrohydraulic drive system. Static and dynamic characteristics of the system. Construction and principle of operation of electric drives. Structure of an electric drive. Structure of an electric servomechanism (functional diagram). Mechanical and control characteristics of an electric motor. Characteristics of stepper motor. Mathematical model of an electric closed drive system. Static characteristics of the system. Comparative analysis of different types of actuator systems.* | | | K_U06,<br>K_U07,<br>K_U11, |
| D1.4 | *Aircraft Measurement and Diagnostic Systems:*<br>*Classification of aircraft measuring instruments and systems. Aircraft Traffic Environment. International Standard Atmosphere. On-board installation of air pressure receivers. Aerometric Switchboards. Angle of attack and glide sensors. Accelerometers and stall transmitters. Aircraft heading measurement. Magnetic and inductive compasses. Theory and classification of gyroscopes. Review and characterisation of aeronautical gyroscopes. Characteristics of aeronautical gyroscopic instruments and systems. Measurement and indication of engine exhaust gas temperature. Measurement and indication of rotational speed of engine rotors. Measurement and indication of pressure, fuel quantity and flow rate. Measurement and indication of other engine operating parameters (vibrations, position of control bodies, unsteady compressor operation, etc.). Essence of technical diagnostics. Basic terms and terminology. Diagnostic signals and parameters. Diagnostic models. Diagnostic algorithms. Diagnostic methods and equipment. Expert systems in diagnostic inference process. Artificial neural networks in diagnostic systems. Overview of design solutions for measurement circuits and systems of selected aircraft used in the Polish Armed Forces.* | **5.0** | **IM/AEE** | K_W02,<br>K_W04,<br>K_W08,<br>K_W13,<br>K_W16,<br>K_U01,<br>K_U07,<br>K_U09, |
| D1.5 | *Avionics Modules and Systems Programming:*<br>*Characteristics of programming languages. Principles of creating programs in high and low level languages. General characteristics of integrated programming environments supporting programming and starting microprocessor-based systems. Program syntax in assembler language and C language. Declaration of variables and constants. Operations on arithmetic operators. Operations on logical operators. The use of pointers and variable arrays. Standard input/output functions, input/output formatting. Operation of interrupt systems. Operation of input/output circuits and serial interfaces. Operation of built-in peripherals of microprocessor systems: counters, timers, real-time clock, A/D and D/A converters. Operation of external devices. General characteristics of visual high-level languages. Introduction to integrated programming environments. Basic data types. Characteristics of JAVA and NET runtime environments. Internal instructions and functions of the language. Definition and calling of user functions. Methods of returning values through a function argument. Basic features of object-oriented programming: range of available arguments and methods, inheritance, classes. Developing a graphic interface of an application. The use of the interrupt system in an application. Operation of computer hardware resources.* | **6.0** | ***AEE*** | K_W05,<br>K_U01,<br>K_U06,<br>K_U07,<br>K_U10,<br>K_U17, |
| D1.6 | *Control Theory:*<br>*Basic concepts of control theory. Time and frequency characteristics of basic elements. Control system structure. Basic quality indicators used to evaluate control systems. Stability of linear systems. Overview of basic control laws. Design of controllers. Theory of state estimators and observers. Control from state vector using* | **5.0** | **AEE** | K_W01,<br>K_W04,<br>K_U02,<br>K_U07, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *observers. Combinational and sequential control systems. Impulse control using time dependence. Fundamentals of nonlinear control. Non-linear regulators. Stability testing of nonlinear systems.* | | | K_U17,<br>K_U18, |
| D1.7 | *Aircraft Power Systems*<br>*Classification of on-board electrical and energy systems (PUEE). Aircraft accumulator batteries. Aircraft DC generators. Aircraft generators of alternating current. Secondary sources of electrical power. On-board electrical power systems and their components. Structures of electrical power systems in a state of inoperability. Elements of on-board transmission and distribution systems. Light signalling systems. Fire-fighting and anti-icing systems. Aircraft engine ignition systems.* | **4.0** | **IM/AEE** | K_W03,<br>K_W13,<br>K_W14,<br>K_U01, K_U11 |
| D1.8 | *Aircraft Control Systems:*<br>*Aircraft as an object of regulation in an automatic control system. Mathematical description of dynamic properties of aircraft. Steering, stability and manoeuvrability characteristics of an aircraft. The construction and principles of operation of semi-automatic flight control systems, vibration damping automatics, longitudinal control automatics, lateral control automatics, stability automatics, load automatic, trim automatics, balance automatics and kinematic ratio control automatics. Technical structures, operating ranges, construction and principle of operation of selected solutions of aircraft control systems.* | **5.0** | **IM/AEE** | K_W02,<br>K_W04,<br>K_W08,<br>K_W14,<br>K_W15,<br>K_U07,<br>K_U11,<br>K_U13,<br>K_U14,<br>K_U18, |
| D1.9 | *Aircraft Navigation Systems:*<br>*Objectives and basic functions of the navigation system. Classification and characteristics of basic aircraft navigation systems. Geophysical fields used in aircraft navigation. Shape and representation of the Earth. Time-keeping. Elements of astronomy. Fundamentals of astronavigation. Aeronautical charts. Navigational parameters of flight performance. Orthodromy and loxodromy. Using magnetic field to determine flight parameters. Inertial track counting systems. Inertial navigation systems. Integrated aircraft navigation systems. Preliminary knowledge of radio navigation. Positioning accuracy of radio navigation systems. Autonomous radio navigation equipment. Radioelectronic systems for short-range navigation. Satellite navigation systems. Systems and equipment supporting landing process* | **5.0** | **IM/AEE** | K_W04,<br>K_W10,<br>K_W13,<br>K_W14,<br>K_W15,<br>K_U11,<br>K_U12,<br>K_U18, |
| D1.10 | *Aircraft Digital Systems and Computer Networks:*<br>*Architectures and components of aircraft avionics systems. Selected organisational elements of on-board computers and avionics modules. Digital circuits used for on-board computers and avionics modules. Integrated avionics modular systems. Input and output devices of on-board computer and avionics modules. General principles and tools for hardware design and software implementation of avionic digital systems Specificity of technologies implemented in hardware and software of digital flight systems. Protection of digital aircraft equipment against electrostatic discharges. Fundamentals of data exchange in aircraft computer systems. On-board computer network architectures. Fibre optics and fibre optics technology on aircraft. "Glass Cockpit" Information Imaging Systems. On-board operational support systems. Cabin systems. Information systems.* | **4.0** | **AEE** | K_W05,<br>K_W13,<br>K_W14,<br>K_U08,<br>K_U03,<br>K_U10,<br>K_U11,<br>K_U13, K_U14 |
| D1.11 | *On-board Visualization Systems and Simulators:*<br>*Evolution of aeronautical information imaging systems. Examples of instrument layout in the cockpit. Perception of information, characteristics of pilot-operator receptors. Elements of aeronautical ergonomics. Electronic indicators. Computer-based information imaging systems. Construction and principle of operation of cathode* | **5.0** | **AEE** | K_W13,<br>K_W14,<br>K_W15,<br>K_U01,<br>K_U03, K_U11 |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *ray tube and panel displays. Types and formats of information presented on the pictorial displays. Construction of HUD and HMD type indicators. Methods and systems of information visualization in simulators. General diagram and fundamentals of simulators. Types of simulators and training devices and their applications. Standards. Fundamentals of human physiology and psychology as a mechatronic system operator. Fundamentals of modelling for simulators. Visualization system. Motion system. Simulator cabins. Imitators of instruments and indicators. Simulation of sounds. Control signal processing and data transmission. Modelling of the environment and emergencies of the simulated system. Analysis of the construction and operation of simulators of different technical systems.* | | | |
| D1.12 | *Basics of Mechatronics Devices Construction:*<br>*Characteristics, classification, applications and constructions of mechatronic, electronic, electrical and electromechanical components and systems. Applied materials and technologies. Basic calculations taking into account technical and reliability conditions. Basic kinematics and dynamics analysis calculations. Basic modelling principles in the environment of computer-aided design systems, construction and drafting (CAD). Geometric analysis of system models. Concurrent and conceptual design. Collaborative design using CAD systems. Visualisation and simulation of product operation in CAD systems.* | **2.0** | **IM/AEE** | K_W02, K_W06, K_W07, K_W09, K_W10, K_W16, K_W19, K_U01, K_U03, K_U05, K_U07, K_U10, K_U11, K_U14, K_K02 |
| **Content group of elective subjects<br>AIRCRAFTS AND HELICOPTERS** | | | | |
| D2.1 | *Flight Mechanics:*<br>*Flight mechanics tasks, forces operating on the aircraft (SP). Dynamics of aircraft motion as a material point. Aircraft motions on rectilinear trajectories inclined at any angle. Aircraft transient motion on vertical and horizontal straight and curvilinear tracks and on space tracks. SP take-off and landing issues, aerodynamic characteristics in the take-off configuration and in the landing configuration. Dynamics of SP motion as a material solid. Equilibrium, static stability and longitudinal controllability of aircraft. Equilibrium, static stability and lateral controllability, aircraft equilibrium curve. Moments acting on an aircraft in transient motion. Peculiarities of aircraft flight at large angles of attack. Suborbital and orbital flights of spacecraft.* | **6.0** | **IM/AEE** | K_W01, K_W08, K_W14, K_U11 |
| D2.2 | *Heat Transfer Issues:*<br>*Concepts and quantities of description of heat transfer issues. Fourier, Newton and Stefan-Boltzmann Laws. Calculation of steady-state heat transfer through multilayered flat and cylindrical walls using thermal resistance. Calculation of heat transfer through rods and ribs under various boundary conditions. Determination of heat transfer coefficients for fluid flows inside and outside channels. Determination of heat transfer coefficients for flowing flat walls. Cooling of gas turbine blades. Heat transfer boundary conditions for gas turbine blades. Determination of temperature distribution in a model turbine blade using Excel.* | **2.0** | **IM/AEE** | K_W01, K_W02, K_W08, K_W11, K_U01, K_U07 |
| D2.3 | *Avionics Systems:*<br>*Definition, architectures and basic characteristics of avionics systems. Electrical power sources on aircraft. Lighting and light signalling systems. Rain and ice protection systems. Aircraft engine* | **6.0** | **AEE** | K_W03, K_W05, K_W14, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *ignition systems. Organisation elements of aircraft on-board computer and data exchange systems. Fibre optics and fibre optics technology. Integrated modular avionics systems. On-board information and maintenance imaging systems. Flight data and cabin voice recorders. Cabin and information systems. Construction and principles of aeronautical measuring instruments and systems. Autonomous Navigation Systems. Aircraft Control Systems. Electromagnetic compatibility issues. Flight and traffic management systems. Servomechanisms and actuators. Fundamentals of radio wave propagation. Radio-electronic communication equipment. Non-autonomous navigation systems. Systems and devices aiding the instrumented landing process. Secondary radar in air traffic control, collision avoidance systems. Radio altimeters and ground proximity warning devices. Weather radars, Doppler radars, area navigation systems.* | | | K_W15,<br>K_U01 |
| D2.4 | *Theory of Aircraft Engines:*<br>*Operating principles of an aircraft piston engine and their characteristics. Operating parameters of a single-flow turbine jet engine. Two-flow turbine jet engine and its application. Propeller and helicopter turbine engine. Parameters and operating characteristics of components (inlet, compressor, combustion chamber, turbine and types of exhaust systems in turbine engines). Basic characteristics of turbine engines. Analysis of engine characteristics linking engine parameters to flight parameters. Conclusions resulting from the analysis of fundamental importance to the problems of construction and operation of aircraft engines.* | **5.0** | **IM** | K_W06,<br>K_W07,<br>K_W11,<br>K_W14,<br>K_U01,<br>K_U07, K_U17 |
| D2.5 | *Strength of Aircraft Structures:*<br>*General information. Girders. Membrane theory of cylindrical shells. Free torsion of thin-walled prismatic bars. Open section bending and shearing of thin-walled bars. Bending and shear of thin-walled bars with closed cross-section. Sandwich construction (three layer construction). Elastic stability of bars. Elastic stability of plates. Structural work after loss of stability. Current directions of development of strength calculation methods for aeronautical structures.* | **5.0** | **IM** | K_W07,<br>K_W13,<br>K_W09,<br>K_W14,<br>K_W16,<br>K_U07, K_U18 |
| D2.6 | *Aeroelasticity:*<br>*General knowledge of aerodynamics of non-stationary flow, main equations, Lagrange integral, velocity potential, boundary conditions, aerodynamic effects of circulationless and circulatory flow. Flow of a thin airfoil with finite velocity at the flow edge. Effect of wing haunch. Flatter, equations of motion, flexion-torsion flatter of wing airfoil. Influence of geometric, elastic and mass characteristics on critical flatter velocity. Flex-torsional flatter of a finite span wing, equations of equilibrium. Approximate methods for calculating flatter velocity and frequency. Galerkin method. Criteria of elastic stability of a structure in flow. Wing flatter oblique wing. Low elongation wing flatter. Flatter of the tailplane. Flatter with one degree of freedom. Flatter free-from-attachment aircraft. Flatter of plates and shells. Non-linear flatter issues. Detachment Flatter. Static aeroelasticity problems. Flatter research from historical perspective.* | **2.0** | **IM** | K_W01,<br>K_W02,<br>K_W14, |
| D2.7 | *Aircraft Structure Design:*<br>*Aircraft requirements and classification. Selection of layout and basic airframe parameters, statistical factors. Construction of wing and its components. Work construction: girder, semi-shell, crust. Structure construction and operation of the wing near the wingtip, nodes and connections. Wing mechanisation. Ailerons, empennage and control system. Fuselage and flight deck. Landing gear, characteristics and classification, landing gear requirements. Main and auxiliary landing gear design, suspension, airwheel* | **8.0** | **IM** | K_W06,<br>K_W07,<br>K_W08,<br>K_W13,<br>K_W15,<br>K_W16,<br>K_U07,<br>K_U10,<br>K_U11, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *design. Selection of layout and basic parameters of helicopter airframe. Lift rotor requirements; types and parameters defining lift rotors. Carrier rotor operating range characteristics, purpose of joints. Carrier rotor hub design. Control disc design, control system design. General helicopter control principles: periodic, pitch and tail rotor control. Tail rotor design. Transmission systems, arrangement of engines in a helicopter. Fuselage and flight deck, constructional peculiarities. Helicopter landing gear. Developmental trends. Mission definition. Design trend analysis. Project cost analysis. Preliminary mass estimation. Forces operating on aircraft and helicopter. Static and dynamic loads. Overload factor, disposable overload, limitations. Selected aspects of related to airworthiness regulations for aircraft. Load curve. Aeroplane and helicopter limitations and tests. Wing and rotor blade loads. Loads on ailerons, flaps and stabilisers and control system. Fuselage and landing gear loads. Airframe and helicopter fatigue calculations. Main airfoil and fuselage design. Selection of configuration of fairings. Selection of propulsion units.. Design of flaps, slots, brakes. Structural component design and material selection. Consideration of stability and controllability requirements in design. Compromises in aeronautical design. Elements of rocket and spacecraft design.* | | | K_U13,<br>K_U14,<br>K_U17, K_U18 |
| D2.8 | *Aircraft Propulsion Systems:*<br>*Construction of aircraft propulsion systems with turbine engines (jet, propeller and helicopter) and piston engines; construction, loads and strength calculations of basic engine units and their parts; construction materials; engine installations - construction and principles of operation, structure and operation of individual units, propellants and lubricants; hydro-mechanical and electronic control systems; reduction gearing of aircraft engines; propeller construction, propeller pitch control; inlet air dust collectors; starting of turbine and piston engines; operation and diagnosis of aircraft propulsion systems; indication of operational parameters of propulsion systems.* | **4.0** | **IM/AEE** | K_W07,<br>K_W08,<br>K_W10,<br>K_W13,<br>K_W14,<br>K_W15,<br>K_U06,<br>K_U11,<br>K_U12, K_U18 |
| D2.9 | Hydropneumatic Systems:<br>*Working fluids and gases used in hydropneumatic systems and conditions of their use. Hydropneumatic energy sources used onboard of aircraft. Hydraulic and pneumatic actuators. Hydraulic boosters. Control elements for flow direction, pressure and flow rate of liquids and working gases. Rigid and flexible hoses. Couplings and connections. Filters. Reservoirs and dampers. Fuel systems. Fire suppression systems. Air-conditioning systems. Anti-icing systems. Hydraulic systems. Oil systems and cooling. Aircraft crew oxygen systems and emergency equipment. Principles of operation of on-board hydropneumatic equipment.* | **4.0** | **IM/AEE** | K_W13,<br>K_W14,<br>K_W15,<br>K_U01,<br>K_U11, K_U12 |
| D2.10 | *Design and manufacture of aircraft structures:*<br>*Specificity of the airframe as a production object. Methods of mapping airframe geometry. Methods of shaping parts from thin sheets and sections. Methods of manufacturing integral metal and composite parts. Connection technologies used in the assembly of parts and subassemblies of airframes (riveting, bonding, gluing). Sub-assembly and final assembly. Methods of assuring quality and reliability of parts. Aircraft wear and damage. Capabilities and technologies for the repair of airframe coverings and strength members. Repairs of sandwich and composite structures.* | **4.0** | **IM/AEE** | K_W04,<br>K_W06,<br>K_W09,<br>K_W10,<br>K_W12,<br>K_U01,<br>K_U06,<br>K_U10, K_U12 |
| D2.11 | *Propellers and Rotors:*<br>*General information. Aerodynes, rotorcraft, propellers, helicopters. Lift rotors, rotor hubs, joints and blades of lift rotors. Propellers. Geometric and aerodynamic quantities characterising a propeller. Vortex theory as applied to propellers and carrier rotors. Flux theory of* | **2.0** | **IM** | K_W07,<br>K_W08,<br>K_W13, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *propeller and carrier rotor. Thrust, efficiency. Coefficients characterising propeller performance. Simplified vortex theory of propellers and mainspring rotors. Apical loss coefficients. Model of vortex carrier line. Blade element theory as applied to propellers and carrier rotors. Elements of non-stationary aerodynamics. Peculiarities of carrier rotor aerodynamics. Working ranges of the carrier rotor. Profile power. Elements of helicopter flight mechanics. Forces on control levers. Basic characteristics of controllability. Steady states of flight. Propeller blade strength* | | | K_W14, K_U11, K_U18 |
| D2.12 | *Basics of Mechanical Engineering 2:*<br>*Characteristics, classification and applications and design of sliding and rolling bearings. Bearing materials. Calculation and principles of bearing selection. Probability of damage on the example of rolling bearings. Mechanisms, types and applications. Methods of analysing kinematics and dynamics of mechanisms. Kinematic analysis of plane and spatial mechanisms. Synthesis of mechanisms. Basic principles of modelling in the environment of computer-aided design, construction and drafting (CAD). Basic knowledge of databases. Geometric analysis of machine part models. Concurrent and conceptual design. Collaborative design using CAD systems. Visualisation and simulation of product operation in CAD systems.* | **2.0** | **IM** | K_W17, K_W19, K_W20, K_U03, K_U05, K_U13, K_U14, K_K02 |
| | **Content group of elective subjects<br>AIRCRAFT PROPULSION** | | | |
| D3.1 | *Flight Mechanics:*<br>*Flight mechanics objectives, forces acting on the aircraft (SP). Dynamics of aircraft motion as a material point. Aircraft motions on rectilinear trajectories inclined at any angle. Aircraft transient motion on vertical and horizontal straight and curvilinear tracks and on space tracks. SP take-off and landing issues, aerodynamic characteristics in the take-off configuration and in the landing configuration. Dynamics of SP motion as a material solid. Aircraft equilibrium, static stability and longitudinal controllability. Equilibrium, static stability and lateral controllability, aircraft equilibrium curve. Moments acting on an aircraft in transient motion. Peculiarities of aircraft flight at large angles of attack. Suborbital and orbital flights of spacecraft.* | **6.0** | **IM/AEE** | K_W01, K_W08, K_W14, K_U11 |
| D3.2 | *Heat transfer issues with elements of combustion theory:*<br>*Concepts and quantities of description of heat transfer issues. Fourier, Newton and Stefan-Boltzmann Laws. Steady-state heat transfer through multilayer flat and cylindrical walls with application of thermal resistances. Calculation of heat transfer through bars and ribs under different types of boundary conditions. General characteristics of heat interception for fluid flows inside and outside ducts. Determination of heat interception coefficients for flowing of flat walls. Heat transfer boundary conditions for gas turbine blades. Chemical kinetics of combustion. Combustion of homogeneous mixtures in laminar turbulent flow. Diffusion combustion. Flame stabilisation.* | **2.0** | **IM/AEE** | K_W01, K_W02, K_W08, K_W11, K_U01, K_U07 |
| D3.3 | *Avionics systems:*<br>*Definition, architectures and basic characteristics of avionics systems. Electrical power sources on aircraft. Lighting and light signalling systems. Rain and ice protection systems. Aircraft engine ignition systems. Organisation elements of aircraft on-board computer and data exchange systems. Fibre optics and fibre optics technology. Integrated modular avionics systems. On-board information and operation imaging systems. Flight data and cabin voice recorders. Cabin and information systems. Construction and principles of aeronautical measuring instruments and systems. Autonomous* | **6.0** | **AEE** | K_W03, K_W05, K_W14, K_W15, K_U01 |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *Navigation Systems. Aircraft Control Systems. Electromagnetic compatibility issues. Flight and traffic management systems. Servomechanisms and actuators. Fundamentals of radio wave propagation. Radio-electronic communication equipment. Non-autonomous navigation systems. Systems and devices supporting instrumented landing. Secondary radar in air traffic control, collision avoidance systems. Radio altimeters and ground proximity warning devices. Weather radars, Doppler radars, area navigation systems.* | | | |
| D3.4 | *Theory of Aircraft Engines:*<br>*Operating principles of an aircraft piston engine and their characteristics. Operating parameters of a single-flow turbine jet engine. Two-flow turbine jet engine and its application. Propeller and helicopter turbine engine. Performance and characteristics of components (inlet, compressor, combustion chamber, turbine and types of exhaust systems in turbine engines). Basic characteristics of turbine engines. Analysis of engine characteristics linking engine parameters to flight parameters. Conclusions resulting from the analysis of fundamental importance to the problems of construction and operation of aircraft engines.* | **5.0** | **IM** | K_W06, K_W07, K_W11, K_W14, K_U01, K_U07, K_U17 |
| D3.5 | *Strength of Aircraft Structure*<br>*General information. Girders. Membrane theory of cylindrical shells. Free torsion of thin-walled prismatic bars. Bending and shearing of thin-walled bars with open section. Bending and shear of thin-walled bars with closed section. Sandwich construction (three layer construction). Elastic stability of bars. Elastic stability of plates. Structural work after loss of stability. Current development trends of strength calculation methods for aeronautical structures.* | **5.0** | **IM** | K_W07, K_W09, K_W13, K_W14, K_W16, K_U07, K_U18 |
| D3.6 | *Aeroelasticity:*<br>*General knowledge of aerodynamics of non-stationary flow, main equations, Lagrange integral, velocity potential, boundary conditions, aerodynamic effects of circulationless and circulatory flow. Flow of a thin airfoil with finite velocity at the flow edge. Effect of wing haunch. Flatter, equations of motion, flexion-torsion flatter of wing airfoil. Influence of geometric, elastic and mass characteristics on critical flatter velocity. Flex-torsional flatter of a finite span wing, equations of equilibrium. Approximate methods for calculating flatter velocity and frequency. Galerkin method. Criteria of elastic stability of a structure in flow. Wing flatter oblique wing. Low elongation wing flatter. Flatter of the tailplane. Flatter with one degree of freedom. Flatter free-from-attachment aircraft. Flatter of plates and shells. Non-linear flatter issues. Detachment Flatter. Static aeroelasticity problems. Flatter research from historical perspective.* | **2.0** | **IM** | K_W01, K_W02, K_W07, K_W08, K_W14, K_U11, K_U18 |
| D3.7 | *Aircraft construction:*<br>*Evolution of aircrafts and helicopters design, classifications. Forces operating on airplane and helicopter. Static and dynamic loads. Overload factor, disposable overload, limitations. Load curve. Wing and rotor blade loads. Loads on ailerons, flaps and spoilers and control system. Fuselage and landing gear loads. Design trend analysis. Preliminary mass estimation. Wing, blade, fuselage, landing gear, mechanisation elements of control systems. Airframe and propulsion system interaction.* | **4.0** | **IM/AEE** | K_W06, K_W08, K_W07, K_W13, K_W15, K_W16, K_U07, K_U10, K_U11, K_U13, K_U14, K_U17, K_U18 |
| D3.8 | *Aircraft Propulsion Systems:*<br>*Construction of aircraft propulsion systems with turbine engines (jet, propeller and helicopter) and piston engines; construction,* | **8.0** | **IM/AEE** | K_W07, K_W08, K_W10, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *loads and strength calculations of basic engine units and their parts; construction materials; engine installations - construction and principles of operation, structure and operation of individual units, propellants and lubricants; hydro-mechanical and electronic control systems; reduction gearing of aircraft engines; propeller construction, propeller pitch control; inlet air dust collectors; starting of turbine and piston engines; operation and diagnosis of aircraft propulsion systems; indication of operational parameters of propulsion systems.* | | | K_W13, K_W14, K_W15, K_U06, K_U11, K_U12, K_U18 |
| D3.9 | *Hydropneumatic Systems*:<br>*Working fluids and gases used in hydropneumatic systems and conditions of their use. Hydropneumatic energy sources used on-board of aircraft. Hydraulic and pneumatic actuators. Hydraulic boosters. Control elements for flow direction, pressure and flow rate of liquids and working gases. Rigid and flexible hoses. Couplings and connections. Filters. Reservoirs and dampers. Fuel systems. Fire suppression systems. Air-conditioning systems. Anti-icing systems. Hydraulic systems. Oil systems and cooling. Aircraft crew oxygen systems and emergency equipment. Principles of operation of on-board hydropneumatic equipment.* | **5.0** | **IM/AEE** | K_W13, K_W14, K_W15, K_U01, K_U11, K_U12 |
| D3.10 | *Manufacturing Technology of Propulsion Systems*<br>*Production quality. Influence of selection of pig iron and surface treatments on part quality. Methods of increasing fatigue life and corrosion resistance of engine parts. Theoretical bases and technological processes of sheet metal parts forming. Technologies of aircraft engine parts manufacturing. Electrotechnology. Connections used in engine construction. Wear of parts - types of wear and tear and methods of their identification. Overhaul of engines.* | **3.0** | **IM/AEE** | K_W04, K_W07, K_W10, K_W12, K_W14, K_U06, K_U10, K_U12, K_U18 |
| D3.11 | *Propellers and Rotors:*<br>*Fundamentals of propeller and rotor theory. Objectives of flight mechanics, forces acting on the aircraft. Peculiarities of the helicopter as an aircraft. Propeller design. Propeller pitch control. Propeller synchronisation. Propeller ice protection. Helicopter and helicopter engines. Reduction gears. Power units. Engine control systems and propeller pitch control systems. Propeller speed limitation methods. Operation, maintenance, storage and servicing of propellers and rotors. Engine controls and propeller pitch control systems. Propeller speed limitation methods. Aircraft propulsion system maintenance.* | **2.0** | **IM** | K_W07, K_W08, K_W13, K_W14, K_U11, K_U18 |
| D3.12 | *Aircraft Fuels and lubricants:*<br>*General information about fuels and lubricants. Aviation fuels - methods of obtaining, properties, energy characteristics. Combustion process of hydrocarbon fuels. Basic fuel combustion reactions. Aviation fuels - basic characteristics, normative requirements, assortment range and principles of use. Additives to aviation fuels. Methods of assessing resistance to knocking combustion. Fuels for aviation turbine engines - basic characteristics, normative requirements, assortment range and principles of use. Fuel additives. Airport control of fuel quality. Deposits and smoking. Malfunctions of aviation turbine engines related to fuel quality. Lubricating oils used in aviation - basic characteristics, normative requirements, range and principles of use. Greases, technical and auxiliary fluids used in aviation. Transport, storage and distribution of fuels and lubricants.* | **1.0** | **IM** | K_W10, K_U06, K_U18, |
| D3.13 | *Basics of Mechanical Engineering 2:*<br>*Characteristics, classification and applications and design of sliding and rolling bearings. Bearing materials. Calculation and principles* | **2.0** | **IM** | K_W17, K_W19, K_W20, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *of bearing selection. Probability of damage on the example of rolling bearings. Mechanisms, types and applications. Methods of analysing kinematics and dynamics of mechanisms. Kinematic analysis of plane and spatial mechanisms. Mechanism synthesis. Basic principles of modelling in the environment of computer-aided design, construction and drafting (CAD). Basic knowledge of databases. Geometric analysis of machine part models. Geometric analysis of machine part models. Concurrent and conceptual design. Collaborative design using CAD systems. Visualisation and simulation of product operation in CAD systems.* | | | K_U01, K_U02, K_U03, K_U05, K_U13, K_U14, K_K02 |
| **Thesis** | | | | |
| E1 | *Diploma Seminar:*<br>*Principles and techniques of preparing seminar papers and techniques of presenting them. The process of self-education of students and its essential conditions. Methodology of knowledge acquisition and elements of technology of mental work. Internet and electronic sources of information acquisition. Library information systems. Types of theses and general requirements for diploma theses. Specificity of the diploma thesis of an engineer. Stages of solving and performing a diploma task. Layout and content of the diploma thesis. Technique of writing and editing the diploma thesis. Diploma thesis evaluation criteria. Ethics and research workshop of an engineer. Protecting and following the copyrights. Plagiarism and computer anti-plagiarism systems. Provisions of the rules of higher education and norms concerning diploma theses, diploma examination and graduation.* | **2.0** | **IM/AEE** | K_W15, K_W19, K_W20, K_U01, K_U02, K_U04, K_U05, K_U13, K_U14, K_K02, |
| E2 | *Diploma Thesis:*<br>*Developing of the diploma project comprises knowledge, skills and competences within aerospace issues in the fields of avionics, aeroplanes and helicopters, and aircraft propulsion systems.*<br>*It constitutes an independent study of a specific engineering topic with scientific elements covering knowledge, skills and competences related to aeronautical engineering.*<br>*The thesis involves solving analytical and design tasks, designing, developing concepts, performing engineering and research tasks, presenting and discussing, and assessing the results obtained.* | **20.0** | **IM/AEE** | K_W09, K_W11, K_W12, K_W13, K_W14, K_W19, K_W20, K_U03, K_U04, K_U09, K_U10, K_U11, K_U12, K_U13, K_U17, K_U18, K_K01, K_K03, K_K04, |
| **Apprenticeship** | | | | |
| F1 | *Apprenticeship:*<br>*Students get acquainted with the rules and regulations of occupational health and safety. Students familiarize themselves with the organizational structure, activity profile, tasks and possibilities of the enterprise. Students familiarize themselves with technical, maintenance, repair and overhaul documentation, its circulation and quality control process. Inspecting the condition of equipment and taking diagnostic measurements using operating and measuring equipment (under the direction of the instructor). Basic maintenance and workshop work at workstations (under the direction of the instructor). Use, installation and configuration of specialised or* | **4.0** | **IM/AEE** | K_W06, K_W09, K_W10, K_W11, K_W13, K_W17, K_W18, K_W19 K_W20 K_U02, |

| No. | Name of class group[16]<br>Name of subject, short description (outline program) | No of ECTS credits | Discipline code [17] | Reference to field-related outcomes |
|---|---|---|---|---|
| | *auxiliary computer software. Preparing and drawing up technical, technological, advertising and promotional documentation.* | | | K_U04, K_U05, K_U06, K_U11, K_U12, K_U13, K_U11, K_U16, K_K01, K_K02, K_K03, |
| **Total** | | **210** | | |

**C.11*-C.14* Group of elective courses of study for the specialisations Aircraft and Helicopters and Propulsion Systems**

**C.11**-C.14** Group of elective subjects for specialisations: Avionics**

## Methods of verifying and assessing the learning outcomes [18]achieved by the student during the whole educational cycle:

Verification of the intended learning outcomes shall be conducted systematically throughout the entire period of study. Passing each module with at least a satisfactory grade [ocena dostateczna] is the requirement for achieving of the intended learning outcomes. The intended learning outcomes are defined for each form of completion of the module (lectures, practical classes, laboratories, project, seminar) in the form of knowledge, skills and social competences, as well as methods and methods of their verification. Detailed methods of verification of the learning outcomes are included in the module information sheet.

Achievement of intended outcomes by a student in the category of social competence results from his/her attitude during the entire period of studies. Students from the second year should participate in the activities of Scientific Student Societies [Koło Naukowe Studentów - KNS] operating at the Military University of Technology. Performing the activities within KNS and participating in seminars will be a main indicator of achieving the intended outcomes in the category of social competence. Details concerning the activities of KNS are regulated by the rules and regulations of KNS and their tutors.

The final form of verification of the acquired knowledge and skills is a positive assessment of the diploma thesis and the final examination.

**Plan of full-time programme** - in Appendix 1.

*[18] general description - see details on course information sheets*

# Appendix 1

Wojskowa Akademia Techniczna

**PLAN OF FULL-TIME AND FIRST CYCLE "ENGINEERING" STUDIES OF GENERAL ACADEMIC PROFILE**
**SCIENTIFIC DISCIPLINE (LEADING) MECHANICAL ENGINEERING**
**FIELD OF STUDY: AERONAUTICS AND ASTRONAUTICS**
**Specialisations profiled by elective subjects: Aircrafts and Helicopters, Avonics, Propulsion Systems**

beginning 2021

| | GROUP OF CLASSES / SUBJECTS | Scientific discipline | total hours/ ECTS | | ECTS / shaping practical skills | ECTS | including hours: | | | | | hours number/assessment/ ECTS credits in semester: | | | | | | | | | | | | | | | | | | | the organisational unit of administration responsible for the subject | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | I | | II | | III | | IV | | V | | VI | | VII | | | | | | | | |
| | | | hours | ECTS | | | lectures | practical class. | lab. | project | semin. | hours | ECTS | hours | ECTS | hours | ECTS | hours | ECTS | hours | ECTS | hours | ECTS | hours | ECTS | | | | | | | | |
| | **A.Content group of general education** | | **336** | **21.0** | | **12.5** | **96** | **240** | | | | **186** | **13.0** | **90** | **4.0** | **30** | **2.0** | **30** | **2.0** | | | | | | | | | | | | | | |
| A.1 | Professional ethics | **NS** | 18 | **1.5** | | **1.0** | 14 | 4 | | | | 18 | Zo | 1.5 | | | | | | | | | | | | | | | | | | WLO |
| A.2 | Introduction to study | **NS** | 6 | **0.5** | | **0.5** | 6 | | | | | 6 | Zo | 0.5 | | | | | | | | | | | | | | | | | | Patronatowik ds. jakości |
| A.3 | Basics of management and entrepreneurship | **NZJ** | 30 | **3.0** | | **1.5** | 16 | 14 | | | | 30 | Zo | 3.0 | | | | | | | | | | | | | | | | | | WLO |
| A.4 | Selected issues of law | **NP** | 18 | **1.5** | | **1.0** | 14 | 4 | | | | 18 | Zo | 1.5 | | | | | | | | | | | | | | | | | | WLO |
| A.5 | Introduction to Computer Science | **ITT** | 36 | **3.0** | | **1.5** | 14 | 22 | | | | 36 | Zo | 3.0 | | | | | | | | | | | | | | | | | | WML/ITR |
| A.6 | Physical education | | 60 | | | | | 60 | | | | 30 | Zo | | 30 | Zo | | | | | | | | | | | | | | | | SWF |
| A.7 | Foreign language | **J** | **120** | **8.0** | | **5.0** | | 120 | | | | 30 | Zo | 2.0 | 30 | Zo | 2 | 30 | Zo | 2 | 30 | Zo | 2 | | | | | | | | | | SJO |
| | Foreign language - Examination B2 | | | | | | | | | | | | | | | | | | E | | | | | | | | | | | | | | SJO |
| A.8 | Poland History | **H** | 30 | **2.0** | | **1.0** | 16 | 14 | | | | | | | 30 | Zo | 2 | | | | | | | | | | | | | | | | WLO |
| A.9 | Protection of Intellectual Property | **NP** | 14 | **1.5** | | **1.0** | 12 | 2 | | | | 14 | Zo | 1.5 | | | | | | | | | | | | | | | | | | WLO |
| A.10 | Occupational Health and Safety | | 4 | | | | 4 | | | | | 4 | Z | | | | | | | | | | | | | | | | | | | BHP |
| | **B. Content group of basic education** | | **728** | **63.0** | **25.0** | **33.0** | **362** | **278** | **88** | | | **190** | **17.0** | **280** | **26** | **258** | **20** | | | | | | | | | | | | | | | | |
| B.1 | Introduction to Metrology | **AEE** | 24 | **2.0** | **1.0** | **1.0** | 12 | 12 | | | | 24 | Zo | 2 | | | | | | | | | | | | | | | | | | WML/ITL |
| B.2 | Mathematics 1 | **M** | 68 | **6.0** | | **3.0** | 30 | 38 | | | | 68 | E | 6 | | | | | | | | | | | | | | | | | | WCY |
| B.3 | Mathematics 2 | **M** | 68 | **6.0** | | **3.0** | 34 | 34 | | | | 68 | E | 6 | | | | | | | | | | | | | | | | | | WCY |
| B.4 | Basics of Engineering Graphics | **IM/AEE** | 30 | **3.0** | **2.0** | **1.5** | 12 | 18 | | | | 30 | Zo | 3 | | | | | | | | | | | | | | | | | | WML/ITL |
| B.5 | Mathematics 3 | **M** | 46 | **4.0** | | **2.0** | 22 | 20 | 4 | | | | | | 46 | E | 4 | | | | | | | | | | | | | | | | WCY |
| B.6 | Physics 1 | **NF** | 80 | **6.0** | | **3.0** | 40 | 30 | 10 | | | | | | 80 | E | 6 | | | | | | | | | | | | | | | | WTC |
| B.7 | Engineering Graphics | **IM/AEE** | 30 | **3.0** | **3.0** | **1.5** | 12 | 18 | | | | | | | 30 | Zo | 3 | | | | | | | | | | | | | | | | WML/ITL/ITU |
| B.8 | Computer Science | **ITT** | 30 | **3.0** | **2.0** | **1.5** | 14 | 16 | | | | | | | 30 | Zo | 3 | | | | | | | | | | | | | | | | WML/ITU |
| B.9 | Material Science | **IMat** | 44 | **4.0** | | **2.0** | 36 | 8 | | | | | | | 44 | E | 4 | | | | | | | | | | | | | | | | WML/ITU |
| B.10 | Manufacturing Engineering | **IM** | 30 | **3.0** | **2.5** | **1.5** | 24 | 6 | | | | | | | 30 | Zo | 3 | | | | | | | | | | | | | | | | WML/ITU |
| B.11 | Metrology 1 | **AEE** | 20 | **3.0** | **3.0** | **1.0** | 16 | 4 | | | | | | | 20 | Zo | 3 | | | | | | | | | | | | | | | | WML/ITL |
| B.12 | Metrology 2 | **AEE** | 24 | **2.0** | | **1.0** | 6 | | 18 | | | | | | | | | 24 | Zo | 2 | | | | | | | | | | | | | WML/ITL |
| B.13 | Physics 2 | **NF** | 60 | **4.0** | | **2.0** | 30 | 20 | 10 | | | | | | | | | 60 | E | 4 | | | | | | | | | | | | | WTC |
| B.14 | Electrical Engineering and Electronics | **AEE** | 80 | **6.0** | **5.0** | **4.5** | 40 | 20 | 20 | | | | | | | | | 80 | E | 6 | | | | | | | | | | | | | WML/ITL, WEL/IRE |
| B.15 | Engineering Mechanics | **IM/AEE** | 68 | **6.0** | **5.0** | **3.0** | 34 | 34 | | | | | | | | | | 68 | E | 6 | | | | | | | | | | | | | WML/ITL |
| B.16 | Strength and Materials Science Laboratory | **IM/IMat** | 26 | **2.0** | **1.5** | **1.5** | | | 26 | | | | | | | | | 26 | Zo | 2 | | | | | | | | | | | | | WML/ITU |
| | **C. Content group of field-related education** | | **674** | **50.0** | **32.5** | **35.5** | **296.0** | **206.0** | **172.0** | | | | | | | **96** | **8.0** | **354** | **26.0** | **90** | **8.0** | **90** | **5.0** | **44** | **3.0** | | | | | | | |
| | **Group of common content** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C.1 | Mathematics 4 | **IM/AEE** | 50 | **5.0** | **3.0** | **2.5** | 24 | 10 | 16 | | | | | | | 60 | Zo | 5 | | | | | | | | | | | | | | | WCY |
| C.2 | Human Factor | **IM/AEE** | 16 | **1.0** | **1.0** | **1.0** | 16 | | | | | | | | | 16 | Zo | 1 | | | | | | | | | | | | | | | WML/ITL |
| C.3 | Aviation Law and Regulations | **NP** | 30 | **2.0** | | **1.5** | 24 | 6 | | | | | | | | 30 | Zo | 2 | | | | | | | | | | | | | | | WML/ITL |
| C.4 | Basics of Machine Construction | **IM/AEE** | 60 | **5.0** | **3.0** | **3.0** | 28 | 32 | | | | | | | | | | 60 | E | 5 | | | | | | | | | | | | | WML/ITL |
| C.5 | Basics of Automation | **AEE** | 44 | **4.0** | **2.0** | **2.0** | 16 | 14 | 14 | | | | | | | | | 44 | E | 4 | | | | | | | | | | | | | WML/ITU |
| C.6 | Digital and microprocessor systems | **AEE** | 40 | **3.0** | **2.0** | **2.0** | 16 | 14 | 10 | | | | | | | | | 40 | Zo | 3 | | | | | | | | | | | | | WML/ITL |
| C.7 | Basics of Modelling Physical Systems | **IM/AEE** | 30 | **2.0** | **1.0** | **1.5** | | 30 | | | | | | | | | | 30 | Zo | 2 | | | | | | | | | | | | | WML/ITL |
| C.8 | Aircraft Materials | **IMat** | 30 | **2.0** | **1.5** | **1.0** | 18 | 12 | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | | | | WML/ITL |
| C.9 | Aircraft Integrated Laboratory | **IM/AEE** | 90 | **5.0** | **3.0** | **5.0** | | | 90 | | | | | | | | | | | | | | | 90 | Zo | 5 | | | | | | | WML/ITL |
| C.10 | Aircraft Maintenance Engineering | **IM/AEE** | 44 | **3.0** | **2.0** | **2.5** | 44 | | | | | | | | | | | | | | | | | | | | 44 | Zo | 3 | | | WML/ITL |
| | **Group of elective content (elect one from the pair of two subjects)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **C.11*** | **Strength of Materials and Structures** | **IM/AEE** | **90** | **7.0** | **6.0** | **5.0** | **44** | **46** | | | | | | | | | | | | | **60** | **Zo** | **4** | **30** | **Zo** | **3** | | | | | | **WML/ITL** |
| **C.11**** | **Aircraft construction and installation** | **IM/AEE** | **90** | **7.0** | **6.0** | **5.0** | **44** | **46** | | | | | | | | | | | | | **60** | **Zo** | **4** | **30** | **Zo** | **3** | | | | | | **WML/ITL** |
| **C.12*** | **Fluid Mechanics** | **IM/AEE** | **60** | **4.0** | **3.0** | **3.0** | **16** | **28** | **16** | | | | | | | | | | | | **60** | **E** | **4** | | | | | | | | | **WML/ITL** |
| **C.12**** | **Fluid Mechanics and Aerodynamics** | **IM/AEE** | **60** | **4.0** | **3.0** | **3.0** | **30** | **14** | **16** | | | | | | | | | | | | **60** | **E** | **4** | | | | | | | | | **WML/ITL** |
| **C.13*** | **Aerodynamics** | **IM/AEE** | **30** | **3.0** | **2.0** | **2.5** | **20** | | **10** | | | | | | | | | | | | | | | **30** | **E** | **3** | | | | | | | **WML/ITL** |
| **C.13**** | **Basics of Flight Mechanics** | **IM/AEE** | **30** | **3.0** | **2.0** | **2.5** | **16** | **10** | **4** | | | | | | | | | | | | | | | **30** | **E** | **3** | | | | | | | **WML/ITL** |
| **C.14*** | **Thermodynamics** | **IM/AEE** | **60** | **4.0** | **3.0** | **3.0** | **30** | **14** | **16** | | | | | | | | | | | | **60** | **Zo** | **4** | | | | | | | | | **WML/ITL** |
| **C.14**** | **Basics of Propulsion Systems** | **IM/AEE** | **60** | **4.0** | **3.0** | **3.0** | **30** | **14** | **16** | | | | | | | | | | | | **60** | **Zo** | **4** | | | | | | | | | **WML/ITL** |
| | **D1. Group of elective content- AAVIONICS** | | **656** | **50.0** | **42.5** | **34.5** | **270** | **194** | **152** | **34** | **6** | | | | | | | | | | **30** | **2** | **282** | **22** | **284** | **21** | **60** | **5** | | | | |
| D1.1 | Modeling of Avionics Systems | **IM/AEE** | 44 | **3.0** | **3.0** | **2.5** | 14 | 30 | | | | | | | | | | | | | | | 44 | Zo | 3 | | | | | | | WML/ITL |
| D1.2 | Aircraft Radioelectronics Systems | **AEE** | 44 | **3.0** | **2.5** | **2.5** | 20 | 8 | 16 | | | | | | | | | | | | | | | | 44 | Zo | 3 | | | | | WEL-IRE |
| D1.3 | Servoactuators and actuators | **IM/AEE** | 44 | **3.0** | **2.5** | **2.5** | 14 | 14 | 16 | | | | | | | | | | | | | | 44 | Zo | 3 | | | | | | | WML/ITL |
| D1.4 | Aircraft Measurement and Diagnostic Systems | **IM/AEE** | 60 | **5.0** | **4.0** | **3.0** | 30 | 14 | 16 | | | | | | | | | | | | 30 | Zo | 2 | 30 | E | 3 | | | | | | WML/ITL |
| D1.5 | Avionics Modules and Systems Programming | **AEE** | 90 | **6.0** | **5.0** | **5.0** | 28 | 28 | 34 | | | | | | | | | | | | | | | 30 | Zo | 2 | 60 | Zo | 4 | | | WML/ITL |
| D1.6 | Control Theory | **AEE** | 60 | **5.0** | **4.0** | **3.0** | 30 | 30 | | | | | | | | | | | | | | | | 60 | E | 5 | | | | | | WML/ITL |
| D1.7 | Aircraft Power Systems | **IM/AEE** | 44 | **4.0** | **3.0** | **2.5** | 16 | 12 | 16 | | | | | | | | | | | | | | | 44 | Zo | 4 | | | | | | WML/ITL |
| D1.8 | Aircraft Control Systems | **IM/AEE** | 60 | **5.0** | **4.5** | **3.0** | 28 | 18 | 14 | | | | | | | | | | | | | | | | | | 60 | E | 5 | | | WML/ITL |
| D1.9 | Aircraft Navigation Systems | **IM/AEE** | 60 | **5.0** | **4.5** | **3.0** | 24 | 20 | 16 | | | | | | | | | | | | | | | | | | 60 | E | 5 | | | WML/ITL/WEL/IRE |
| D1.10 | Aircraft Digital Systems and Computer Networks | **AEE** | 60 | **4.0** | **4.0** | **3.0** | 30 | 8 | 8 | 14 | | | | | | | | | | | | | | | | | 60 | E | 4 | | | WML/ITL |
| D1.11 | On-board Visualization Systems and Simulators | **AEE** | 60 | **5.0** | **4.0** | **3.0** | 26 | 12 | 16 | | 6 | | | | | | | | | | | | | | | | | | | 60 | E | 5 | WML/ITL |
| D1.12 | Basics of Mechatronics Devices Construction | **IM/AEE** | 30 | **2.0** | **1.5** | **1.5** | 10 | | | 20 | | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | WML/ITL |
| | **D2. Group of elective content - AIRCRAFTS AND HELICOPTERS** | | **690** | **50.0** | **42.5** | **35** | **336** | **230** | **88** | **36** | | | | | | | | | | **30** | **2** | **300** | **22** | **300** | **21** | **60** | **5** | | | | |
| D2.1 | Flight echanics | **IM/AEE** | 90 | **6.0** | **5.0** | **5.0** | 44 | 46 | | | | | | | | | | | | | | | | 30 | Zo | 2 | 60 | E | 4 | | | WML/ITL |
| D2.2 | Heat Transfer Issues | **IM/AEE** | 30 | **2.0** | **2.0** | **1.5** | 14 | | 16 | | | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | WML/ITL |
| D2.3 | Avionic Systems | **AEE** | 90 | **6.0** | **5.0** | **4.0** | 46 | 20 | 24 | | | | | | | | | | | | 30 | Zo | 2 | 30 | Zo | 2 | 30 | Zo | 2 | | | WML/ITL |
| D2.4 | Theory of Aircraft Engines | **IM** | 60 | **5.0** | **4.0** | **3.0** | 40 | 20 | | | | | | | | | | | | | | | | 60 | E | 5 | | | | | | WML/ITL |
| D2.5 | Strength of Aircraft Structure | **IM** | 60 | **5.0** | **4.0** | **3.0** | 16 | 30 | 14 | | | | | | | | | | | | | | | 60 | E | 5 | | | | | | WML/ITL |
| D2.6 | Aeroelasticity | **IM** | 30 | **2.0** | **2.0** | **1.5** | 14 | 16 | | | | | | | | | | | | | | | | | | | 30 | Zo | 2 | | | WML/ITL |
| D2.7 | Aircraft Structure Design | **IM** | 90 | **8.0** | **7.0** | **5.0** | 38 | 36 | | 16 | | | | | | | | | | | | | | | | | 60 | E | 5 | 30 | E | 3 | WML/ITL |
| D2.8 | Aircraft Propulsion Systems | **IM/AEE** | 60 | **4.0** | **4.0** | **3.0** | 30 | 30 | | | | | | | | | | | | | | | | | | | 60 | E | 4 | | | WML/ITL |
| D2.9 | Hydropneumatic Systems | **IM/AEE** | 60 | **5.0** | **4.0** | **3.0** | 36 | 8 | 16 | | | | | | | | | | | | | | | 30 | Zo | 3 | 30 | Zo | 2 | | | WML/ITL |
| D2.10 | Design and manufacture of aircraft structures | **IM/AEE** | 60 | **4.0** | **3.0** | **3.0** | 30 | 12 | 18 | | | | | | | | | | | | | | | | | | 30 | Zo | 2 | 30 | Zo | 2 | WML/ITL |
| D2.11 | Propellers and Rotors | **IM** | 30 | **1.0** | **1.0** | **1.5** | 18 | 12 | | | | | | | | | | | | | | | | 30 | Zo | 1 | | | | | | WML/ITL |
| D2.12 | Basics of Mechanical Engineering 2 | **IM** | 30 | **2.0** | **1.5** | **1.5** | 10 | | | 20 | | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | WML/ITL |
| | **D3. Group of elective content - PROPULSION SYSTEMS** | | **720** | **50.0** | **42.5** | **36.5** | **332** | **250** | **102** | **36** | | | | | | | | | | **30** | **2** | **300** | **22** | **300** | **21** | **90** | **5** | | | | |
| D3.1 | Flight Mechanics | **IM/AEE** | 90 | **6.0** | **5.0** | **5.0** | 44 | 46 | | | | | | | | | | | | | | | | 30 | Zo | 2 | 60 | E | 4 | | | WML/ITL |
| D3.2 | Heat Transfer Issues | **IM/AEE** | 30 | **2.0** | **2.0** | **1.5** | 14 | | 16 | | | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | WML/ITL |
| D3.3 | Avionic Systems | **AEE** | 90 | **6.0** | **5.0** | **4.0** | 46 | 20 | 24 | | | | | | | | | | | | 30 | Zo | 2 | 30 | Zo | 2 | 30 | Zo | 2 | | | WML/ITL |
| D3.4 | Theory of Aircraft Engines | **IM** | 60 | **5.0** | **4.0** | **3.0** | 40 | 20 | | | | | | | | | | | | | | | | 60 | E | 5 | | | | | | WML/ITL |
| D3.5 | Strength of Aircraft Structure | **IM** | 60 | **5.0** | **4.5** | **3.0** | 16 | 30 | 14 | | | | | | | | | | | | | | | 60 | E | 5 | | | | | | WML/ITL |
| D3.6 | Aeroelasticity | **IM** | 30 | **2.0** | **2.0** | **1.5** | 14 | 16 | | | | | | | | | | | | | | | | | | | 30 | Zo | 2 | | | WML/ITL |
| D3.7 | Aircraft Construction | **IM/AEE** | 60 | **4.0** | **3.0** | **3.0** | 30 | 30 | | | | | | | | | | | | | | | | | | | 60 | E | 4 | | | WML/ITL |
| D3.8 | Aircraft Propulsion Systems | **IM/AEE** | 90 | **8.0** | **7.0** | **5.0** | 36 | 38 | | 16 | | | | | | | | | | | | | | | | | 60 | E | 5 | 30 | E | 3 | WML/ITL |
| D3.9 | Hydropneumatic Systems | **IM/AEE** | 60 | **4.0** | **4.0** | **3.0** | 36 | 8 | 16 | | | | | | | | | | | | | | | 30 | Zo | 2 | 30 | Zo | 2 | | | WML/ITL |
| D3.10 | Technology of manufacturing of propulsion systems | **IM/AEE** | 60 | **3.0** | **2.5** | **3.0** | 20 | 20 | 20 | | | | | | | | | | | | | | | | | | 30 | Zo | 2 | 30 | Zo | 1 | WML/ITL |
| D3.11 | Propellers and Rotors | **IM** | 30 | **2.0** | **1.0** | **1.5** | 16 | 14 | | | | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | WML/ITL |
| D3.12 | Aircraft Fuels and Lubricants | **IM** | 30 | **1.0** | **1.0** | **1.5** | 10 | 8 | 12 | | | | | | | | | | | | | | | | | | | | | 30 | Zo | 1 | WML/ITL |
| D3.13 | Basics of Mechanical Engineering 2 | **IM** | 30 | **2.0** | **1.5** | **1.5** | 10 | | | 20 | | | | | | | | | | | | | | 30 | Zo | 2 | | | | | | WML/ITL |
| | **E. Diploma Thesis** | | | **30** | **22.0** | **7.0** | **7.0** | | | | | **30** | | | | | | | | | | | | | | | | | | | **30** | **22** | |
| E1 | Diploma Seminar | **IM/AEE** | 30 | **2.0** | **1.0** | **2.0** | | | | | **30** | | | | | | | | | | | | | | | | | | | **30** | **Z** | **2** | WML/ITL |
| E2 | Diploma Thesis | **IM/AEE** | | **20.0** | **6.0** | **5.0** | | | | | | | | | | | | | | | | | | | | | | | | | **Z** | **20** | WML/ITL |
| | **F. Apprenticeship** | Number of weeks | | **4.0** | | **2.0** | **Completion date** | | | | | | | | | | | | | | | | | | | | **4** | **4** | | | | |
| F.1 | Apprenticeship | **4** | | **4.0** | | **2.0** | **after VI sem.** | | | | | | | | | | | | | | | | | | | | 4 | Z | 4 | | | WML/ITL |
| | TOTAL HOURS * / ECTS credits - Avionics | | **2424** | **210.0** | **107.0** | **124.5** | **1034** | **914** | **406** | **34** | **36** | **376** | **30.0** | **370** | **30.0** | **384** | **30.0** | **414** | **30.0** | **372** | **30.0** | **374** | **30.0** | **134** | **30.0** | | | | | | | | |
| | TOTAL HOURS * / ECTS credits - Aircrafts and helicopters | | **2458** | **210.0** | **107.0** | **125.0** | **1090** | **954** | **348** | **36** | **30** | **376** | **30.0** | **370** | **30.0** | **384** | **30.0** | **414** | **30.0** | **390** | **30.0** | **390** | **30.0** | **134** | **30.0** | | | | | | | | |
| | TOTAL HOURS * / ECTS credits - Propulsion systems | | **2488** | **210.0** | **107.0** | **126.5** | **1086** | **974** | **362** | **36** | **30** | **376** | **30.0** | **370** | **30.0** | **384** | **30.0** | **414** | **30.0** | **390** | **30.0** | **390** | **30.0** | **164** | **30.0** | | | | | | | | |
| | **dopuszczalny deficyt pkt. ECTS*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Types and number of assessments in semester: | | | | | | | | | | | number of exams **E** | | 2 | | 3 | | 3 | | 4 | | 3 | | 3 | | 1 | | | | | | | |
| | | | | | | | | | | | | number of graded credits **Zo** | | 10 | | 7 | | 5 | | 5 | | 7 | | 3 | | 1/2 | | | | | | | |
| | | | | | | | | | | | | number of credits **Z** | | 1 | | | | | | | | | | 1 | | 1 | | | | | | | |
| | | | | | | | | | | | | number of interim projects **P** | | | | | | | | 1 | | | | 1 | | | | | | | | | |

* delete as appropriate
Semesters IV - VII - education including elective subjects
Additional condition for admission to the diploma examination is confirmed knowledge of a foreign language at B2 level.

Curriculum adopted by Senat WAT Date 27 maja 2021 r.

**Legend**

**C.11*-C.14* Group of field-related content elected for specialization: Aircrafts, Helicopters and Propulsion Systems**

**C.11**-C.14** Group of field-related content elective for specialization: Avionics**

*** in accordance with the decision of the WML Dean concerning the norms and standards of the didactic process

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I hereby certify the compliance of the above translation with the original document in Polish. ----------
Monika Janik, a certified translator of the English language, entered onto the List of Certified Translators held by the Minister of Justice, entry No TP 139/13 ----------
Rep. No ---------- 163/2021
Warsaw, 18 May 2021----------

WYDZIAŁOWA RADA
SAMORZĄDU WYDZIAŁU
MECHATRONIKI UZBROJENIA I
LOTNICTWA WAT

Warszawa, 15 kwietnia 2021 r.

**Przewodniczący**

**Wydziałowej Rady ds. Kształcenia**

**Dr inż. Zdzisław ROCHALA**

*Dotyczy: zaopiniowania programów studiów.*

Wydziałowa Rada Samorządu, po dokonaniu analizy przedstawionych programów studiów , postanowiła pozytywnie zaopiniować „ Programy studiów inżynierskich" o profilu ogólnoakademickim , rozpoczynających się od 1 października roku akademickiego 2021/2022

nw. kierunków studiów:

- „ lotnictwo i kosmonautyka" ;
- „mechatronika";
- „inżynieria bezpieczeństwa";
- „inżynieria systemów bezzałogowych".

Za Samorząd WRS WML
Przewodnicząca

Aneta MISIAK

# OPINIA

**Wydziałowej Rady ds. Kształcenia**
**Wydziału Mechatroniki, Uzbrojenia i Lotnictwa**
**Wojskowej Akademii Technicznej**
**im. Jarosława Dąbrowskiego**

**nr 15/2021 z dnia 28 kwietnia 2021 r.**

w sprawie opracowania projektu programu studiów I stopnia

Wydziałowa Rada ds. Kształcenia Wydziału Mechatroniki, Uzbrojenia i Lotnictwa Wojskowej Akademii Technicznej pozytywnie opiniuje projekt programu studiów I stopnia dla kierunku *lotnictwo i kosmonautyka* obowiązujący od roku akademickiego 2020/2021, opracowany w języku polskim i języku angielskim.

**Przewodniczący**

**dr inż. Zdzisław ROCHALA, prof. WAT**

Wojskowa Akademia Techniczna

**Uchwała**
**Rady Dyscypliny Naukowej „Inżynieria Mechaniczna"**
**Wojskowej Akademii Technicznej**
**im. Jarosława Dąbrowskiego**

**nr 20/RDN IM/2021 z dnia 19 maja 2021 r.**

**w sprawie zaopiniowania projektu programu studiów I stopnia na kierunku „lotnictwo i kosmonautyka" opracowany w języku polskim i w języku angielskim**

Na podstawie § 25 ust. 1 pkt 13 Statutu WAT, stanowiącego załącznik do uchwały Senatu WAT nr 16/WAT/2019 z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (tj. obwieszczenie Rektora WAT nr 2/WAT/2019 z dnia 9 października 2019 r.), uchwala, co następuje:

§ 1

Rada Dyscypliny Naukowej „Inżynieria Mechaniczna" pozytywnie opiniuje projekt programu studiów I stopnia na kierunku *„lotnictwo i kosmonautyka"*, opracowany w języku polskim i w języku angielskim, obowiązujący się od roku akademickiego 2021/2022 na Wydziale Mechatroniki, Uzbrojenia i Lotnictwa.

§ 2

Uchwała wchodzi w życie z dniem podjęcia.

**Przewodniczący**

**prof. dr hab. inż. Jerzy MAŁACHOWSKI**