Programme		
Aerospace Engineering		
Degree	Type	Academic year
Msc	full-time	2019/2020
Purposes		
The objectives of the study is to gain the skills allowing for the independent and creative analysis of advanced engineering problems. The graduates are prepared not only for the work in industry but also for solving the research problems. Each diploma thesis is reviewed by 2 reviewers and is defended in the presence of commission consisting of professors and assistant professors.		
Effects of education		
Code of effect:	**Aero2_W01**	
Description:	Student has an extended and in-depth knowledge of mathematics, physics, chemistry and other areas of science useful to formulate and solve complex tasks related to aviation and astronautics.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W02**	
Description:	Student knows the classification of partial differential equations and methods for solving certain types of such equations.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W03**	
Description:	Student knows the mathematical optimization method applying in aviation.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W04**	
Description:	Student knows selected items of special relativity. Has knowledge of the wave properties of light. Has knowledge of the applications of photonics in the technology.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W05**	
Description:	Student knows the chemical composition and construction of the atmosphere. Student knows the most important physical phenomena that occur in the atmosphere, and have an impact on the prediction of weather and flight safety.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W06**	
Description:	Student has a thorough knowledge of the areas associated with the direction of studies.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W07**	
Description:	Familiar with the method of adjustment, cascading systems regulations and methods for the evaluation of dynamic property of the adjusting system. Has knowledge of the regulatory systems design methods.	
Area of study related learning outcomes		
Code of effect:	**Aero2_W08**	
Description:	Student has knowledge of basic and complex mechanisms of heat transfer. Knows the basic laws governing heat flows. Student knows the determination of thermophysical properties of	

Effects of education	
	materials, important from the point of view of the heat exchange.
Area of study related learning outcomes	
Code of effect:	**Aero2_W09**
Description:	Familiar with methods of identifying parameters of systems occurring in the technique. Know the advantages and limitations of different methods of signal processing.
Area of study related learning outcomes	
Code of effect:	**Aero2_W10**
Description:	Student has a structured, thorough theoretically general knowledge covering the key issues with areospace engineering: structural strength, aerodynamics, on-board equipment.
Area of study related learning outcomes	
Code of effect:	**Aero2_W11**
Description:	Student has knowledge about the movement of the aircraft. Student knows the equations of motion non-deformed aircraft and with additional degrees of freedom. The student has knowledge of the linearization equations of motion, methods of calculating aerodynamic derivatives and methods of research of movement of aircraft in different phases of flight.
Area of study related learning outcomes	
Code of effect:	**Aero2_W12**
Description:	Student has knowledge of the construction and principles of operation of radar systems, safety systems. Student has an extended knowledge of systems and installations, discussed in the first degree studies.iów.
Area of study related learning outcomes	
Code of effect:	**Aero2_W13**
Description:	Student has knowledge about the design process of the ship flying. Student has knowledge about the functions, characteristics and typical examples of designs of the ship. Knows selected fragments of the laws in force the construction of aircraft.
Area of study related learning outcomes	
Code of effect:	**Aero2_W14**
Description:	Student has theoretical knowledge detailed with some areas of aerospace engineering in the construction or design airframe drive units, and combustion theory or design simulation and integration of on-board systems or aerospace.
Area of study related learning outcomes	
Code of effect:	**Aero2_W15**
Description:	Student has knowledge of development trends and the most important new developments in the area of aerospace and related disciplines.
Area of study related learning outcomes	
Code of effect:	**Aero2_W16**
Description:	Student knows the proposed design solutions

Effects of education	
	and future and unusual types of drives.
Area of study related learning outcomes	
Code of effect:	**Aero2_W17**
Description:	Student has knowledge of the unmanned systems Air, their on-board systems and Earth stations.
Area of study related learning outcomes	
Code of effect:	**Aero2_W18**
Description:	Student knows the methods of a systemic approach to the design and organization of space missions.
Area of study related learning outcomes	
Code of effect:	**Aero2_W19**
Description:	Student has a basic understanding of the life cycle of the equipment, facilities and technical systems. Familiar with the methods of operation of aircraft in terms of safety, reliability and cost, and in particular the management of the continuing airworthiness of taking into account the regulatory requirements and the development of non-destructive methods to assess the condition.
Area of study related learning outcomes	
Code of effect:	**Aero2_W20**
Description:	Student knows the basic methods, techniques, tools and materials used in solving complex engineering tasks related to the areospace engineering.
Area of study related learning outcomes	
Code of effect:	**Aero2_W21**
Description:	Student has knowledge necessary to understand social, economic, legal and other non-technical conditions of power engineering activity and to take them into account in engineering practice.
Area of study related learning outcomes	
Code of effect:	**Aero2_W22**
Description:	Student has basic knowledge on management, such as quality management and management of business activity.
Area of study related learning outcomes	
Code of effect:	**Aero2_W23**
Description:	Student knows and understands basic terms and rules connected with industrial property protection and copyright, as well as the need for intellectual property management; can use the resources of patent information.
Area of study related learning outcomes	
Code of effect:	**Aero2_W24**
Description:	Student knows general rules of founding and development of forms of individual entrepreneurship, using the knowledge in scientific fields and disciplines relevant to areospace engineering.
Area of study related learning outcomes	

Effects of education

Code of effect:	**Aero2_U01**
Description:	Student can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Area of study related learning outcomes	
Code of effect:	**Aero2_U02**
Description:	Student can communicate using various techniques in the professional environment and other environments, also in English.
Area of study related learning outcomes	
Code of effect:	**Aero2_U03**
Description:	Student can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for areospace engineering, and present his/her own research results.
Area of study related learning outcomes	
Code of effect:	**Aero2_U04**
Description:	Student can prepare and give an oral presentation on detailed issues from the field of areospace engineering in Polish and in a foreign language.
Area of study related learning outcomes	
Code of effect:	**Aero2_U05**
Description:	Student can set the goals of further education and organise his/her learning process.
Area of study related learning outcomes	
Code of effect:	**Aero2_U06**
Description:	Student has language skills in scientific fields and disciplines relevant to the field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for areospace engineering.
Area of study related learning outcomes	
Code of effect:	**Aero2_U07**
Description:	Can use information and communication techniques appropriate to realise tasks typical for areospace engineering, can prepare an article for publication presenting his/her own analyses.
Area of study related learning outcomes	
Code of effect:	**Aero2_U08**
Description:	Can plan and conduct experiments, such as measurements and computer simulations, interpret the results obtained and draw conclusions.
Area of study related learning outcomes	
Code of effect:	**Aero2_U09**
Description:	Can use to formulate and solve engineering tasks

Effects of education	
	and simple problems research analytical methods, simulation and experimental.
Area of study related learning outcomes	
Code of effect:	**Aero2_U10**
Description:	Can-by formulating and solving tasks engineer ¬ European-integrate knowledge of scientific fields and disciplines applicable to aerospace and system approach, taking into account also non-technical aspects.
Area of study related learning outcomes	
Code of effect:	**Aero2_U11**
Description:	Able to formulate and test hypotheses related to engineering problems and easy to research problems.
Area of study related learning outcomes	
Code of effect:	**Aero2_U12**
Description:	Can evaluate the usefulness and the possibility of using new achievements (techniques and technologies) in Aeronautics and Astronautics.
Area of study related learning outcomes	
Code of effect:	**Aero2_U13**
Description:	Student has the necessary preparation to work in an industrial environment and knows safety rules related to this job.
Area of study related learning outcomes	
Code of effect:	**Aero2_U14**
Description:	Student is able to make a preliminary economic analysis of the activities undertaken the engineering.
Area of study related learning outcomes	
Code of effect:	**Aero2_U15**
Description:	It can make a critical analysis of the methods of operation and evaluate existing in aviation and astronautics technical solutions: equipment, facilities, systems, processes, services, etc.
Area of study related learning outcomes	
Code of effect:	**Aero2_U16**
Description:	Can suggest improvements/enhancements of existing technical solutions.
Area of study related learning outcomes	
Code of effect:	**Aero2_U17**
Description:	Can identify and formulate the specification of complex engineering tasks, specific to the aerospace, including unusual tasks, including taking into account their non-technical aspects.
Area of study related learning outcomes	
Code of effect:	**Aero2_U18**
Description:	Can assess the suitability of methods and tools for engineering solutions, specific to the aerospace, including a glimpse of the limitations of these methods and tools; can-by applying new methods of conceptually also ¬ solve complex engineering tasks specific to the aerospace, including unusual tasks and the tasks that

Effects of education	
	contain a research component.
Area of study related learning outcomes	
Code of effect:	**Aero2_U19**
Description:	Can-in accordance with the specifications, taking into account the non-technical aspects-design a complex device, object, system or process, associated with your air or kosmonautyczną specialization, and realise this project-at least in part-by using the appropriate methods, techniques and tools, if necessary, adapt for this purpose existing or developing new tools.
Area of study related learning outcomes	
Code of effect:	**Aero2_K01**
Description:	Student understands the need for life-long learning; can inspire and organise the learning process of other people.
Area of study related learning outcomes	
Code of effect:	**Aero2_K02**
Description:	Student is aware of the importance of engineering activity and understands its non-technical aspects and consequences, such as its impact on the environment and the responsibility for ensuing decisions.
Area of study related learning outcomes	
Code of effect:	**Aero2_K03**
Description:	Student can cooperate and work in a team, assuming various roles.
Area of study related learning outcomes	
Code of effect:	**Aero2_K04**
Description:	Student can appropriately set priorities for realisation of a task set by him-/herself or others.
Area of study related learning outcomes	
Code of effect:	**Aero2_K05**
Description:	Student correctly identifies and solves dilemmas connected with his/her job.
Area of study related learning outcomes	
Code of effect:	**Aero2_K06**
Description:	Student can think and act in a creative and entrepreneurial way.
Area of study related learning outcomes	
Code of effect:	**Aero2_K07**
Description:	Student is aware of the social role of a technical university graduate, in particular understands the need to formulate and deliver, especially via mass media, information and opinions on technical achievements and other aspects of engineering activity; strives to make the information and opinions widely understandable, presenting various points of view.
Area of study related learning outcomes	

Courses by semester

Semester 1

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Aerospace Engineering	Specialization	Advanced Computational Fluid Dynamics	3	30	0	15	0
Aerospace Engineering	Specialization	Aircraft Maintenance Management	2	0	15	0	0
Aerospace Engineering	Specialization	Aircraft Systems Laboratory	3	0	0	45	0
Aerospace Engineering	Specialization	Composite materials in Aerospace	3	30	15	0	0
Aerospace Engineering	Specialization	Control in Aerospace	3	30	0	0	0
Aerospace Engineering	Specialization	Dynamics of flight	3	30	0	0	0
Aerospace Engineering	Specialization	Heat Transfer in Aerospace	4	45	0	0	0
Aerospace Engineering	Specialization	Mechanics of Thin Walled Structures	3	15	15	15	0
Aerospace Engineering	Specialization	Partial Differential Equations	4	15	30	0	0
Aerospace Engineering	Specialization	Physics of the Atmosphere	2	15	0	0	0
Aerospace Engineering	Specialization	Space Technology	2	30	0	0	0

Semester 2

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Aerospace Engineering	Specialization	Advanced Aerospace Engines Laboratory	2	0	0	30	0
Aerospace Engineering	Specialization	Attitude and navigation systems	4	15	15	0	15
Aerospace Engineering	Specialization	Fatigue and Aircratf Diagnostic Systems	4	30	0	15	0
Aerospace Engineering	Specialization	Intermediate Master Project	6	0	0	0	90
Aerospace Engineering	Specialization	Physics 2	2	30	0	0	0
Aerospace Engineering	Specialization	Sensors and Measurement Systems	3	15	0	15	0
Aerospace Engineering	Specialization	Signals and Identification Methods	3	15	15	0	0
Aerospace Engineering	Specialization	Structural Analysis of Aeroengines	4	30	0	0	0

Semester 3

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Aerospace Engineering	Specialization	Elective course(s) AE1	5	75	0	0	0
Aerospace Engineering	Specialization	Master Diploma Seminar	2	0	0	0	30
Aerospace Engineering	Specialization	Master Diploma Thesis	20	0	0	0	225
Aerospace Engineering	Specialization	Optmization in Aircraft Design	3	30	0	0	15

Description of course

Code of course	ML.ANK323	
Name of course	Advanced Computational Fluid Dynamics	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Prof. J. Rokicki	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Computational Fluid Dynamics, Fluid Mechanics, Computer Science II.	
Limit of students	60 - lecture, 12 – lab. group	
C. Effects of education and manner of teaching		
Purpose of course	To familiarize the students with the algorithms and advanced methods of computational fluid dynamics After completing this course the students will be able to understand advanced algorithms of CFD as well as perform advanced simulations using comertial CFD code (mesh generation, setting up boundary and initial conditions, monitoring simulations, assessment and visualization of results).	
Effects of education	See Table 1.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Structured and unstructured grids. Grid generation algorithms. First-order hyperbolic systems. Stability of finite difference formulas - von Neumann spectral analysis. Numerical dispersions and diffusion. Nonlinear, hyperbolic partial differential equations, Riemann problem. Multi dimensional problems. Numerical error estimation and analysis, adaptive grids. Turbulence modelling.	
Methods of evaluation	Assesment method: 1 lecture test (60 points), lab. continuous assignement (20 points), lab. test (20 points), resulting mark: (30-49 N, 50-59 3.0, 60-69 3.5, 70-79 4.0, 80-89 4.5, 90-100 5.0), if necessary the optional final exam may override the score received during the lecture test.	

Description of course

	Practical work: lab work.
Methods of verification of effects of education	See Table 1.
Exam	no
Literature	1) Hirsch, Charles, Numerical computation of internal and external flows, 2007 Versteeg. 2) Henk Kaarle, An introduction to computational fluid dynamics, 2007. 3) J. Blazek, Computational Fluid Dynamics: Principles and Applications, 2005.
Website of the course	http://c-cfd.meil.pw.edu.pl/ccfd/index.php?item=6

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher : 50 hours, including: a) lecture – 15 hours; b) lab. – 30 hours; c) consultations – 5 hours. 2) The number of hours of independent work of student: 25 hours, including: a) preparation for labs and lectures -15 hours; b) practical computational assignment -10 hours . Total: approx. 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 50 hours, including: a) lecture – 15 – hours; b) lab. – 30 hours; c) consultations – 5 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits, 45 hours including: a) participation in the labs. - 30 godzin; b) preparation for the labs and the computational assignement- 15 hours.

E. Additional information

Notes	
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Table 1. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK323_W1**
Description:	Student is acquinted with the properties of the eigenvalue problem.
Verification:	Test.
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_W1**
Description:	Student is acquinted with the properties of the eigenvalue problem.
Verification:	Test.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_W2**
Description:	Student knows methods of solution of hyperbolic diffferential systems.
Verification:	Final test.
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_W2**
Description:	Student knows methods of solution of hyperbolic diffferential systems.

Table 1. Learning outcomes	
Verification:	Final test.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_W3**
Description:	Student knows discretization methods applied for hyperbolic PDEs.
Verification:	Final test.
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_W3**
Description:	Student knows discretization methods applied for hyperbolic PDEs.
Verification:	Final test.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK323_U1**
Description:	Student is able to solve complex flow and heat transfer problems using commercial simulation programs.
Verification:	Evaluation of the progress during lab tutorials.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U1**
Description:	Student is able to solve complex flow and heat transfer problems using commercial simulation programs.
Verification:	Evaluation of the progress during lab tutorials.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U1**
Description:	Student is able to solve complex flow and heat transfer problems using commercial simulation programs.
Verification:	Evaluation of the progress during lab tutorials.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U1**
Description:	Student is able to solve complex flow and heat transfer problems using commercial simulation programs.
Verification:	Evaluation of the progress during lab tutorials.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U2**
Description:	Student can assess usefulness of a numerical method applied to a PDE.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U2**
Description:	Student can assess usefulness of a numerical method applied to a PDE.
Verification:	Assessment of progress/activity in lab tutorials.

Table 1. Learning outcomes	
Field of study related learning outcomes	Aero2_U15
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U2**
Description:	Student can assess usefulness of a numerical method applied to a PDE.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U2**
Description:	Student can assess usefulness of a numerical method applied to a PDE.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U2**
Description:	Student can assess usefulness of a numerical method applied to a PDE.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U3**
Description:	Student has skills to use advanced functionalities of commercial programs.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK323_U3**
Description:	Student has skills to use advanced functionalities of commercial programs.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK496	
Name of course	Aircraft Maintenance Management	
Version of course	2016	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Kamila Kustron, Ph. D.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Basics of Aircraft Design and Maintenance.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	Description of important factors which impact aircraft maintenance performance and to use them to formulate the multioptimization model to minimize cost and lead time, and maximize quality of aircraft maintenance, which benefits aircraft maintenance managers in making decisions for material procurement.	
Effects of education	See Table 2.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	15h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Defining the management issue. Introduction to Aviation Management System based on the best practices, worked by Boeing and Airbus. Aviation Management System. What? When? Why? from history to present. Aviation Industry characterization, Aviation Industry Certification, Airworthiness Certificate, Delivery Inspection. Documentation for Maintenance. Aircraft Maintenance Cost Philosophies & Economics. Maintenance Costs (Direct /Indirect) Breakdown. ON aircraft maintenance and OFF Aircraft Maintenance. Non-Destructive Test (NDT) and Health Monitoring methods in diagnostics of new aircraft. Human Factor in Aviation Maintenance. Safety Management System. Quality assessment.	
Methods of evaluation	100% pass mark of a Continuous Airworthiness Management project and its presenting.	
Methods of verification of effects of education	See Table 2.	

Description of course

Exam	no
Literature	1) Kinnison H. Aviation Maintenance Management. McGraw-Hill Companies, NY,USA, 2004. 2) Kinnison H.A., Siddiqui T., Aviation Maintenance Management, Second Edition McGraw-Hill Professional, 2013. 3) http://www.easa.europa.eu, http://www.icao.int, http://www.caa.co.uk, http://www.ntsb.gov, http://www.ulc.gov.pl, http://www.casa.gov.au.
Website of the course	http://www.meil.pw.edu.pl/add/ADD/Teaching/Subjects/Aircraft-Maintenance-Management

D. Student's activity

Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 18, including: a) attendance at the exercises -15 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student - 58, including: a) preparing a continuous airworthiness management project for a chosen two types of aircraft (10 aircraft) for known planed scheduled flights - 30 hours; b) preparing a presentation which will be assessment of a chosen type aircraft accidents, only based on Accident Investigating Boards' Reports - 10hours. Total: 58 hours
Number of ECTS credits on the course with direct participation of academic teacher	0,5 ECTS credits -
Number of ECTS credits on practical activities on the course	Preparing a continuous airworthiness management project for a chosen two types of aircraft (10 aircraft) for known planed scheduled flights - 30 hours, preparing a presentation which will be assessment of a chosen type aircraft accidents, only based on Accident Investigating Boards' Reports - 10 hours; total: 40 hours =1,5 ECTS credits.

E. Additional information

Notes	
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Table 2. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive tests used in aerospace, know their use in the management of the continuing airworthiness.

Table 2. Learning outcomes	
Verification:	Project.
Field of study related learning outcomes	Aero2_W24
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive tests used in aerospace, know their use in the management of the continuing airworthiness.
Verification:	Project.
Field of study related learning outcomes	Aero2_W22
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive tests used in aerospace, know their use in the management of the continuing airworthiness.
Verification:	Project.
Field of study related learning outcomes	Aero2_W21
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive tests used in aerospace, know their use in the management of the continuing airworthiness.
Verification:	Project.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive

Table 2. Learning outcomes	
	tests used in aerospace, know their use in the management of the continuing airworthiness.
Verification:	Project.
Field of study related learning outcomes	Aero2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive tests used in aerospace, know their use in the management of the continuing airworthiness.
Verification:	Project.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W1**
Description:	Know the procedures and requirements for the management of continuing airworthiness, know the rules of the airline-AOC holder, has a basic knowledge of airline management, is knowledgeable about the effects of the environment and on the environment in the system of aircraft operation, knows the methods of aircraft operation, know the non-destructive tests used in aerospace, know their use in the management of the continuing airworthiness.
Verification:	Project.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W24
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W22
Area of study related learning outcomes	

Table 2. Learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W21
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_W2**
Description:	Know the actions of Aviation Safety Agency in shaping the quality of aeronautical products and operating systems.
Verification:	Project.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK496_U1**
Description:	Can develop a documentation of the continuing airworthiness management in terms of legal requirements.
Verification:	Project.
Field of study related learning outcomes	Aero2_U17
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_U2**
Description:	Know the rules of work safety in units operating the aircraft.
Verification:	Project.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANK496_K1**
Description:	Able to work in a team in the search for information and achieving aims.
Verification:	Project.

Table 2. Learning outcomes	
Field of study related learning outcomes	Aero2_K07
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_K1**
Description:	Able to work in a team in the search for information and achieving aims.
Verification:	Project.
Field of study related learning outcomes	Aero2_K06
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_K1**
Description:	Able to work in a team in the search for information and achieving aims.
Verification:	Project.
Field of study related learning outcomes	Aero2_K03
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_K1**
Description:	Able to work in a team in the search for information and achieving aims.
Verification:	Project.
Field of study related learning outcomes	Aero2_K02
Area of study related learning outcomes	
Code of effect:	**ML.ANK496_K1**
Description:	Able to work in a team in the search for information and achieving aims.
Verification:	Project.
Field of study related learning outcomes	Aero2_K01
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS646	
Name of course	Aircraft Systems Laboratory	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Przemysław Bibik, Ph.D., Associate Professor.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Basic knowledge of mechanics, electronics and electrical engineering, aeronautical systems and avionics.	
Limit of students	36	
C. Effects of education and manner of teaching		
Purpose of course	To familiarize students with handling and recording data from the selected navigation sensors and control equipment. Presentation of methods of testing and correcting errors of these devices and methods of experimental evaluation of their performance. Familiarization with the data processing algorithms of the selected sensors.	
Effects of education	See Table 3.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	45h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Students get detailed knowledge of the principles of operation of the selected equipment and sensors of aeronautical systems. They conduct experiments and prepare the numerical tools allowing to determine the characteristics and to study the errors of each device.	
Methods of evaluation	Reports on individual laboratories. Final mark is an average of all reports.	
Methods of verification of effects of education	See Table 3.	
Exam	no	
Literature	1) Instructions to laboratory experiments provided by lecturer, with recommended text for self-studying. 2) User manuals of selected aeronautical system. Additional: may be provided by lecturer.	
Website of the course		

Description of course

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the labs – 45 hours; b) consultancy meetings – 5 hours. 2) The number of hours of independent work of student – 35, including: a) preparation for the laboratories: 15 hours; b) preparation of the laboratories' reports: 20 hours. TOTAL – 85 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 50 hours, including: a) attendance at the labs – 45 hours; b) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits - hours, including: a) attendance at the labs – 45 hours; b) consultancy meetings – 5 hours; c) preparation for the laboratories - 15 hours; d) preparation of the laboratories' reports - 20 hours.

E. Additional information

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Table 3. Learning outcomes

General academic profile - skils

Code of effect:	**ML.ANS646_U1**
Description:	Student is able to plan and carry out an experiment using a selected on-board sensor.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U1**
Description:	Student is able to plan and carry out an experiment using a selected on-board sensor.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U1**
Description:	Student is able to plan and carry out an experiment using a selected on-board sensor.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U1**
Description:	Student is able to plan and carry out an experiment using a selected on-board sensor.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U2**
Description:	Student is able to use the typical sensors, devices and measurement systems.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U03

Table 3. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U2**
Description:	Student is able to use the typical sensors, devices and measurement systems.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U2**
Description:	Student is able to use the typical sensors, devices and measurement systems.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U2**
Description:	Student is able to use the typical sensors, devices and measurement systems.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U3**
Description:	Student is able to post-process the results of the experiment and prepare the measurement report.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U3**
Description:	Student is able to post-process the results of the experiment and prepare the measurement report.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U3**
Description:	Student is able to post-process the results of the experiment and prepare the measurement report.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U3**
Description:	Student is able to post-process the results of the experiment and prepare the measurement report.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U4**
Description:	Student is able to interpret the results of measurements and draw conclusions based on them in relation to the set objectives of the experiment.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U08

Table 3. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U4**
Description:	Student is able to interpret the results of measurements and draw conclusions based on them in relation to the set objectives of the experiment.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U4**
Description:	Student is able to interpret the results of measurements and draw conclusions based on them in relation to the set objectives of the experiment.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U4**
Description:	Student is able to interpret the results of measurements and draw conclusions based on them in relation to the set objectives of the experiment.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U4**
Description:	Student is able to interpret the results of measurements and draw conclusions based on them in relation to the set objectives of the experiment.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U5**
Description:	Student is able to use dedicated software.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U5**
Description:	Student is able to use dedicated software.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U5**
Description:	Student is able to use dedicated software.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U6**
Description:	Student is able to work in a group and present the results of their work.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	

Table 3. Learning outcomes	
Code of effect:	**ML.ANS646_U6**
Description:	Student is able to work in a group and present the results of their work.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U6**
Description:	Student is able to work in a group and present the results of their work.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U6**
Description:	Student is able to work in a group and present the results of their work.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS646_U6**
Description:	Student is able to work in a group and present the results of their work.
Verification:	Evaluation of the report.
Field of study related learning outcomes	Aero2_U13
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS520	
Name of course	Composite materials in Aerospace	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Piotr Czarnocki, prof. PW	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students	min.15	
C. Effects of education and manner of teaching		
Purpose of course	To gain fundamental engineering knowledge about possible application of polymeric matrix composite materials for airframes of modern aircrafts. Principles of design and manufacturing of composite airframes for modern aircrafts.	
Effects of education	See Table 4.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	15h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Definitions and terminology. Mission of constituents, (reinforcement and matrix). Mechanical properties of constituents versus mechanical properties of composite. Clasical theory of laminates. Fatigue. Damage of composite materials. Failure modes. Failure criteria. FE codes for stress analysis. Tests to assess mechanical properties. Design philosophy. Design rules-laminate sizing. Joining: co-bonding, adhesive joints, mechanical joints. Manufacturing techniques. Tooling for laminates. Limitation in usage of laminates. Quality assurance. Repairs.	
Methods of evaluation	2 tests.	
Methods of verification of effects of education	See Table 4.	
Exam	no	
Literature	Recommended texts (reading): 1) Book 1: H.D. Middleton, ”Composite materials in aircraft structure” . 2) Book 2: R.M. Jones, “Mechanics of composite materials”. 3) Book 3: M. C-Y Niu, “ Composite airframe structures” . Further	

Description of course

	Readings: - Will be provided by lecturer.
Website of the course	-

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 45, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours. 2) The number of hours of independent work of student – 30, including: a) systematic preparation for classes - 20 hours; b) preparing for tests -10 hours. TOTAL – 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 45 hours, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credit.

E. Additional information

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Table 4. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANS520_W1**
Description:	Knowing constitutive equations for laminates.
Verification:	Test.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W1**
Description:	Knowing constitutive equations for laminates.
Verification:	Test.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W1**
Description:	Knowing constitutive equations for laminates.
Verification:	Test.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W2**
Description:	Knowing basic relationships between mechanical properties of components and composite material.
Verification:	Test.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W2**
Description:	Knowing basic relationships between mechanical properties of components and composite material.
Verification:	Test.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W2**

Table 4. Learning outcomes	
Description:	Knowing basic relationships between mechanical properties of components and composite material.
Verification:	Test.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W3**
Description:	Knowing manufacturing processes related to fabrication of airframe components.
Verification:	Test.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W3**
Description:	Knowing manufacturing processes related to fabrication of airframe components.
Verification:	Test.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W3**
Description:	Knowing manufacturing processes related to fabrication of airframe components.
Verification:	Test.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_W4**
Description:	Knowing quality control methods. Knowing basic failure criteria. Knowing basic principles of composite airframe certification procedure.
Verification:	Test.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS520_U1**
Description:	Can estimate mechanical properties of laminate based on mechanical properties of components.
Verification:	Test.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U1**
Description:	Can estimate mechanical properties of laminate based on mechanical properties of components.
Verification:	Test.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U1**
Description:	Can estimate mechanical properties of laminate based on mechanical properties of components.
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U1**
Description:	Can estimate mechanical properties of laminate based on mechanical properties of components.
Verification:	Test.

Table 4. Learning outcomes	
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U2**
Description:	Can design airframe composite parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U2**
Description:	Can design airframe composite parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U2**
Description:	Can design airframe composite parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U2**
Description:	Can design airframe composite parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U3**
Description:	Can perform basic stress analysis.
Verification:	Test.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U3**
Description:	Can perform basic stress analysis.
Verification:	Test.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U3**
Description:	Can perform basic stress analysis.
Verification:	Test.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U3**
Description:	Can perform basic stress analysis.
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U4**
Description:	Can design molds for composite airframe parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U4**
Description:	Can design molds for composite airframe parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U4**
Description:	Can design molds for composite airframe parts.

Table 4. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS520_U4**
Description:	Can design molds for composite airframe parts.
Verification:	Test.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK389	
Name of course	Control in Aerospace	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Robert Głębocki, Ph.D., Associate Professor	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	none	
C. Effects of education and manner of teaching		
Purpose of course	To learn about designing automatic control systems and methods applied in aeronautics and astronautics. After completing the course students will be able to identify dynamic properties and to design control system for various platforms.	
Effects of education	See Table 5.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Control methods used in aeronautics and astronautics (airplanes, helicopters, rockets). Navigation units influence on control systems. Aircraft actuators dynamics. Identification of aircraft control systems (first and second order system models) Automatic control (PID control, Lead Lag control, unconventional control algorithms) Aircraft control systems designing Aircraft systems examples (SAS, CAS, FBW).	
Methods of evaluation	Assesment method: e.g. , 60% class tests, 40% home project - Aircraft automatic SISO control system simulation and investigation.	
Methods of verification of effects of education	See Table 5.	
Exam	no	
Literature	Recommended texts (reading): 1) materials prepared by lecturer. 2) Nelson R. C. Flight stability and automatic control. 3) McLean D.; Automatic flight control systems.	
Website of the course	-	
D. Student’s activity		

Description of course

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 35, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student – 40, including: a) 10 hours - preparing for test; b) 15 hours - home work; c) 15 hours - preparation for lecture, analyse of the literature.
Number of ECTS credits on the course with direct participation of academic teacher	1,2 ECTS credits - number of hours that require the presence of a teacher - 35, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 5. Learning outcomes

General academic profile - knowledge

Code of effect:	**EW2**
Description:	Umie dobrać nastawy regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**EW2**
Description:	Umie dobrać nastawy regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**EW2**
Description:	Umie dobrać nastawy regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**EW2**
Description:	Umie dobrać nastawy regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
Code of effect:	**EW2**
Description:	Umie dobrać nastawy regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W07
Area of study related learning outcomes	
Code of effect:	**EW3**
Description:	Posiada wiedzę na temat identyfikacji dynamiki obiektów i procesów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	

Table 5. Learning outcomes	
Code of effect:	**EW3**
Description:	Posiada wiedzę na temat identyfikacji dynamiki obiektów i procesów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W18
Area of study related learning outcomes	
Code of effect:	**EW3**
Description:	Posiada wiedzę na temat identyfikacji dynamiki obiektów i procesów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**EW3**
Description:	Posiada wiedzę na temat identyfikacji dynamiki obiektów i procesów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**EW3**
Description:	Posiada wiedzę na temat identyfikacji dynamiki obiektów i procesów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**EW3**
Description:	Posiada wiedzę na temat identyfikacji dynamiki obiektów i procesów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W07
Area of study related learning outcomes	
Code of effect:	**EW4**
Description:	Posiada wiedzę na temat stosowanych rozwiązań lotniczych układów sterowania
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**EW4**
Description:	Posiada wiedzę na temat stosowanych rozwiązań lotniczych układów sterowania
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
Code of effect:	**EW4**
Description:	Posiada wiedzę na temat stosowanych rozwiązań lotniczych układów sterowania
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W07
Area of study related learning outcomes	
Code of effect:	**EW4**
Description:	Posiada wiedzę na temat stosowanych rozwiązań lotniczych układów sterowania
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W12
Area of study related learning outcomes	

Table 5. Learning outcomes	
Code of effect:	**EW5**
Description:	Posiada wiedzę na temat regulatorów i kompensatorów i ich roli w układach automatyki
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**EW5**
Description:	Posiada wiedzę na temat regulatorów i kompensatorów i ich roli w układach automatyki
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**EW5**
Description:	Posiada wiedzę na temat regulatorów i kompensatorów i ich roli w układach automatyki
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**EW5**
Description:	Posiada wiedzę na temat regulatorów i kompensatorów i ich roli w układach automatyki
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**EW5**
Description:	Posiada wiedzę na temat regulatorów i kompensatorów i ich roli w układach automatyki
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
Code of effect:	**EW5**
Description:	Posiada wiedzę na temat regulatorów i kompensatorów i ich roli w układach automatyki
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_W07
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W07
Area of study related learning outcomes	

Table 5. Learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W06
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W12
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANK389_W1**
Description:	The student has knowledge of the structure of control systems.
Verification:	Colloquium and homework.
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**EU1**
Description:	Student posiada umiejętność doboru praw sterowania i nastaw regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**EU1**
Description:	Student posiada umiejętność doboru praw sterowania i nastaw regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**EU1**
Description:	Student posiada umiejętność doboru praw sterowania i nastaw regulatorów
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U01

Table 5. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U04
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**EU2**
Description:	Student posiada umiejętność zaprojektowania struktury układu regulacji
Verification:	kolokwium i praca domowa
Field of study related learning outcomes	Aero2_U15

Table 5. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**EU3**
Description:	Student umie dobrać kompensator do układu dynamicznego
Verification:	kolokwium
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**EU3**
Description:	Student umie dobrać kompensator do układu dynamicznego
Verification:	kolokwium
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**EU3**
Description:	Student umie dobrać kompensator do układu dynamicznego
Verification:	kolokwium
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**EU4**
Description:	Potrafi korzystać z programów narzędziowych wspomagających projektowanie układów automatyki
Verification:	praca domowa
Field of study related learning outcomes	Aero2_U04
Area of study related learning outcomes	
Code of effect:	**EU4**
Description:	Potrafi korzystać z programów narzędziowych wspomagających projektowanie układów automatyki
Verification:	praca domowa
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**EU4**
Description:	Potrafi korzystać z programów narzędziowych wspomagających projektowanie układów automatyki
Verification:	praca domowa
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ES1**
Description:	Student umie pracować w grupie
Verification:	praca domowa
Field of study related learning outcomes	Aero2_K03
Area of study related learning outcomes	
Code of effect:	**ES1**
Description:	Student umie pracować w grupie
Verification:	praca domowa
Field of study related learning outcomes	Aero2_K04
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK312	
Name of course	Dynamics of flight	
Version of course	2016	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr inż. Piotr Lichota	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Mechanics I and Mechanics II, Flight Mechanics I and Flight Mechanics II.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	After completing this course the student will be able to build a physical and a mathematical of an aircraft which dynamic characteristics he investigates. Student will be able to analyze longitudinal and lateral dynamic stability, evaluate steady spin parameters, determine spin stability through numerical simulation and knows system identification basics.	
Effects of education	See Table 6.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Static stability. Coordinate systems. Transformations. Equations of motion. Steady state. Linearization. Aerodynamic derivatives. System representations. Dynamic stability. Reduced order models. Motion at high angles of attack. System identification.	
Methods of evaluation	Final written examination. It is possible to pass the subject after obtaining positive marks from tests written during classes.	
Methods of verification of effects of education	See Table 6.	
Exam	yes	
Literature	1. Cook, M. V., „Flight Dynamics Principles,” 2 wyd., Elsevier, Amsterdam, 2007. 2. Etkin B., „Dynamics of Atmospheric Flight,” 2 wyd., John Wiley & Sons Inc., Nowy Jork, 1972 (reprint Dover Publications 2005). 3. Jategaonkar, R. V., „Flight	

Description of course

	Vehicle System Identification: A Time Domain Methodology," Progess in Astronautics and Aeronautics, AIAA, Reston, Virginia, 2006. 4. McLean, D., „Automatic Flight Control Systems" Series in Systems and Control Engineering" Prentice Hall, Nowy Jork, 1990. 5. Napolitano, M. R., „Aircraft Dynamics: From Modeling to Simulation" John Wiley & Sons Inc., Hoboken, New Jersey, 2012. 6. Nelson, R. C., „Flight Stability and Automatic Control," 2 wyd., McGraw-Hill, Boston, Massachusetts, 1998. 7. Pamadi., B. N., „Performance, Stability, Dynamics and Control of Airplanes," AIAA Education Series, AIAA, Reston, Virginia, 2004. 8. Roskam, J., „Flight Dynamics and Automatic Flight Controls," 5 wyd., DARcorporation, Lawrence, Kansas, 2007. 9. Stevens, B. L., Lewis, F. L., „Aircraft Control and Simulation," 2 wyd., John Wiley & Sons, Hoboken, New Jersey, 2003. 10. Yechout, T. R, „Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability and Classical Feedback Control" AIAA Education Series, AIAA, Reston, Virginia, 2003 .
Website of the course	http://meil.pw.edu.pl/zm/ZM/Dydaktyka/Prowadzone-przedmioty/Dynamics-of-flight

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 31, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 1 hours. 2) The number of hours of independent work of student – 25, including: • systematic preparation for classes, reading recommended literature by the teacher - 30 hours; • preparing for exam - 15 hours. TOTAL – 76 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.25 ECTS credits - 31 hours, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 1 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 6. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK312_W1**
Description:	Student has the basic knowledge about aircraft motion modelling, coordinate systems and equations of motion derivation.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W01

Table 6. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_W2**
Description:	Student knows how to develop equations of motion for both rigid body and elastic aircraft.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_W3**
Description:	Student knows equations of motion linearization methods.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_W4**
Description:	Student knows how to obtain aerodynamic derivatives.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_W5**
Description:	Student knows how to analyze the aircraft stability.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_W6**
Description:	Student knows how to analyze aircraft motion at high angles of attack.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W11
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_W7**
Description:	Student has basic knowledge about aircraft system identification.
Verification:	Exam.
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK312_U1**
Description:	Student can make assumptions that results in simplified aircraft motion model.
Verification:	Exam.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_U2**
Description:	Student uses Newton's II Law to derive aircraft equations of motion.
Verification:	Exam.
Field of study related learning outcomes	Aero2_U04
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_U3**
Description:	Student can analyze longitudinal and lateral dynamic stability.
Verification:	Exam.

Table 6. Learning outcomes	
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANK312_U4**
Description:	Student can evaluate steady spin parameters.
Verification:	Exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK425	
Name of course	Heat Transfer in Aerospace	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Dr hab. inż. Maciej Jaworski	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Thermodynamics, Fluid Mechanics, Calculus – Partial Differential Equations.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	To learn about basic and complex heat transfer mechanisms, as well as fundamental laws governing these physical processes. To introduces several analytical and numerical methods available for solving heat transfer problems. To learn about particular heat transfer processes, important from the point of view of aerospace engineering.	
Effects of education	See Table 7.	
Form of didactic studies and number of hours per semester	Lecture	45h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Basic mechanisms of heat transfer – conduction, convection, radiation; fundamental laws. - Thermophysical properties of substances. - Conduction: energy conservation equation; physical, boundary and initial conditions. Steady-state conduction; thermal resistance concept; extended surfaces. Transient conduction: lumped thermal capacity model, general solution of transient heat conduction, conduction with periodic boundary conditions. Introduction to numerical methods in heat transfer. Convection heat transfer: free and forced confection; external and internal flow, correlations for the evaluation of heat transfer coefficient. Convection heat transfer: supersonic external flows, ablation, transpiration and effusion cooling. Convection heat transfer:	

Description of course

	boiling and condensation, heat pipes, two-phase flow cooling techniques. Radiation: basic equation, radiation resistance concept.
Methods of evaluation	Three tests during the course; each test contains both theoretical and practical problems.
Methods of verification of effects of education	See Table 7.
Exam	no
Literature	Cengel Y.A.: Heat and mass transfer, a practical approach, McGraw-Hill, 2007. Bejan A., Kraus A.D.: Heat Transfer Handbook, John Wiley & Sons, 2003.
Website of the course	www.itc.pw.edu.pl

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 45 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student – 50, including: • solution of computational problems (homework) - 25 hours; • preparation for class tests -15 hours; • reading recommended literature by the teacher - 10 hours. TOTAL – 100 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 50 hours, including: a) attendance at the lectures - 45 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits.

E. Additional information

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Table 7. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK425_W01**
Description:	Student knows fundamental mechanisms of heat transfer and related physical principles.
Verification:	Classtest no. 1.
Field of study related learning outcomes	Aero2_W08
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W01**
Description:	Student knows fundamental mechanisms of heat transfer and related physical principles.
Verification:	Classtest no. 1.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W02**
Description:	Student knows transport equations which govern heat conduction processes, as well as the boundary conditions typical for heat transfer problems.
Verification:	Class test no. 1.
Field of study related learning outcomes	Aero2_W08

Table 7. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W02**
Description:	Student knows transport equations which govern heat conduction processes, as well as the boundary conditions typical for heat transfer problems.
Verification:	Class test no. 1.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W03**
Description:	Student knows various particular cases of convective heat transfer including heat transfer at high flow flow rates.
Verification:	Class test no. 2.
Field of study related learning outcomes	Aero2_W08
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W04**
Description:	Student has knowledge about the aircraft-industry applied method of the overheating protection of the engine elements exposed to high thermal loadings.
Verification:	Class test no. 2.
Field of study related learning outcomes	Aero2_W08
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W05**
Description:	Student knows mathematical modelling of the radiative heat transfer phenomena, and is able to determine relevant properies of a radiating surface.
Verification:	Class test no. 3.
Field of study related learning outcomes	Aero2_W08
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_W05**
Description:	Student knows mathematical modelling of the radiative heat transfer phenomena, and is able to determine relevant properies of a radiating surface.
Verification:	Class test no. 3.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK425_U01**
Description:	Student is able to apply the laws governing fundamental mechanisms of heat transfer to obtain a solution to complex heat transfer problems.
Verification:	Class test no. 1.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_U02**
Description:	Student can apply a proper form of the equation of heat conduction to describe mathematically simple heat transfer problems and find analytical solutions.

Table 7. Learning outcomes	
Verification:	Class test no. 1.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_U03**
Description:	Student can apply the criterial equations to describe convective heat transfer problems.
Verification:	Class test no. 2.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK425_U04**
Description:	Student is able to perform calculations of the radiative heat transfer for simple geometries.
Verification:	Class test no. 3.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS642	
Name of course	Mechanics of Thin Walled Structures	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Adam Dacko, prof. PW.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Solid Mechanics, Mechanics of Structures / Strength of Structures.	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	To provide engineers insight into specifics of structural analysis of thin walled structures. The course gives foundations of work of thin-walled beams, bending effects in shells, axisymmetrical pressure vessels and structures, buckling and post-buckling analysis. After completing his course the students will be able to apply a correct approach for analysis of thin walled structures. That means choose a proper model and analysis methods applying to this model, as well as estimation of obtained results. Critical assessment of outcome of analysis is the basis of sound engineering approach.	
Effects of education	See Table 8.	
Form of didactic studies and number of hours per semester	Lecture	15h
	Exercise type of course	15h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Plate bending theory (Kirchhoff). Small and large deflections. Out of plane loads. In plane load rotating disks and compound pipes. Thin-walled beams open and closed section. Shell theory (Kirchhoff-Love). Small and large deflections. Shell, monocoque and semi-monocoque models. Stability of structures (energy approach). Post-buckling behavior.	
Methods of evaluation	60% continuous assessment based on written test, 20% short test problems, 20% computer labs.	

Description of course

Methods of verification of effects of education	See Table 8.
Exam	no
Literature	1. Megson - Introduction_to_Aircraft_Structural_Analysis. 2. Allen - Introduction to Aerospace Structural Analysis. 3. Gjelsvik The Theory of Thin Walled Bars. 4. Hearn - Mechanics of Materials Case. 5. Chilver, Ross - Strength of Materials and Structures. 6. Timoshenko Theory of plates and shells. 7. Timoshenko, Gere Theory of elastic stability.
Website of the course	

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 15 hours; b) attendance at the labs – 15 hours; c) attendance at the exercises - 15 hours; d) consultancy meetings – 5 hours. 2) The number of hours of independent work of student – 40, including: a) preparation for tests: 15 hours; b) preparation for lecture and exercises, analyse of the literature - 10 hours; c) preparing for the lab: 15 hours. TOTAL – 90 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 50 hours, including: a) attendance at the lectures - 15 hours; b) attendance at the labs – 15 hours; c) attendance at the exercises - 15 hours; d) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits.

E. Additional information

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Table 8. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANS642_W1**
Description:	Knows principles of thin-walled structures, assumptions of technical theory of shallow shells. Knows principles of equations binding displacements, strains and stresses, including cases of large deflections.
Verification:	Test.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	

Code of effect:	**ML.ANS642_W1**
Description:	Knows principles of thin-walled structures, assumptions of technical theory of shallow shells. Knows principles of equations binding displacements, strains and stresses, including cases of large deflections.
Verification:	Test.

Table 8. Learning outcomes	
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W2**
Description:	Ma podstawową wiedzę o metodach analitycznych służących wyznaczania przemieszczeń, odkształceń i naprężeń w prostych płytach prostokątnych, powłokach walcowych oraz o metodzie elementów skończonych pozwalającej rozwiązywać złożone przypadki konstrukcji cienkościennych.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W2**
Description:	Ma podstawową wiedzę o metodach analitycznych służących wyznaczania przemieszczeń, odkształceń i naprężeń w prostych płytach prostokątnych, powłokach walcowych oraz o metodzie elementów skończonych pozwalającej rozwiązywać złożone przypadki konstrukcji cienkościennych.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W3**
Description:	Knows the basic terms and the principles of basic equations for calculation of critical loads for thin walled structures.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W3**
Description:	Knows the basic terms and the principles of basic equations for calculation of critical loads for thin walled structures.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W4**
Description:	Has the basic knowledge of analytical methods of calculation of critical loads for simple rectangular plates, cylindrical shells under compression and torsion. Also about energy methods and Finite Element Method allowing calculation of critical loads for complex structures.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W4**

Table 8. Learning outcomes	
Description:	Has the basic knowledge of analytical methods of calculation of critical loads for simple rectangular plates, cylindrical shells under compression and torsion. Also about energy methods and Finite Element Method allowing calculation of critical loads for complex structures.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_W4**
Description:	Has the basic knowledge of analytical methods of calculation of critical loads for simple rectangular plates, cylindrical shells under compression and torsion. Also about energy methods and Finite Element Method allowing calculation of critical loads for complex structures.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS642_U1**
Description:	Knows how to build simple mathematical models of real thin-walled structures.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U2**
Description:	Knows how to determine displacements, strains and stresses for simple loads of rectangular plates, cylindrical shells by solving PDE of equilibrium - by exact methods or approximate methods (collocation, Galerkin or Ritz methods).
Verification:	Test.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U2**
Description:	Knows how to determine displacements, strains and stresses for simple loads of rectangular plates, cylindrical shells by solving PDE of equilibrium - by exact methods or approximate methods (collocation, Galerkin or Ritz methods).
Verification:	Test.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U3**
Description:	Knows how to calculate displacements, strains and stresses in not to complex thin-walled structures using different Finite Element systems.
Verification:	Test, evaluation of the student's work during laboratory exercises.

Table 8. Learning outcomes	
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U4**
Description:	Knows how to calculate the critical loads for rectangular plates, the circular cylinders under compression and torsion, by solving PDE of equilibrium - by exact methods or approximate methods (collocation, Galerkin or Ritz methods).
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U4**
Description:	Knows how to calculate the critical loads for rectangular plates, the circular cylinders under compression and torsion, by solving PDE of equilibrium - by exact methods or approximate methods (collocation, Galerkin or Ritz methods).
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U5**
Description:	Knows how to calculate critical loads in not to complex thin-walled structures using different Finite Element systems.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U5**
Description:	Knows how to calculate critical loads in not to complex thin-walled structures using different Finite Element systems.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS642_U5**
Description:	Knows how to calculate critical loads in not to complex thin-walled structures using different Finite Element systems.
Verification:	Test, evaluation of the student's work during laboratory exercises.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	

Description of course

Code of course	ML.NK481A	
Name of course	Partial Differential Equations	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Mathematics and Information Science.	
Coordinator of course	Prof. Andrzej Fryszkowski	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Calculus 1, Calculus 2, Calculus 3.	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	To familiarize students with the foundations of the theory of Partial Differential Equations, selected PDE-based models and solution techniques.	
Effects of education	See Table 9.	
Form of didactic studies and number of hours per semester	Lecture	15h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	1. DEs of the first order - the method of characteristics for quasi-linear PDE. The Cauchy problem. 2. Classification of the 2nd-order PDEs. Canonical forms of hyperbolic, parabolic and elliptic PDEs.. 3. Solution of the Cauchy problem for the string. D'Alembert formula for a nonhomogeneous equation. 4. Initial/boundary value problem for the string of finite length. Oscillation of rectangular and circular membrane. 5. Solution of the initial/boundary value problem for the rod by means of the method of separation of variables. 6. Fourier integral, Cauchy problem for heat transfer equation in infinite domain, maximum principle for a heat transfer problem. 7. Elliptic equations and properties of harmonic functions. Dirichlet and neumann type boundary conditions for the Laplace equation.	
Methods of evaluation	Midterm test - 55 p. Final exam - 45 p. Evaluation of the progress/activity during tutorial meetings - 5 p. Total up to 100 p., at least 51 p. to pass the course.	
Methods of verification of effects of education	See Table 9.	

Description of course

Exam	yes
Literature	1. Salsa S.: Partial differential equations in action. From modelling to Theory. Springer, 2009. 2. Olver P.: Introduction to Partial Differential Equations. Springer, 2014. 3. Tyn Myint-U, Debnath L.: Linear Partial Differential Equations for Scientists and Engineers, Birkhauser, 2007.
Website of the course	-

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises – 30 hours; c) consultancy meetings – 5 hours. 2) The number of hours of independent work of student – 50 hours, including; • systematic preparation for classes - 30 hours; • preparing for exams - 20 hours. Total - 100 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits – 50 hours, including: a) attendance at the lectures- 15 hours; b) attendance at the exercises – 30 hours. c) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 9. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.NK481A_W1**
Description:	Student is familiar with the basic theoretical concepts in the theory of PDEs: linear, nearly-linear and quasi-linear. Student knows the method of characteristics for the 1st-order quasi-linear PDE.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W1**
Description:	Student is familiar with the basic theoretical concepts in the theory of PDEs: linear, nearly-linear and quasi-linear. Student knows the method of characteristics for the 1st-order quasi-linear PDE.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W2**
Description:	Student knows the classification of the nearly-linear PDEs of the second order.
Verification:	Test and exam.

Table 9. Learning outcomes	
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W2**
Description:	Student knows the classification of the nearly-linear PDEs of the second order.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W3**
Description:	Student is familar with the formulation of basic boundary value problems for 2nd-order hyperbolic, parabolic and elliptic PDEs. Student knows basic examples of application of such problems in physics and engineering.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W3**
Description:	Student is familar with the formulation of basic boundary value problems for 2nd-order hyperbolic, parabolic and elliptic PDEs. Student knows basic examples of application of such problems in physics and engineering.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W4**
Description:	Student knows the method of separation of variables.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_W4**
Description:	Student knows the method of separation of variables.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_W02
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.NK481A_U1**
Description:	Student can transform a PDE (in 2D case) to a canonical form.
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.NK481A_U2**
Description:	Student can solve a simple initial/boundary value problem for a hyperbolic and parabolic PDEs using the method of separation of variables.
Verification:	Test and exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK321	
Name of course	Physics of the Atmosphere	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr inż. Wojciech Grendysa	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	50	
C. Effects of education and manner of teaching		
Purpose of course	After subject is finished student should: have the knowledge about basic structure of Earth atmosphere, have the knowledge about atmospheric phenomenas, which impact the weather, have the knowledge about atmospheric phenomenas, which cause danger for flight of aircraft.	
Effects of education	See Table 10.	
Form of didactic studies and number of hours per semester	Lecture	15h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The atmosphere composition. Physical parameters of atmosphere versus height. Winds. Humidity, Clouds and fog. Icing. Storms and cyclones. Wind shear, microburst. Whether in the mountains region. Weather forecast. Turbulence. Mathematical model of atmosphere. Standard Atmosphere. Prevention against atmosphere danger.	
Methods of evaluation	Test.	
Methods of verification of effects of education	See Table 10.	
Exam	no	
Literature	1. Selected lectures in electronic form (web site). 2. J.D. Andreson – Introduction to Flight, McGraw-Hill , 2004. 3. Materials available on the website: http://www.meil.pw.edu.pl/add/ADD/Teaching/Subjects/Physics-of-Atmosphere.	
Website of the course	http://www.meil.pw.edu.pl/add/ADD/Teaching/Subjects/Physics-of-Atmosphere	

Description of course

D. Student’s activity

Number of ECTS credits	2
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher - 17, including: a) attendance at the lectures - 17 hours; b) consultancy meetings – 2 hours. 2) The number of hours of independent work of student – 40 hours, including: • systematic preparation for classes, reading recommended literature by the teacher - 30 hours; • preparing for test - 10 hours. Total - 57 hours.
Number of ECTS credits on the course with direct participation of academic teacher	0.5 ECTS credits - 17 hours, including: a) attendance at the lectures - 17 hours; b) consultancy meetings – 2 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 10. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK321_W1**
Description:	Student knows the structure of the atmosphere, its chemical composition and basic physical phenomena occurring in the atmosphere and their impact on aircraft.
Verification:	Test.
Field of study related learning outcomes	Aero2_W05
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ML.ANK321_U1**
Description:	Student is able to recognize the atmospheric hazards acting on the aircraft.
Verification:	Test.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	

General academic profile - social competences

Code of effect:	**ML.ANK321_K1**
Description:	Student understands the interaction of the environment - airplane.
Verification:	Test.
Field of study related learning outcomes	Aero2_K02
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK398	
Name of course	Space Technology	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr inż. A. Kobiera, dr inż. J. Kindracki.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Astronautics.	
Limit of students	150	
C. Effects of education and manner of teaching		
Purpose of course	Acquisition of knowledge about main principles of spacecraft systems including , space and ground segment, basic principles of design of spacecraft subsystems, elements of orbital mechanics and applications of space technology.	
Effects of education	See Table 11.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Space environment. Orbit parameters. Spacecraft as a technical system. Launchers. Main subsystem of satellites: mechanical structure, mechanisms, power system, thermal system, attitude and orbit control systems, telemetry and control systems. Manned spacecrafts. Ground stations. Applications of space technology.	
Methods of evaluation	Exam.	
Methods of verification of effects of education	See Table 11.	
Exam	yes	
Literature	1) P. Fortescue, J. Stark and G. Swinerd, Spacecraft systems engineering, Wiley, Chichester, 2007. 2) C. D. Brown, Elements of spacecraft design, AIAA, Reston, 2002. 3) W. Ley, K. Wittmann, W. Hallmann Handbook of Space Technology, Wiley and Sons, 2009.	
Website of the course	estudia.meil.pw.edu.pl	
D. Student's activity		
Number of ECTS credits	2	
Number of hours of student's work to achieve	1) Number of hours that require the presence of a	

Description of course

effects of education	teacher - 19, including: a) attendance at the lectures - 15 hours; b) exam(average) - 4 hours. 2) The number of hours of independent work of student – 30, including; • repetition of the material during semester - 15 hours; • preparing for exams - 15 hours. Total - 49 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit - 19, including: a) attendance at the lectures - 15 hours; b) exam(average) - 4 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 11. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK398_W1**
Description:	Student knows specifics of design of devices working in space environment.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W06
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W1**
Description:	Student knows specifics of design of devices working in space environment.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W05
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W2**
Description:	Student knows problems of system engineering related to design, manufacturing and realization of space missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W23
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W2**
Description:	Student knows problems of system engineering related to design, manufacturing and realization of space missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W21
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W2**
Description:	Student knows problems of system engineering related to design, manufacturing and realization of space missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W18
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work

Table 11. Learning outcomes	
	principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W12
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W08
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W3**
Description:	Student knows and basic subsystems of spacecrafts and understands their work principles.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W18
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W4**
Description:	Student knows examples of design os spacecrafts and course of their missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W4**
Description:	Student knows examples of design os

Table 11. Learning outcomes	
	spacecrafts and course of their missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W5**
Description:	Students knows applications of space technologies in other technology branches, economy, management, education and other aspects of society.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W24
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_W5**
Description:	Students knows applications of space technologies in other technology branches, economy, management, education and other aspects of society.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_W21
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK398_U1**
Description:	Student can choose types of spacecraft subsystems for specific mission requirements.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U17
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U1**
Description:	Student can choose types of spacecraft subsystems for specific mission requirements.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U16
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U1**
Description:	Student can choose types of spacecraft subsystems for specific mission requirements.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U1**
Description:	Student can choose types of spacecraft subsystems for specific mission requirements.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U2**
Description:	Students is able to roughly estimate the most important parameters of spacecraft subsystems and elements of space missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U2**
Description:	Students is able to roughly estimate the most

Table 11. Learning outcomes	
	important parameters of spacecraft subsystems and elements of space missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U2**
Description:	Students is able to roughly estimate the most important parameters of spacecraft subsystems and elements of space missions.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U15
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U3**
Description:	Student can define the most important requirements for mission and system in reference to mission objectives.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U17
Area of study related learning outcomes	
Code of effect:	**ML.ANK398_U3**
Description:	Student can define the most important requirements for mission and system in reference to mission objectives.
Verification:	Test question in exam.
Field of study related learning outcomes	Aero2_U15
Area of study related learning outcomes	

Description of course

Code of course	ML.AN600	
Name of course	Advanced Aerospace Engines Laboratory	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Prof. Marian Gieras	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Student should have basic knowledge in the field of combustion processes and principles of operation and construction of the aircraft propulsion.	
Limit of students	6	
C. Effects of education and manner of teaching		
Purpose of course	Have a working knowledge about fundamentals, operation and construction of different kind of aircraft engines. Knowledge about the structure of a typical engine test bench and the basic methods of conducting tests and measurements of different types of aircraft engines. Ability to perform typical aircraft engine operating characteristics.	
Effects of education	See Table 12.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	30h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Types of flames, burners and combustion chambers. Methods of flame stabilization as well as methods visualization and registration of combustion processes in aircraft engine combustion chambers, Fundamentals of deflagration and detonation processes in context operating conditions of rotational detonation and pulse detonation jet engine. Methods of measurement and data acquisition systems. Structure and measurement equipments of typical engine test bench. Investigation of a: pulse jet, piston, turbine as well as rotational detonation engine. Determining of different types of aircraft engines performances.	

Description of course

Methods of evaluation	Assessment will be made on the basis reports realised by students and colloquium test.
Methods of verification of effects of education	See Table 12.
Exam	no
Literature	1. Archer R.D., Saarlas M.: An Introduction to Aerospace Propulsion, Prentice Hall 1996. 2. Mattingly J.D.: Elements of gas turbine Propulsion, McGraw Hill 1996. 3. Mattingly J.D., Heiser W.H., Pratt D.T.: Aircraft engine design, AIAA 2002. 4. Strehlow R. A. Combustion Fundamentals, McGraw-Hill, New York 1984. 5. A. H. Lefebvre, „Gas Turbine Combustion", Taylor & Francis, USA, 1998.
Website of the course	

D. Student's activity

Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 32, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student – 30, including: a) preparation for test - 10 hours; b) reading recommended literature by the teacher - 10 hours; c) preparation of reports from the lab - 10 hours. Total: 62 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.3 ECTS credits - 32 hours, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits - 62 hours, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 2 hours. c) preparation for test - 10 hours; d) reading recommended literature by the teacher - 10 hours; e) preparation of reports from the lab - 10 hours.

E. Additional information

Notes	Participation in laboratory exercise is obligatory.
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Table 12. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.AN600_W1**
Description:	Student knows the basics of combustion, heat and mass transfer and thermodynamic changes in aircraft engines, construction and various types of combustion chambers of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W16
Area of study related learning outcomes	

Code of effect:	**ML.AN600_W1**
Description:	Student knows the basics of combustion, heat and mass transfer and thermodynamic changes in aircraft engines, construction and various

Table 12. Learning outcomes	
	types of combustion chambers of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W1**
Description:	Student knows the basics of combustion, heat and mass transfer and thermodynamic changes in aircraft engines, construction and various types of combustion chambers of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W08
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W2**
Description:	Student has knowledge of aerodynamics and organization of processes of combustion in the combustion chambers of aircraft engines and rockets.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W16
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W2**
Description:	Student has knowledge of aerodynamics and organization of processes of combustion in the combustion chambers of aircraft engines and rockets.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W2**
Description:	Student has knowledge of aerodynamics and organization of processes of combustion in the combustion chambers of aircraft engines and rockets.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W3**
Description:	Student knows the principles of operation and design of various aircraft propulsion.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W16
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W3**
Description:	Student knows the principles of operation and design of various aircraft propulsion.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W3**
Description:	Student knows the principles of operation and design of various aircraft propulsion.
Verification:	Colloquium, evaluation of the report.

Table 12. Learning outcomes	
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W4**
Description:	Student knows the structure and equipment of aviation engine test bench.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.AN600_W4**
Description:	Student knows the structure and equipment of aviation engine test bench.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.AN600_U1**
Description:	Student knows the basic methods of testing on aircraft engines test bench.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.AN600_U1**
Description:	Student knows the basic methods of testing on aircraft engines test bench.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.AN600_U2**
Description:	Student can perform the characteristics of different types of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.AN600_U2**
Description:	Student can perform the characteristics of different types of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.AN600_U3**
Description:	Student is able to calculate the basic parameters of the gas-dynamic different types of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.AN600_U3**
Description:	Student is able to calculate the basic parameters of the gas-dynamic different types of aircraft engines.
Verification:	Colloquium, evaluation of the report.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
General academic profile - social competences	

Table 12. Learning outcomes	
Code of effect:	**ML.AN600_K1**
Description:	Student understands the need for teamwork and is able to work in a team.
Verification:	Determination of appropriate characteristics of the aircraft engine, preparation of a report from exercise.
Field of study related learning outcomes	Aero2_K04
Area of study related learning outcomes	
Code of effect:	**ML.AN600_K1**
Description:	Student understands the need for teamwork and is able to work in a team.
Verification:	Determination of appropriate characteristics of the aircraft engine, preparation of a report from exercise.
Field of study related learning outcomes	Aero2_K03
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS647	
Name of course	Attitude and navigation systems	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Prof Janusz Narkiewicz	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	None, but it is recommended to have the base knowledge of flight mechanics, and aeronautical systems.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	To get acquainted navigation systems and methods for determination of position and attitude used in various fields of technology.	
Effects of education	See Table 13.	
Form of didactic studies and number of hours per semester	Lecture	15h
	Exercise type of course	15h
	Laboratory	0h
	Project type of course	15h
	Computer lessons	0h
Contents of education	Lecture: Overview of the methods for position and attitude determination. Architecture of the attitude systems. Sensors and their errors. Accelerometers. Gyroscpes: mechanical, vibrating, dynamically tunned, laser and FOG. Earth gravity and gravity sensors. Earth shape and coordinate systems. Non-othogonal sensors. Application of GNSS for attitude determination. Leveling and gyrocompassing. INS/GPS integration. Project. Design of navigation system composed of prescribed sensors. Design algorithm and program simulation the system. Tutorials: Examples for illustrating topic presented during lectures.	
Methods of evaluation	One test during semester. Report and presentation of the project.	
Methods of verification of effects of education	See Table 13.	
Exam	no	
Literature	Literature will be given for each lecture based on books available in university and faculty library.	

Description of course

	Specialised literature will be offered for projects.
Website of the course	

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) attendance at the design exercises - 15 hours; d) consultancy meetings - 5 hours. 2) The number of hours of independent work of student - 50, including: • systematic preparation for classes - 10 hours; • reading recommended literature by the teacher - 10 hours; • work on the project - 20 hours; • preparing for test - 10 hours. Total - 100 hours. TOTAL: 75 hours
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 50 hours, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) attendance at the design exercises - 15 hours; d) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits - 55 hours, including: a) attendance at the design exercises - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 5 hours. d) work on the project - 20 hours.

E. Additional information

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Table 13. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANS647_W1**
Description:	A student knows operation principles of navigation and attitude systems, on levels of algorithm structure and signal processing.
Verification:	Test, project.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W1**
Description:	A student knows operation principles of navigation and attitude systems, on levels of algorithm structure and signal processing.
Verification:	Test, project.
Field of study related learning outcomes	Aero2_W12
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W1**
Description:	A student knows operation principles of navigation and attitude systems, on levels of algorithm structure and signal processing.
Verification:	Test, project.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	

Table 13. Learning outcomes	
Code of effect:	**ML.ANS647_W2**
Description:	She / he knows the errors sources and methods of their modelling and diminishing in navigation systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W2**
Description:	She / he knows the errors sources and methods of their modelling and diminishing in navigation systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W06
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W2**
Description:	She / he knows the errors sources and methods of their modelling and diminishing in navigation systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W2**
Description:	She / he knows the errors sources and methods of their modelling and diminishing in navigation systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W2**
Description:	She / he knows the errors sources and methods of their modelling and diminishing in navigation systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_W2**
Description:	She / he knows the errors sources and methods of their modelling and diminishing in navigation systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W12
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS647_U1**
Description:	She / he is capable to develop mathematical and simulation model of system containing various sensors.
Verification:	Project.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U1**
Description:	She / he is capable to develop mathematical and simulation model of system containing various sensors.

Table 13. Learning outcomes	
Verification:	Project.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U2**
Description:	She / he is able to develop efficient method and computer program for navigation system. She / he verify and validate the simulation software developed, presenting the proper software operation
Verification:	Project.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U2**
Description:	She / he is able to develop efficient method and computer program for navigation system. She / he verify and validate the simulation software developed, presenting the proper software operation
Verification:	Project.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U2**
Description:	She / he is able to develop efficient method and computer program for navigation system. She / he verify and validate the simulation software developed, presenting the proper software operation
Verification:	Project.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U2**
Description:	She / he is able to develop efficient method and computer program for navigation system. She / he verify and validate the simulation software developed, presenting the proper software operation
Verification:	Project.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U3**
Description:	She / he knows how to write report describing the work done.
Verification:	Project.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U3**
Description:	She / he knows how to write report describing the work done.
Verification:	Project.
Field of study related learning outcomes	Aero2_U04
Area of study related learning outcomes	
Code of effect:	**ML.ANS647_U3**
Description:	She / he knows how to write report describing the work done.

Table 13. Learning outcomes	
Verification:	Project.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS652	
Name of course	Fatigue and Aircratf Diagnostic Systems	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Mirosław Rodzewicz, prof. PW.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Aircraft Design.	
Limit of students	36	
C. Effects of education and manner of teaching		
Purpose of course	After completing the course the student will get the ability in the domain of aircraft load recording and determination the operational load spectra, the ways of fatigue life estimating as well, and the methods of diagnostics of the aircraft airframes.	
Effects of education	See Table 14.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Variable loads and their sources. Fatigue characteristics of the materials applied in aeronautics. Influence of stress concentration (notches). Fatigue wears of the airframe induced by variable loads (cumulation of fatigue damage). Phases of fatigue wear. Residual strength and residual fatigue life. Maintenance systems in aspects of fatigue life of the aircraft structure. Diagnostics – methods and investigation systems. Investigation procedures of the aircraft operators. Role of fatigue tests in the procedure of aircraft certification.	
Methods of evaluation	Tests, homework, preparing presentations.	
Methods of verification of effects of education	See Table 14.	
Exam	no	
Literature	1) N. G. Belly: Fatigue and damage tollerance tests of aircraft structures, CWA 22 Corporation, 2001. 2) B. Harris - edition: "Fatigue in composites", CRC Press, Cambridge England, 2003. 3) Jaap Schijve : "Fatigue of Structures and	

Description of course

	Materials Book Description", Hardcover 2009, 2nd Edition. 4) www.ndt-ed.org 5) http://itlims.meil.pw.edu.pl/zsis/pomoce/MAT_LOT/ANS652_MR1.pdf.
Website of the course	http://itlims.meil.pw.edu.pl/zsis/pomoce/MAT_LOT/ANS652_MR1.pdfw

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 30 hours; b) attendance at the labs – 15 hours; c) consultancy meetings – 5 hours. 2) The number of hours of independent work of student - 50, including: a) performing homeworks - 15 hours; b) preparing presentations - 10 hours; c) preparing for the tests - 10 hours; d) reading recommended literature by the teacher - 15 hours. TOTAL : 100 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 50 hours, including: a) attendance at the lectures - 30 hours; b) attendance at the labs – 15 hours; c) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits - 45 hours, including: a) attendance at the labs – 15 hours; b) consultancy meetings – 5 hours; c) performing homeworks - 15 hours; d) preparing presentations - 10 hours.

E. Additional information

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Table 14. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANS652_W1**
Description:	Has a knowledge regarding the sources of variable loads acting on the aircraft, he is familiar with the ways of measurement and recording the loads, and he knows the regulations in this matter.
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W1**
Description:	Has a knowledge regarding the sources of variable loads acting on the aircraft, he is familiar with the ways of measurement and recording the loads, and he knows the regulations in this matter.
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W2**
Description:	Knows how to derive the load spectrum and haw to extrapolate it.

Table 14. Learning outcomes	
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W3**
Description:	Knows the fatigue characteristics of the materials which are applied in aeronautical structures, and he realize himself the role of the stress concentration.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W3**
Description:	Knows the fatigue characteristics of the materials which are applied in aeronautical structures, and he realize himself the role of the stress concentration.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W3**
Description:	Knows the fatigue characteristics of the materials which are applied in aeronautical structures, and he realize himself the role of the stress concentration.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W3**
Description:	Knows the fatigue characteristics of the materials which are applied in aeronautical structures, and he realize himself the role of the stress concentration.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W4**
Description:	Is familiar with the theories of fatigue failures commutation.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W4**
Description:	Is familiar with the theories of fatigue failures commutation.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W4**
Description:	Is familiar with the theories of fatigue failures commutation.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W5**

Table 14. Learning outcomes	
Description:	Has the knowledge regarding methods of non-destructive testing and diagnostics of aeronautical structures.
Verification:	Test no. 3 and evaluation of the report.
Field of study related learning outcomes	Aero2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_W5**
Description:	Has the knowledge regarding methods of non-destructive testing and diagnostics of aeronautical structures.
Verification:	Test no. 3 and evaluation of the report.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS652_U1**
Description:	Is able to estimate the range of operational loads of the aircraft by calculations or in experimental way.
Verification:	Test no.1.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U1**
Description:	Is able to estimate the range of operational loads of the aircraft by calculations or in experimental way.
Verification:	Test no.1.
Field of study related learning outcomes	Aero2_U17
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U1**
Description:	Is able to estimate the range of operational loads of the aircraft by calculations or in experimental way.
Verification:	Test no.1.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U2**
Description:	Is able to determine the transfer arrays and half-cycles arrays on the basis of recorded load signal.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U2**
Description:	Is able to determine the transfer arrays and half-cycles arrays on the basis of recorded load signal.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U2**
Description:	Is able to determine the transfer arrays and half-cycles arrays on the basis of recorded load signal.
Verification:	Test no. 2.

Table 14. Learning outcomes	
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U2**
Description:	Is able to determine the transfer arrays and half-cycles arrays on the basis of recorded load signal.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_U06
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U3**
Description:	Is able to derive the incremental type of load spectrum and to use it for the block type of load spectrum design.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U3**
Description:	Is able to derive the incremental type of load spectrum and to use it for the block type of load spectrum design.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U06
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U4**
Description:	Can digitize the fatigue properties of the materials and structures, which are given in the form of S-N curves or the High diagrams.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U4**
Description:	Can digitize the fatigue properties of the materials and structures, which are given in the form of S-N curves or the High diagrams.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U5**
Description:	Is able to use the theory of linear accumulation of fatigue failures for estimation of fatigue life.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U5**
Description:	Is able to use the theory of linear accumulation of fatigue failures for estimation of fatigue life.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U5**
Description:	Is able to use the theory of linear accumulation of fatigue failures for estimation of fatigue life.
Verification:	Homework.
Field of study related learning outcomes	Aero2_U06

Table 14. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U6**
Description:	Is able to operate the ultrasonic flaw detector, endoscope, and to make defectoscopy by flaw penetration method.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U6**
Description:	Is able to operate the ultrasonic flaw detector, endoscope, and to make defectoscopy by flaw penetration method.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U6**
Description:	Is able to operate the ultrasonic flaw detector, endoscope, and to make defectoscopy by flaw penetration method.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_U6**
Description:	Is able to operate the ultrasonic flaw detector, endoscope, and to make defectoscopy by flaw penetration method.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANS652_K1**
Description:	Can cooperate with other peoples in the group, and can present the results of his work.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_K02
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_K1**
Description:	Can cooperate with other peoples in the group, and can present the results of his work.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_K01
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_K1**
Description:	Can cooperate with other peoples in the group, and can present the results of his work.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_K06

Table 14. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_K1**
Description:	Can cooperate with other peoples in the group, and can present the results of his work.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_K05
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_K1**
Description:	Can cooperate with other peoples in the group, and can present the results of his work.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_K04
Area of study related learning outcomes	
Code of effect:	**ML.ANS652_K1**
Description:	Can cooperate with other peoples in the group, and can present the results of his work.
Verification:	Evaluation of work of the student during laboratory exercises.
Field of study related learning outcomes	Aero2_K03
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK491	
Name of course	Intermediate Master Project	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Paweł Pyrzanowski, prof. PW.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	The aim of the course is to get the student's ability to perform advanced design, especially through the work of their own, with a little help of the teacher. In particular, the solution of the problem, selection of literature, research methods, presentation and critical analysis of the results. The exact specification depends on the subject of work.	
Effects of education	See Table 15.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	90h
	Computer lessons	0h
Contents of education	Detailed course content depends on the subject and character of the work (design and construction, computational, experimental).	
Methods of evaluation	The evaluation shall assess the appropriate separation of tasks, analysis of the literature, the solution of the problem and its written presentation.	
Methods of verification of effects of education	See Table 15.	
Exam	no	
Literature	Books and academic textbooks, journals, Internet.	
Website of the course		
D. Student’s activity		
Number of ECTS credits	6	
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher – 89, including: a) consultancy meetings - 85 hours; b) final completion of the course – 4 hours. 2) The number of hours of independent	

Description of course

	work of student - 90.
Number of ECTS credits on the course with direct participation of academic teacher	3 ECTS credits – number of hours that require the presence of a teacher – 89, including: a) consultancy meetings - 85 hours; b) final completion of the course – 4 hours.
Number of ECTS credits on practical activities on the course	4,5 ECTS credits.

E. Additional information

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Table 15. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK491_W1**
Description:	Has knowledge on development trends and most important new achievements in aerospace engineering.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_W1**
Description:	Has knowledge on development trends and most important new achievements in aerospace engineering.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ML.ANK491_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in aerospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U16
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in aerospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U15
Area of study related learning outcomes	

Table 15. Learning outcomes	
Code of effect:	**ML.ANK491_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in aerospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_U3**
Description:	The student can solve simple task of aviation and aerospace with the help of tutor.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_U3**
Description:	The student can solve simple task of aviation and aerospace with the help of tutor.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_U4**
Description:	Student can critically assess the results of the solved problem.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_U5**
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_U5**
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	The final report evaluated by the teacher.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANK491_K1**
Description:	The student is able to think in a creative way independently proposing a way to solve the task.
Verification:	The current assessment of the progress of work.
Field of study related learning outcomes	Aero2_K06
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_K1**
Description:	The student is able to think in a creative way independently proposing a way to solve the task.
Verification:	The current assessment of the progress of work.
Field of study related learning outcomes	Aero2_K04

Table 15. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANK491_K1**
Description:	The student is able to think in a creative way independently proposing a way to solve the task.
Verification:	The current assessment of the progress of work.
Field of study related learning outcomes	Aero2_K01
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK480	
Name of course	Physics 2	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Physics.	
Coordinator of course	Dr inż. Piotr Lesiak	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	Consolidation and extension of the knowledge of basic concepts and methodology of the modern physics; learning of elements of Special Theory of Relativity, wave and corpuscular properties of light and application of photonics in technology and telecommunication.	
Effects of education	See Table 16.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Basic concepts of classical mechanics: space properties, relation between conservation principles and space symmetries, force fields, work and energy. Elements of STR: contraction of length and time, the Lorentz transformation, time space of STR, relativistic dynamics, relativistic energy, the Einstein's formula and its consequences, Doppler effect. Classical electrodynamics and optoelectronics: definition of electromagnetic field, Maxwell equations, electromagnetic waves and their spectrum, optical vision, light interference and interferometers, wave diffraction, holography, light propagation in material media, refraction and reflection of light at media interfaces, internal refraction, birefringence, optical nonlinearity, wave guides and light guides (properties, manufacturing and applications).	
Methods of evaluation	Two tests (covering the lecture material) during	

Description of course	
	the semester.
Methods of verification of effects of education	See Table 16.
Exam	no
Literature	Recommended reading for extended knowledge might be selected chapters from: 1. Woodhouse N.M.J.: Special Relativity. Springer 2003. 2. Hayt W.H., Buck J.A.: Engineering Electromagnetics. 8th ed., McGraw-Hill, 2012. 3. Griffiths D.J.: Introduction to Electrodynamics, 4th Ed. Addison-Wesley, 2012. 4. Zangwill A.: Modern electrodynamics. Cambridge UP, 2012.
Website of the course	
D. Student's activity	
Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 33 hours, including: a) attendance at the lectures -30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student – 42 hours, including: a) preparation to lectures (based of the recommended reading) – 18 hours; b) preparation to the tests: 2*12=24 hours. Total workload: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.3 ECTS credits – number of hours that require the presence of a teacher – 33, including: a) attendance at the lectures – 30 hours; b) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
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Table 16. Learning outcomes	
General academic profile - knowledge	
Code of effect:	**ML.ANK480_W01**
Description:	Student has a basic, systematic knowledge on electromagnetic and optical phenomena, sufficient to understand principles of operation of typical measuring and diagnostic devices.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK480_W02**
Description:	Student has a basic knowledge on space-time structure, symmetry concepts and their relation to conservation principles formulated for fundamental physical quantities and fields.
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
General academic profile - skils	

Table 16. Learning outcomes	
Code of effect:	**ML.ANK480_U01**
Description:	Student can use the physical principles to solve simple problems in the relativistic mechanics and wave optics.
Verification:	Tests no. 1 and 2.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK480_U02**
Description:	Student van explain principles of operation of typical devices which are using wave optical phenomena and understands implied capabilities.
Verification:	Tests no. 2.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK480_U02**
Description:	Student van explain principles of operation of typical devices which are using wave optical phenomena and understands implied capabilities.
Verification:	Tests no. 2.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANK480_K01**
Description:	Student is aware of the necessity for continuous skill/knowledge development by a self-study, needed in order to follow recent progress in science-based technologies.
Verification:	Interaction with student during lectures and consultancy meetings.
Field of study related learning outcomes	Aero2_K01
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS511	
Name of course	Sensors and Measurement Systems	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr inż. Przemysław Bibik	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	winter semester	
Preliminary requirements	Recommended Aeronautical Systems I and II.	
Limit of students	12 students in one group.	
C. Effects of education and manner of teaching		
Purpose of course	The course aims to familiarize students with the design of measurement systems, methods of measurement of physical quantities and methods of results analysis.	
Effects of education	See Table 17.	
Form of didactic studies and number of hours per semester	Lecture	15h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The lecture covers the basic issues related to the design and operation of measurement systems and analysis of measurement results. It covers the design, operation and characteristics of typical sensors, the structure of the measuring systems, sensors, calibration methods, and methods of measurement systems protection against interference. Presented are the interfaces and buses used in common measuring systems, D/A and A/D converters and the principles of sampling and quantization of signals. It also covers the basic methods of statistical analysis of measurement results like the determination of mean, median, standard deviation and quantiles, histograms and box plots. In the laboratory, students are acquainted with the principle of operation, characteristics and errors of sensors and measuring systems of fundamental physical quantities.	
Methods of evaluation	Passing the course requires the completion of the lecture and laboratory. Completion of the lecture	

Description of course

	is based on the evaluation of two tests, the laboratory part completion is based on the average of the reports marks. Final mark is the average of the test and laboratory.
Methods of verification of effects of education	See Table 17.
Exam	no
Literature	1. Nawrocki, W.: „ Measurement Systems and Sensors”, 2005 ARTECH HOUSE, INC., e-book ebrary. 2. Fraden, J.: „ Handbook of Modern Sensors - Physics, Designs and Applications (3rd Edition)”, e-book Knovel . 3. Osiander, R.: „MEMS and microstructures in aerospace applications ”, 2006. 4. Pallet E.H.J.: „Aircraft Instrument Systems”, IAP, 1993. 5. Titterton, D.: „Strapdown Inertial Navigation Technology”, 1997. Additional: 1. Materials provided by the course leader.
Website of the course	-

D. Student’s activity

Number of ECTS credits	3
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher - 32, including: a) attendance at the labs - 15 hours; b) attendance at the lectures - 15 hours; c) consultancy meetings - 2 hours. 2) The number of hours of independent work of student - 45, including: • preparation for tests - 10 hours; • preparation for laboratories and making of reports – 25 hours; • reading recommended literature by the teacher - 10 hours. TOTAL: 77 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.3 ECTS credits - 32 hours, including: a) attendance at the labs - 15 hours; b) attendance at the lectures - 15 hours; c) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits - 42 hours, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours. c) preparation for laboratories and making of reports – 25 hours.

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Table 17. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANS511_W1**
Description:	Student has general knowledge on measurement systems structures.
Verification:	Test no. 1
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	

Code of effect:	**ML.ANS511_W1**
Description:	Student has general knowledge on measurement systems structures.
Verification:	Test no. 1

Table 17. Learning outcomes	
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_W1**
Description:	Student has general knowledge on measurement systems structures.
Verification:	Test no. 1
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_W1**
Description:	Student has general knowledge on measurement systems structures.
Verification:	Test no. 1
Field of study related learning outcomes	Aero2_W06
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_W2**
Description:	Student has a systematic knowledge about the types and properties of sensors.
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_W2**
Description:	Student has a systematic knowledge about the types and properties of sensors.
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_W2**
Description:	Student has a systematic knowledge about the types and properties of sensors.
Verification:	Test no. 1.
Field of study related learning outcomes	Aero2_W06
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_W3**
Description:	Student has a basic knowledge of statistical analysis of measurement results.
Verification:	Test no. 2.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS511_U1**
Description:	Student is able to select sensors and the structure of the measurement system appropriate for a given process.
Verification:	Evaluation of reports, test no. 1.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U1**
Description:	Student is able to select sensors and the structure of the measurement system appropriate for a given process.
Verification:	Evaluation of reports, test no. 1.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U1**

Table 17. Learning outcomes	
Description:	Student is able to select sensors and the structure of the measurement system appropriate for a given process.
Verification:	Evaluation of reports, test no. 1.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U1**
Description:	Student is able to select sensors and the structure of the measurement system appropriate for a given process.
Verification:	Evaluation of reports, test no. 1.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U2**
Description:	Student can determine the basic properties of the sensor based on its specifications.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U2**
Description:	Student can determine the basic properties of the sensor based on its specifications.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U2**
Description:	Student can determine the basic properties of the sensor based on its specifications.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U06
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U3**
Description:	Student can perform the process of calibrating a sensor.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U4**
Description:	Student can determine basic estimators and plot a histogram and box plot based on measurement data.
Verification:	Evaluation of reports, test no. 2.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U4**
Description:	Student can determine basic estimators and plot a histogram and box plot based on measurement data.
Verification:	Evaluation of reports, test no. 2.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U5**
Description:	Student is able to work in a group and present the results of own work.

Table 17. Learning outcomes	
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U5**
Description:	Student is able to work in a group and present the results of own work.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U5**
Description:	Student is able to work in a group and present the results of own work.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U5**
Description:	Student is able to work in a group and present the results of own work.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U5**
Description:	Student is able to work in a group and present the results of own work.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANS511_U5**
Description:	Student is able to work in a group and present the results of own work.
Verification:	Evaluation of reports.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK 495	
Name of course	Signals and Identification Methods	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	prof. Janusz Narkiewicz	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	winter semester	
Preliminary requirements	None, but it is recommended to have the base knowledge in modelling of systems and signal theory.	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	Present the background of methods for building reliable models of various systems and components and identification of their parameters.	
Effects of education	See Table 18.	
Form of didactic studies and number of hours per semester	Lecture	15h
	Exercise type of course	15h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Lecture: Basic definitions signal, model, identification, estimation, deterministic and stochastic signals. Transformation from time to frequency domain Analog / Digital conversion. Filters: analog and digital, filter optimization.. Signal coding. Modelling of static and dynamic processes. Estimation theory. The least squares method for estimation. Experiment planning. Data processing errors and their estimation. Tutorials: Examples of topic presented during lectures.	
Methods of evaluation	Three tests during semester.	
Methods of verification of effects of education	See Table 18.	
Exam	no	
Literature	Literature is given for each lecture using books from university and faculty library.	
Website of the course	http//zaiol.meil.pw.edu.pl	
D. Student's activity		
Number of ECTS credits	3	
Number of hours of student's work to achieve	1) Number of hours that require the presence of a	

Description of course

effects of education	teacher - 32 , including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: 45, including: • systematic preparation for classes - 15 hours; • work on homework (solving tasks) - 15 hours; • preparation for class tests – 15 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.3 ECTS credits - 32 hours, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credit.

E. Additional information

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Table 18. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK495_W1**
Description:	A student knows basic methods of mechanical systems identification: assumptions and limitations. She / he is able to select the proper method to various systems.
Verification:	Test.
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	
Code of effect:	**ML.ANK495_W2**
Description:	She / he knows the selected filtering methods for deterministic signals. She / he knows the least squares approach.
Verification:	Test.
Field of study related learning outcomes	Aero2_W09
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ML.ANK495_U1**
Description:	She / he knows how to perform signal harmonic analysis and interpret the results.
Verification:	Test.
Field of study related learning outcomes	Aero2_U17
Area of study related learning outcomes	
Code of effect:	**ML.ANK495_U1**
Description:	She / he knows how to perform signal harmonic analysis and interpret the results.
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK495_U2**
Description:	She /he knows the background of Kalman filtering methods and can apply this method for filtering signals with stochastic disturbances.

Table 18. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANK495_U2**
Description:	She /he knows the background of Kalman filtering methods and can apply this method for filtering signals with stochastic disturbances.
Verification:	Test.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS650	
Name of course	Structural Analysis of Aeroengines	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	prof. dr hab. inż. Marek Żochowski	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	2 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Solid Mechanics, Mechanics of Structures, Strength of Structures.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	Course results: Ability of strength calculations of aircraft engines elements within elastic range.	
Effects of education	See Table 19.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Turbine engines and piston engines. Main strength elements of turbine engines: blades, discs, circular plates cylindrical shells, spherical and conical shells. Main loadings: inertia forces due to centrifugal acceleration, gas pressure, changes of temperature (thermal forces). Discs: of constant thickness stepped thickness, continuous thickness change , not heated, weakly heated, strongly heated. Displacements strains, stresses in discs (the plane problem of the strength construction), determined by analytical methods. For the discs of continuous thickness change, strongly heated (the change of elastic constants of the material), discs of radial compressors, and discs working over plastic limit of the material numerical methods (FEM) are applied. Circular plates axisymmetrically loaded – analytical solutions. Cylindrical and spherical shells: determination of internal forces strains and displacements by analytical methods. The analysis of complex constructions (consisting of discs, plates and shells) loaded by external forces and changes of	

Description of course

	temperature.
Methods of evaluation	Homeworks, final exam.
Methods of verification of effects of education	See Table 19.
Exam	yes
Literature	Literature is given for each lecture using books from university and faculty library.
Website of the course	

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 35, including: a) attendance at the lectures - 30 hours; b) exam - 5 hours. 2) The number of hours of independent work of student - 65, including: • systematic preparation for classes, reading recommended literature by the teacher - 30 hours; • work on homework (solving tasks) – 20 hours; • preparation for the final examination – 15 hours. TOTAL = 100 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.4 ECTS credits - 35 hours, including: a) attendance at the lectures - 30 hours; b) exam - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 19. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANS650_W1**
Description:	Knows the structure and the way how to model basic structural elements of the turbo aeroengine.
Verification:	Assessment of homeworks, test.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W1**
Description:	Knows the structure and the way how to model basic structural elements of the turbo aeroengine.
Verification:	Assessment of homeworks, test.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W2**
Description:	Knows the basics loads of elements of aeroengines (mass loads, pressure loads thermal loads).
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W2**
Description:	Knows the basics loads of elements of

Table 19. Learning outcomes	
	aeroengines (mass loads, pressure loads thermal loads).
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W3**
Description:	Knows the analytical and approximate methods (FE) of calculation of displacements, strains and stresses in rotating discs.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W3**
Description:	Knows the analytical and approximate methods (FE) of calculation of displacements, strains and stresses in rotating discs.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W4**
Description:	Knows the analytical methods of calculation of internal forces, strains and displacements in circular plates, cylindrical and spherical shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W4**
Description:	Knows the analytical methods of calculation of internal forces, strains and displacements in circular plates, cylindrical and spherical shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W5**
Description:	Knows how to model and to analyze complex axisymmetric structures.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W14
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_W5**
Description:	Knows how to model and to analyze complex axisymmetric structures.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_W10
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models

Table 19. Learning outcomes	
	to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS65_U1**
Description:	Knows how to apply simple mathematical models to analyze components of turbo aeroengines.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U2**
Description:	Knows how to calculate, using analytical methods, displacements, strains and stresses in discs under different loads.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U2**
Description:	Knows how to calculate, using analytical methods, displacements, strains and stresses in discs under different loads.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U2**
Description:	Knows how to calculate, using analytical methods, displacements, strains and stresses in discs under different loads.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U18

Table 19. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U2**
Description:	Knows how to calculate, using analytical methods, displacements, strains and stresses in discs under different loads.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U2**
Description:	Knows how to calculate, using analytical methods, displacements, strains and stresses in discs under different loads.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U2**
Description:	Knows how to calculate, using analytical methods, displacements, strains and stresses in discs under different loads.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.

Table 19. Learning outcomes	
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U3**
Description:	Knows how to perform stress analysis of circular plates and cylindrical and spherical shells using analytical methods.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U4**

Table 19. Learning outcomes	
Description:	Knows how to model and analyze complex structures composed of disks, plates and shells.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS650_U5**

Table 19. Learning outcomes	
Description:	Knows how to apply approximate methods (FE) to analyze of e.g. disks of variable thickness, subject to strong thermal loads and working beyond elastic range.
Verification:	Assessment of homeworks, exam.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	

Description of course

Code of course	ANFKT_AE1	
Name of course	Elective course(s) AE1	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Academic teachers of the Faculty of Power and Aeronautical Engineering. Detailed data contains syllabus of specific course.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Elective	
Language of course	polski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Detailed data contains syllabus of specific course.	
Limit of students	Detailed data contains syllabus of specific course.	
C. Effects of education and manner of teaching		
Purpose of course	Detailed data contains syllabus of specific course.	
Effects of education	See Table 20.	
Form of didactic studies and number of hours per semester	Lecture	75h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Detailed data contains syllabus of specific course.	
Methods of evaluation	Detailed data contains syllabus of specific course.	
Methods of verification of effects of education	See Table 20.	
Exam	no	
Literature	Detailed data contains syllabus of specific course.	
Website of the course	Detailed data contains syllabus of specific course.	
D. Student’s activity		
Number of ECTS credits	5	
Number of hours of student’s work to achieve effects of education	Number of hours that require the presence of a teacher ~90 (lectures / classes / labs / projects). The number of hours of independent work of student ~60.	
Number of ECTS credits on the course with direct participation of academic teacher	3 ECTS credits - number of hours that require the presence of a teacher ~90 (lectures / classes / labs / projects).	
Number of ECTS credits on practical activities on the course	Detailed data contains syllabus of specific course.	
E. Additional information		
Notes	Specific learning outcomes are defined for the chosen course.	
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Table 20. Learning outcomes

Description of course

Code of course	ML.ANW138	
Name of course	Master Diploma Seminar	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Paweł Pyrzanowski, prof. PW., teacher authorized by the Faculty Council.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	The aim of the course is to familiarize with the methods of collecting information on a given topic and its presentation in a public forum.	
Effects of education	See Table 21.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	30h
	Computer lessons	0h
Contents of education	1. Collection of materials on a given topic taking into account all available sources, including books, academic textbooks, journals and the Internet. The collected material should be included in the form of a written brief containing references to the sources of information used and their analysis. This part should be formed in cooperation with the leading job and be controlled during individual meetings. 2. Defense work. It is recommended that the defense takes place in a larger group of students. Each person during 10-15 minutes shows the result of the work in the form of a presentation, then answer questions about the work asked by all present.	
Methods of evaluation	The evaluation shall assess the quality of collected information and the manner of its presentation. It is recommended that the presentation took place in a wide circle of students, who together with the teacher will evaluate the work.	
Methods of verification of effects of education	See Table 21.	

Description of course

Exam	no
Literature	Books and academic textbooks, journals, Internet.
Website of the course	

D. Student's activity

Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 30, including: a) consultancy meetings - 28 hours; b) final completion – 2 hours. 2) The number of hours of independent work of student – 30. Total : 60 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit - number of hours that require the presence of a teacher - 30, including: a) consultancy meetings - 28 hours; b) final completion – 2 hours.
Number of ECTS credits on practical activities on the course	1.2 ECTS credits.

E. Additional information

Notes	
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Table 21. Learning outcomes

General academic profile - skils

Code of effect:	**ML.ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in areospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	Aero2_U16
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in areospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	Aero2_U15
Area of study related learning outcomes	

Table 21. Learning outcomes	
Code of effect:	**ML.ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in areospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	Aero2_U05
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in areospace engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_U2**
Description:	The student is able to present in writing the results of their work in the form of a short report.
Verification:	Prepared and evaluated report.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_U3**
Description:	The student is able in a short and clear way to present the results of their work in the form of oral expression during a meeting of several people.
Verification:	Oral presentation of the work.
Field of study related learning outcomes	Aero2_U04
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANW138_K1**
Description:	Understands the need for life-long learning; can inspire and organise the learning process of other people.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	Aero2_K01
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_K2**

Table 21. Learning outcomes	
Description:	The student understands the need of discussion, both in the aim of presenting own results, as well as the joint work on the issue.
Verification:	Oral presentation of the work.
Field of study related learning outcomes	Aero2_K07
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_K2**
Description:	The student understands the need of discussion, both in the aim of presenting own results, as well as the joint work on the issue.
Verification:	Oral presentation of the work.
Field of study related learning outcomes	Aero2_K04
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_K2**
Description:	The student understands the need of discussion, both in the aim of presenting own results, as well as the joint work on the issue.
Verification:	Oral presentation of the work.
Field of study related learning outcomes	Aero2_K03
Area of study related learning outcomes	
Code of effect:	**ML.ANW138_K3**
Description:	He/She is aware of non-technical aspects of engineering activity.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	Aero2_K02
Area of study related learning outcomes	

Description of course

Code of course	ML.ANW137	
Name of course	Master Diploma Thesis	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Paweł Pyrzanowski, prof. PW., teacher authorized by the Faculty Council.	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	The aim of the course is to get the student's ability to perform advanced design, especially through the work of their own. In particular, the solution of the problem, selection of literature, research methods, presentation and critical analysis of the results. The exact specification depends on the subject of work.	
Effects of education	See Table 22.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	225h
	Computer lessons	0h
Contents of education	Detailed course content depends on the subject and character of the work (design and construction, computational, experimental).	
Methods of evaluation	Teacher (promoter of the Thesis) and the reviewer assumed execution of tasks In case of a positive evaluation followed the final assessment is issued by the exam committee during the final exam.	
Methods of verification of effects of education	See Table 22.	
Exam	yes	
Literature	Books and academic textbooks, journals, Internet.	
Website of the course		
D. Student’s activity		
Number of ECTS credits	20	
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher – 226, including: a) consultancy meetings - 225 hours; b) final exam – 1 hours. 2) The number of hours of independent work of student –	

Description of course

	300.
Number of ECTS credits on the course with direct participation of academic teacher	9 ECTS credits – number of hours that require the presence of a teacher – 226, including: a) consultancy meetings - 225 hours; b) final exam – 1 hours.
Number of ECTS credits on practical activities on the course	12 ECTS credits.

E. Additional information

Notes	
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Table 22. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANW137_W1**
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_W1**
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_W01
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ML.ANW137_U1**
Description:	Student can identify the solved problem in a wide range of science, based on the literature.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U01
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U2**
Description:	Student can use the literature to search for tips to solve the research problem.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U16
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U3**
Description:	He/She can solve simple task scientific.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U12
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U3**
Description:	He/She can solve simple task scientific.
Verification:	Assessment of master thesis and the diploma examination.

Table 22. Learning outcomes	
Field of study related learning outcomes	Aero2_U11
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U3**
Description:	He/She can solve simple task scientific.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U4**
Description:	Student can critically assess the results of the solved problem.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U16
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U4**
Description:	Student can critically assess the results of the solved problem.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U15
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U5**
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U07
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U5**
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U03
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_U6**
Description:	Student is able to identify and formulate specification of complex engineering tasks specific to aerospace, including unusual tasks, including taking into consideration their non-technical aspects.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_U17
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANW137_K1**
Description:	Development of self-learning needs in order to achieve the desired effect.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_K01
Area of study related learning outcomes	

Table 22. Learning outcomes	
Code of effect:	**ML.ANW137_K2**
Description:	Student is aware of the importance of non-technical aspects and effects of engineering activities, including its impact on the environment, and the associated responsibility for decisions.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_K02
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_K3**
Description:	Student is able appropriately to determine priorities serving the realization determined by oneself or other tasks.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_K04
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_K4**
Description:	Student correctly identifies and resolves dilemmas associated with his profession.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_K05
Area of study related learning outcomes	
Code of effect:	**ML.ANW137_K5**
Description:	Student understands the need to inform the society - also through the mass media - about the achievements of technology and other aspects of engineer activity. Student can transfer such information in a commonly understood manner.
Verification:	Assessment of master thesis and the diploma examination.
Field of study related learning outcomes	Aero2_K07
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK306	
Name of course	Optmization in Aircraft Design	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering.	
Coordinator of course	dr hab. inż. Tomasz Goetzendorf-Grabowski	
B. General characteristic of the course		
Block of courses	Aerospace Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Aircraft Design 1 .	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	After subject is completed student should: • have the basic knowledge of mathematical methods of optimization, • be able to solve simple optimization problems in aircraft design.	
Effects of education	See Table 23.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	15h
	Computer lessons	0h
Contents of education	Convergent and divergent spiral in design process. Sizing in aircraft design. The most important elements taken under consideration during optimization (geometry, aerodynamics, propulsion system, mission and performance, structure, stability and FCS, etc.). Optimal wing load and thrust load. Optimization in design of specific type of aircraft (combat, firefighting, GA, etc.) Selection of objective function. Mathematical and numerical methods in optimization.	
Methods of evaluation	Projects and test .	
Methods of verification of effects of education	See Table 23.	
Exam	no	
Literature	1. D.P. Raymer, Aircraft Design: A Conceptual Approach, AIAA Eductaion Series. 2. G.N. Vanderplaats: Numerical Optimization Techniques For Engineering Design, McGraw Hill. 3. Ross Baldick: Applied Optimization, Cambridge University Press, 2006. 4. J. Nocedal, S.J. Wright, Numerical Optimization, Springer 1999.	
Website of the course	http://www.meil.pw.edu.pl/add/ADD/Teaching/Subj	

Description of course

	ects/Optimization-In-Aircraft-Design

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 45, including: a) attendance at the lecture – 30 hours; b) attendance at the design tutorials – 15 hours. 2) The number of hours of independent work of student - 45, including: a) homework to prepare the projects - 30 hours; b) homework to prepare to test - 15 hours. Total - 90 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - 45 hours, including: a) attendance at the lecture – 30 hours; b) attendance at the design tutorials – 15 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credit - project.

E. Additional information

Notes	
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Table 23. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK306_W1**
Description:	Student knows the mathematical basics of optimization methods.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W03
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_W2**
Description:	Student knows the application of optimization methods in issues related to the design of aircraft.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_W2**
Description:	Student knows the application of optimization methods in issues related to the design of aircraft.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_W2**
Description:	Student knows the application of optimization methods in issues related to the design of aircraft.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_W3**
Description:	Student knows the rules of creating a new project, its stages and basic problems.

Table 23. Learning outcomes	
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_W3**
Description:	Student knows the rules of creating a new project, its stages and basic problems.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W15
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_W3**
Description:	Student knows the rules of creating a new project, its stages and basic problems.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_W13
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK306_U1**
Description:	Student is able to formulate a simple optimization problem.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_U10
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_U1**
Description:	Student is able to formulate a simple optimization problem.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_U2**
Description:	Student is able to solve simple optimization problem related to aircraft design.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_U19
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_U2**
Description:	Student is able to solve simple optimization problem related to aircraft design.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_U18
Area of study related learning outcomes	
Code of effect:	**ML.ANK306_U2**
Description:	Student is able to solve simple optimization problem related to aircraft design.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_U16
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANK306_K1**
Description:	Student can formulate priorities on design issues.
Verification:	Test, projects.
Field of study related learning outcomes	Aero2_K04
Area of study related learning outcomes	