

Programme		
Power Engineering		
Degree	Type	Academic year
Bsc	full-time	2019/2020
Purposes		
<p>The objectives of the study is to create the solid fundamental engineering knowledge during the first year of the study, then learn deeply the problems devoted to the subject of the study. The graduates are prepared to work in industry and to solve engineering problems. At first the aforementioned abilities should be proved in the diploma thesis where a given problem must be solved and the work must be documented and explained. Each diploma thesis is reviewed by 2 reviewers and is defended in the presence of commission consisting of professors and assistant professors.</p>		
Effects of education		
Code of effect:	E1_W01	
Description:	has basic knowledge on applied mathematics, such as elements of linear algebra, analytical geometry, mathematical analysis, theory of differential equations and probability, including analytical and numerical methods.	
Area of study related learning outcomes		
Code of effect:	E1_W02	
Description:	has knowledge on the structure of the matter and description of its mechanical, electromagnetic and optical properties; is familiar with the basics of modern physics, which helps understand basic physical phenomena occurring in heat machines, and the operations of typical measurement and diagnostic tools; is familiar with general rules of measurements of physical quantities and methods of analysis of their reliability and measurement errors	
Area of study related learning outcomes		
Code of effect:	E1_W03	
Description:	knows the basics of computer programming, has elementary knowledge on the rules of doing calculations on computers and limitations of floating-point arithmetic; knows the formulations and properties of basic calculation algorithms in algebra, mathematical analysis and differential equations; has basic knowledge on the methodology of doing and validating computer calculations	
Area of study related learning outcomes		
Code of effect:	E1_W04	
Description:	has structured and theoretically founded knowledge in the area of general mechanics of material point and rigid body systems; has structured and theoretically founded knowledge in the area of mechanics of the solid body, also on materials and construction strength, is familiar with methods of strength analysis of basic mechanical structures	
Area of study related learning outcomes		
Code of effect:	E1_W05	
Description:	has knowledge of the basics of physical and	

Effects of education	mathematical methods of engineering thermodynamics and so understands basic heat and flow processes and phenomena
Area of study related learning outcomes	
Code of effect:	E1_W06
Description:	knows basic laws of fluid mechanics, has theoretical knowledge in the area of basics of liquid and gas mechanics, which helps understand basic physical phenomena in internal and external flows
Area of study related learning outcomes	
Code of effect:	E1_W07
Description:	has knowledge on materials used in power engineering, methods of their manufacturing, machining and their aging, including corrosion and anti-corrosion protection, is familiar with the basics of plastic forming, casting, machining, surface and erosion machining
Area of study related learning outcomes	
Code of effect:	E1_W08
Description:	has elementary knowledge on constructing typical mechanical elements and their connections; knows determinist and probabilistic methods of their modelling; has knowledge on powertrains
Area of study related learning outcomes	
Code of effect:	E1_W09
Description:	has structured and theoretically founded knowledge of general basics of automation and control, such as types and structures of control systems, elements of control systems, basics of modelling dynamic systems, design and analysis of linear control systems
Area of study related learning outcomes	
Code of effect:	E1_W10
Description:	is familiar with the methodology of energy evaluation of processes, and also with the importance of accumulated consumption of natural resources and fossil fuels
Area of study related learning outcomes	
Code of effect:	E1_W11
Description:	is familiar with heat exchange processes in heating and cooling devices
Area of study related learning outcomes	
Code of effect:	E1_W12
Description:	is familiar with basic technologies of energy conversion and with determining process efficiency.
Area of study related learning outcomes	
Code of effect:	E1_W13
Description:	is familiar with problems connected with burning fuels and knows the basic heat cycles of engines, power plants and cooling devices
Area of study related learning outcomes	

Effects of education	
Code of effect:	E1_W14
Description:	is familiar with the rules and technologies of environmental protection connected with power processes.
Area of study related learning outcomes	
Code of effect:	E1_W15
Description:	understands problems connected with electrical energy transfer, with electrical technology and operations of electric machines and knows the methods of determining basic functional parameters of electric devices and non-electric quantities measured with electric methods.
Area of study related learning outcomes	
Code of effect:	E1_W16
Description:	knows the structure of basic conventional power engineering devices - steam boilers, gas and steam turbines, heat recuperators and regenerators, compressors and fans.
Area of study related learning outcomes	
Code of effect:	E1_W17
Description:	knows the basics of cogenerated power engineering and operation of CHP systems, as well as the rules of using waste energy.
Area of study related learning outcomes	
Code of effect:	E1_W18
Description:	knows the basics of energy conversion and operation of renewable power engineering devices - solar, wind, hydro power engineering, photovoltaic cells, hydrogen power engineering, fuel cells, geothermal energy and biomass.
Area of study related learning outcomes	
Code of effect:	E1_W19
Description:	has knowledge on control systems in power units and information systems at the level of power units, power plants and power companies.
Area of study related learning outcomes	
Code of effect:	E1_W20
Description:	knows the methods and technologies used in cooling and air-conditioning, knows the construction of basic devices.
Area of study related learning outcomes	
Code of effect:	E1_W21
Description:	understands the rules of the energy market and systems of emissions trade
Area of study related learning outcomes	
Code of effect:	E1_W22
Description:	knows and understands the rules of choice of electric machines for the needs of a power engineering installation, knows the methods of choice of basic elements of electronic systems.
Area of study related learning outcomes	
Code of effect:	E1_W23
Description:	knows future methods of energy conversion, new types of power plants and "smart grid" issues.

Effects of education	
Area of study related learning outcomes	
Code of effect:	E1_W24
Description:	knows new technologies and trends in cooling and air-conditioning.
Area of study related learning outcomes	
Code of effect:	E1_W25
Description:	knows current trends in renewable power engineering and new types of technical solutions for renewable energy sources.
Area of study related learning outcomes	
Code of effect:	E1_W26
Description:	knows new trends in industrial IT systems connected with power engineering - starting with mining data for modern IT systems through processing and analysing them.
Area of study related learning outcomes	
Code of effect:	E1_W27
Description:	understands the basics of nuclear power engineering and knows current directions of development of nuclear power engineering and basic problems connected with nuclear reactor failures.
Area of study related learning outcomes	
Code of effect:	E1_W28
Description:	has basic knowledge on life cycle of technical devices, objects and systems in power engineering, understands the rules of operation and maintenance of machines and knows the rules of choice of construction and maintenance materials for power machines and devices.
Area of study related learning outcomes	
Code of effect:	E1_W29
Description:	knows the basics of engineering graphics, which helps solve technical problems in the field of power engineering.
Area of study related learning outcomes	
Code of effect:	E1_W30
Description:	knows the rules of technical drawing and design of machine parts and devices using CAD systems.
Area of study related learning outcomes	
Code of effect:	E1_W31
Description:	has basic knowledge necessary to understand social, economic, legal and other non-technical conditions of power engineering activity.
Area of study related learning outcomes	
Code of effect:	E1_W32
Description:	has basic knowledge on management, also quality management and management of business activity.
Area of study related learning outcomes	
Code of effect:	E1_W33
Description:	knows and understands basic terms and rules connected with industrial property protection and

Effects of education	
	copyright; can use the resources of patent information.
Area of study related learning outcomes	
Code of effect:	E1_W34
Description:	knows general rules of founding and development of forms of individual entrepreneurship, using the knowledge inscientific fields and disciplines relevant to power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U01
Description:	can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U02
Description:	can communicate using various techniques in the professional environment and other environments, knows the technical terminology used in power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U03
Description:	can prepare a well-documented discussion of power engineering problems in Polish and in a foreign language regarded as basic for scientific fields and disciplines relevant to the field of study.
Area of study related learning outcomes	
Code of effect:	E1_U04
Description:	can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language
Area of study related learning outcomes	
Code of effect:	E1_U05
Description:	has the ability of learning on his/her own and developing skills using available databases, technical information and the Internet
Area of study related learning outcomes	
Code of effect:	E1_U06
Description:	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.
Area of study related learning outcomes	
Code of effect:	E1_U07
Description:	can use professional press, terminology, symbols, and abbreviations connected with power engineering.

Effects of education	
Area of study related learning outcomes	
Code of effect:	E1_U08
Description:	can use information and communication techniques appropriate to realise tasks typical for power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U09
Description:	can plan and conduct experiments, such as measurements and computer simulations, interpret the results obtained and draw conclusions, uses laws of physics and experimental physics methods when analysing the course of various physical and chemical processes.
Area of study related learning outcomes	
Code of effect:	E1_U10
Description:	can make basic physical measurements, organise and present their results, and in particular can build a simple measurement system using standard measuring devices, in accordance with a given scheme and specification, can determine the results of uncertainties of direct and indirect measurements, can evaluate the reliability of measurement results and their interpretation against his/her physical knowledge.
Area of study related learning outcomes	
Code of effect:	E1_U11
Description:	can use analytical, simulation and experimental methods to formulate and solve engineering tasks.
Area of study related learning outcomes	
Code of effect:	E1_U12
Description:	can solve tasks described with mathematical methods, using analytical and numerical methods of solving simple power engineering problems.
Area of study related learning outcomes	
Code of effect:	E1_U13
Description:	can model simple mechanical systems, by analysing their operation and using the methods of engineering graphics; can use CAD software.
Area of study related learning outcomes	
Code of effect:	E1_U14
Description:	can determine the values of accumulated indicators of energy and natural resources consumption for full technological cycles
Area of study related learning outcomes	
Code of effect:	E1_U15
Description:	can use norms and standards relevant to power engineering and procedures connected with work-related safety norms.
Area of study related learning outcomes	
Code of effect:	E1_U16

Effects of education	
Description:	can conduct comparative analyses of various technological solutions using mathematical and economic methods, can make a technical and economic analysis.
Area of study related learning outcomes	
Code of effect:	E1_U17
Description:	can determine the efficiency of basic power machines and devices, can conduct a technical and economic analysis of a full technological cycle.
Area of study related learning outcomes	
Code of effect:	E1_U18
Description:	can estimate and calculate technical indicators - of existing technical solutions in power engineering, in particular of devices, objects, systems, processes and services.
Area of study related learning outcomes	
Code of effect:	E1_U19
Description:	can calculate the quantity of emissions of harmful substances released to the environment in an industrial process.
Area of study related learning outcomes	
Code of effect:	E1_U20
Description:	can solve simple tasks in the area of electric power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U21
Description:	can calculate temperature and heat flux distributions for simple heat flow processes of a simple geometry.
Area of study related learning outcomes	
Code of effect:	E1_U22
Description:	can describe the course of physical and chemical processes using the laws of thermodynamics, heat and mass transfer and fluid mechanics.
Area of study related learning outcomes	
Code of effect:	E1_U23
Description:	can use existing mathematical models of working fluids used in power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U24
Description:	can analyse the influence of selected parameters of a process on its power efficiency and effectiveness.
Area of study related learning outcomes	
Code of effect:	E1_U25
Description:	can select typical machine parts and determine physical properties of machine elements.
Area of study related learning outcomes	
Code of effect:	E1_U26
Description:	can select control methods for simple systems used in power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U27

Effects of education	
Description:	can select power devices (turbines, boilers, compressors etc.) in the process of system design in the power industry.
Area of study related learning outcomes	
Code of effect:	E1_U28
Description:	can use technologies of renewable power engineering.
Area of study related learning outcomes	
Code of effect:	E1_U29
Description:	can prepare and present a typical project, system or process typical for power engineering in an appropriate form.
Area of study related learning outcomes	
Code of effect:	E1_K01
Description:	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:	E1_K02
Description:	is aware of the importance of engineering activity and understands its non-technical aspects and consequences, including its impact on the environment and the responsibility for ensuing decisions.
Area of study related learning outcomes	
Code of effect:	E1_K03
Description:	can cooperate and work in a team, assuming various roles.
Area of study related learning outcomes	
Code of effect:	E1_K04
Description:	can appropriately set priorities for realisation of a task set by him-/herself or others.
Area of study related learning outcomes	
Code of effect:	E1_K05
Description:	correctly identifies and solves dilemmas connected with his/her job.
Area of study related learning outcomes	
Code of effect:	E1_K06
Description:	can think and act in an entrepreneurial way.
Area of study related learning outcomes	
Code of effect:	E1_K07
Description:	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.
Area of study related learning outcomes	

Courses by semester

Semester 1

Programme of study - Power Engineering

Warsaw University of Technology ECTS Catalog

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	HES Courses	HES Elective Course 1	2	30	0	0	0
Power Engineering	HES Courses	Wittgenstein's Philosophy and Ethics	2	30	0	0	0
Power Engineering	Specialization	Algebra and Geometry	4	0	45	0	0
Power Engineering	Specialization	Calculus I	7	30	45	0	0
Power Engineering	Specialization	Computer Science I	5	30	0	30	0
Power Engineering	Specialization	Engineering Graphics	2	15	15	0	0
Power Engineering	Specialization	Engineering Physics	3	15	30	0	0
Power Engineering	Specialization	Environment Protection	2	30	0	0	0
Power Engineering	Specialization	Health and Safety Training	0	0	30	0	0
Power Engineering	Specialization	Materials I	2	30	0	0	0
Power Engineering	Specialization	Mechanics I	3	15	15	0	0

Semester 2

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	HES Courses	Economics	2	30	0	0	0
Power Engineering	HES Courses	HES Elective Course 2	2	450	0	0	0
Power Engineering	Languages	Foreign/Polish Language 1	2	0	30	0	0
Power Engineering	Physical Education and Sports	Physical Education and Sport 2	0	0	30	0	0
Power Engineering	Specialization	Calculus II	5	30	30	0	0
Power Engineering	Specialization	Computer Science II	2	15	0	15	0
Power Engineering	Specialization	Electric Circuits I	3	30	15	0	0
Power Engineering	Specialization	Engineering Graphics - CAD1	2	0	30	0	0
Power Engineering	Specialization	Mechanics II	5	30	30	0	0
Power Engineering	Specialization	Mechanics of Structures I	4	30	15	0	0
Power Engineering	Specialization	Thermodynamics I	5	30	30	0	0

Semester 3

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	Languages	Foreign Language 2	2	0	30	0	0
Power Engineering	Languages	Foreign/Polish Language 2	2	0	30	0	0
Power Engineering	Physical Education and Sports	Physical Education and Sport 3	0	0	30	0	0
Power Engineering	Specialization	Basics of Automation and Control 1	4	30	15	0	0
Power Engineering	Specialization	Electric circuits 2	2	0	0	30	0
Power Engineering	Specialization	Fluid Mechanics I	4	30	15	0	0
Power Engineering	Specialization	Heat Transfer 1	3	15	15	0	0
Power Engineering	Specialization	Machine Design I	3	15	15	0	0
Power Engineering	Specialization	Theory of Heat Machines	3	30	15	0	0
Power Engineering	Specialization	Thermodynamics 2	3	0	0	30	0
Power Engineering	Specialization	Thermodynamics 3	3	15	15	0	0

Semester 4

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	Languages	Foreign Language 3	2	0	30	0	0
Power Engineering	Physical Education and Sports	Physical Education and Sport 4	0	0	30	0	0
Power Engineering	Specialization	Combustion and Fuels	3	15	15	0	0
Power Engineering	Specialization	Electric Machines 1	3	15	15	0	0
Power Engineering	Specialization	Electric Power Systems	5	30	15	0	0
Power Engineering	Specialization	Electronics 1	2	15	15	0	0
Power Engineering	Specialization	Electronics 2	1	0	0	15	0
Power Engineering	Specialization	Fluid Mechanics 2	1	0	0	15	0
Power Engineering	Specialization	Fluid Mechanics 3	2	15	15	0	0
Power Engineering	Specialization	Fundamentals of Management	2	30	0	0	0
Power Engineering	Specialization	Heat Transfer 2	1	0	0	15	0
Power Engineering	Specialization	Machine Design II	3	15	15	0	0
Power Engineering	Specialization	Measurements and techniques of experiment	2	15	15	0	0
Power Engineering	Specialization	Theory of Flow Machines	3	30	15	0	0

Semester 5

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	Languages	Foreign Language 4	2	0	30	0	0
Power Engineering	Physical Education	Physical Education and Sport 5	0	0	30	0	0

Programme of study - Power Engineering

Warsaw University of Technology ECTS Catalog

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
	and Sports						
Power Engineering	Specialization	Chemistry of Water	2	30	0	0	0
Power Engineering	Specialization	Elective Course PE1	2	30	0	0	0
Power Engineering	Specialization	Electric Machines 2	1	0	0	15	0
Power Engineering	Specialization	Electric Power Systems 2	3	0	0	30	0
Power Engineering	Specialization	Energy Sources and Conversion	2	15	15	0	0
Power Engineering	Specialization	Energy systems	3	15	15	0	0
Power Engineering	Specialization	Fundamentals of Operation and Maintenance	5	30	15	0	0
Power Engineering	Specialization	Internal Combustion Engines	2	30	0	0	0
Power Engineering	Specialization	Marketing	2	30	0	0	0
Power Engineering	Specialization	Rotodynamic Pumps and Pumping Systems	2	30	0	0	0
Power Engineering	Specialization	Steam Boilers	2	15	15	0	0
Power Engineering	Specialization	Turbines	2	30	0	0	0

Semester 6

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	Physical Education and Sports	Physical Education and Sport 6	0	0	30	0	0
Power Engineering	Specialization	Advanced Renewable Energy Sources	3	30	15	0	0
Power Engineering	Specialization	Control of Heat Processes	2	30	0	0	0
Power Engineering	Specialization	Elective Course PE2	2	30	0	0	0
Power Engineering	Specialization	Heat Pumps	2	15	15	0	0
Power Engineering	Specialization	Intermediate Engineering Project.	6	0	0	0	60
Power Engineering	Specialization	Physics I	3	30	0	0	0
Power Engineering	Specialization	Power Engineering Machines and Systems 1	2	0	0	30	0
Power Engineering	Specialization	RES-Solar Engineering 1	2	30	0	0	0
Power Engineering	Specialization	Technologies of Environmental Protection	2	30	0	0	0
Power Engineering	Specialization	Thermal Power Stations	2	30	0	0	0

Semester 7

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Power Engineering	Specialization	Elective Course PE3	2	30	0	0	0
Power Engineering	Specialization	Energy Market	3	30	0	0	0
Power Engineering	Specialization	Energy Storage	2	30	0	0	0
Power Engineering	Specialization	Engineering Diploma Seminar	2	0	0	0	30
Power Engineering	Specialization	Engineering Diploma Thesis	15	0	0	0	180
Power Engineering	Specialization	Gas turbines and gas-steam systems	2	30	0	0	0
Power Engineering	Specialization	Power Engineering Machines and Systems 2	2	0	0	30	0
Power Engineering	Specialization	RES-Solar Engineering 2	1	0	0	15	0

Description of course

Code of course	ANHES_1
Name of course	HES Elective Course 1
Version of course	2013.

A. Place of the course in system of studies

Level of education	First 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 Administration and Social Sciences.
Coordinator of course	Academic teachers of the Faculty of Administration and Social Sciences. Detailed data contains syllabus of specific course.

B. General characteristic of the course

Block of courses	Power Engineering
Group of courses	HES Courses
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	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 1.	
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	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 1.	
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	2
Number of hours of student's work to achieve effects of education	Number of hours that require the presence of a teacher ~30 lectures. The number of hours of independent work of student ~30.
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 lectures.
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 1. Learning outcomes

Description of course

Code of course	ML.ANW103	
Name of course	Wittgenstein's Philosophy and Ethics	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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 Administration and Social Sciences	
Coordinator of course	prof. dr hab. Marek Maciejczak	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	HES Courses	
Type of course	Elective	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	winter semester	
Preliminary requirements	General knowledge in the secondary school.	
Limit of students	150	
C. Effects of education and manner of teaching		
Purpose of course	The course introduces students to main books of the of Western Philosophy, which had a decisive impact upon contemporary ideas in ethics, esthetics, psychology, religion, semantics: The Tractatus logico-philosophicus and Philosophical Investigations of Ludwig Wittgenstein. Their scope is critique of language. The understanding of how language works means knowing better the nature of thoughts, i.e. mind. Besides of language, Wittgenstein's ideas on Mathematics, Ethics, Religion, Society, Culture and Science, are also taken into account.	
Effects of education	See Table 2.	
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	1. What is philosophy? Different concepts of philosophy, its main trends, periods, books and thinkers. 2. Example of philosophical ideas in the present dispute of moral situation of the individual in a consumerist society. There is a strong tendency to erasure of the ethical aspect of man's deeds. May the need of moral sensitivity be seen as a condition of happy life? 3. Analytical current in the XX philosophy. Ludwig Wittgenstein - person and life. Wittgenstein tried to understand himself as a genius, endowed with w guiding sense of ethical imperative. His letters, conversations, diaries, philosophical texts are	

Description of course

	documents of determination to know himself better and better. 4. Wittgenstein's first and only one book published during his lifetime – Tractatus logico-philosophicus (1921). The tractarian theory of language and meaning. Language of sciences and definition of truth. The difference between what can be said and what can be only shown. 5. Ethics in the Tractatus. The tractarian theory of linguistic meaning provides the answer to the questions, why there are no ethical propositions and why ethics is not merely senseless but ineffable. 6. The lecture on Ethics (1930). The only one public lecture delivered by Wittgenstein to the Heretic Club in Cambridge. Ethics is running up against the limits of language. It is an attempt to say something that cannot be said. Examples of ethical problems – discussion. 7. Wittgenstein later philosophy. Anthropological method in philosophy. Philosophical Investigations (1953). Philosophy as a battle against the bewitchment of our intelligence by means of language. Philosophy as seeing differences and similarities. Seeing connection as condition of understanding ethics, aesthetics, religion, mathematics. 8. Grammar of religious beliefs. Language in religion. The nature of religious beliefs. 9. Culture. The dominance of science in modern culture. The modern mentality. Value of culture and tradition. 10. Summary: Wittgenstein's legacy.
Methods of evaluation	Two class-tests and (voluntary) additional brief critical essay (presentation) on topics chosen by students. Individual contribution to discussions in the class will be also noted and factored into the final mark.
Methods of verification of effects of education	See Table 2.
Exam	no
Literature	1. Ray Monk, Wittgenstein: The Duty of Genius, London: Vintage, 1990. 2. Wittgenstein's Lectures, 1932-35, ed. by A. Ambrose, Blackwell 1979. 3. Wittgenstein, Lectures and Conversations on Aesthetics, Psychology & Religious Beliefs. Edited by C. Barrett, Blackwell, Oxford, 1966.
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 lectures - 30 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student : • systematic preparation for classes - 10 hours; • preparing presentation of selected topic - 5 hours; • preparing to colloque - 5 hours. Total: 52 hours.

Description of course

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 - 32, including: a) attendance at the lectures-15 hours; b) consultancy meetings - 2 hours.
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Number of ECTS credits on practical activities on the course	-
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E. Additional information

Notes	-
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Table 2. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW103_W01
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Description:	He has a basic knowledge essential to understand philosophical-social conditions of engineering activity.
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Verification:	Tests.
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Field of study related learning outcomes	E1_W31
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Area of study related learning outcomes	
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General academic profile - skills

Code of effect:	ML.ANW103_U01
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Description:	He can interpret information in the field of philosophical and social conditions engineering business.
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Verification:	Tests.
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Field of study related learning outcomes	E1_U05
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Area of study related learning outcomes	
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Code of effect:	ML.ANW103_U01
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Description:	He can interpret information in the field of philosophical and social conditions engineering business.
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Verification:	Tests.
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Field of study related learning outcomes	E1_U01
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Area of study related learning outcomes	
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General academic profile - social competences

Code of effect:	ML.ANW103_K01
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Description:	He understands the need for the constant learning.
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Verification:	Tests.
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Field of study related learning outcomes	E1_K01
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Area of study related learning outcomes	
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Code of effect:	ML.ANW103_K02
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Description:	He is aware of a social role of the graduate of a technical university.
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Verification:	Tests.
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Field of study related learning outcomes	E1_K01
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Area of study related learning outcomes	
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Code of effect:	ML.ANW103_K02
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Description:	He is aware of a social role of the graduate of a technical university.
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Verification:	Tests.
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Field of study related learning outcomes	E1_K06
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Table 2. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ML.ANW103_K02
Description:	He is aware of a social role of the graduate of a technical university.
Verification:	Tests.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	
Code of effect:	ML.ANW103_K03
Description:	Is aware of compliance with the principles professional ethics.
Verification:	Tests.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	ML.ANW103_K04
Description:	He is aware of a social role of media, is able to notice their positive and negative functions.
Verification:	Tests.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	

Description of course

Code of course	ANW 101	
Name of course	Algebra and Geometry	
Version of course	07.03.2012	
A. Place of the course in system of studies		
Level of education	First 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	dr Ewa Lewińska	
B. General characteristic of the course		
Block of courses	Power 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	winter semester	
Preliminary requirements	-	
Limit of students	Without limits	
C. Effects of education and manner of teaching		
Purpose of course	To get students familiar with basic concepts of linear algebra and with some elements of 3-d analytic geometry. To introduce fundamental abstract definitions of linear spaces, algebraic bases, linear mappings and to reinterpret earlier material from this abstract point of view.	
Effects of education	See Table 3.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	45h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Complex numbers. Polynomials. Matrices and matrix operations. Determinants, invertible matrices and Cramers Rule. Systems of linear equations and Gauss Elimination Method. Rank of a matrix and Kronecker-Capelli Theorem. Homogeneous systems. Eigenvalues and eigenvectors. Vectors in the 3-d Cartesian coordinate system. Scalar, vector and box products. Equations of planes and lines and orthogonal projections onto them. Definition of a linear space. Linear subspaces. Algebraic basis and dimension of a linear space. Linear mappings. Inner product spaces. Orthogonality of vectors. Diagonalization of matrices. Diagonalization of real symmetric matrices.	
Methods of evaluation	50% at a mid-semester class test, 50% at an exam, if the class test is failed, then 100% at an exam.	
Methods of verification of effects of education	See Table 3.	

Description of course

Exam	yes
Literature	Recommended texts (reading): 1. Anton H., Rorres Ch.-Elementary linear algebra. 2. Lay D.C.- Linear algebra and its applications. 3. Kolman B., Hill D.R.- Elementary linear algebra.
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 - 47, including: a) attendance at the exercises - 45 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: a) homework and preparation for the exercises-15 hours, b) preparation for a class test -10 hours, c) presence at the exam - 5 hours. TOTAL: 77 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits – number of hours that require the presence of a teacher - 47, including: a) attendance at the exercises - 45 hours; b) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	-
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Table 3. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW101_W1
Description:	Student knows arithmetics of complex numbers. Student has acquired basic knowledge about polynomials of a complex variable.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW101_W2
Description:	Student knows fundamentals of matrix algebra, theory of determinants as well as basic solution method for linear algebraic systems of equations. Student comprehends the concepts of matrix eigenvalues and eigenvectors.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW101_W3
Description:	Students knows basic concepts and definitions in the theory of linear spaces and linear transformations.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW101_W4

Table 3. Learning outcomes	
Description:	Student has a basic knowledge in the area of analytical geometry. Student knows basic theoretical facts about second-order surfaces and lines in space.
Verification:	Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW101_U1
Description:	Student can carry out elementary calculations with complex numbers, including evaluation of powers and roots. Student can factorize the complex polynomials and determine their roots.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW101_U1
Description:	Student can carry out elementary calculations with complex numbers, including evaluation of powers and roots. Student can factorize the complex polynomials and determine their roots.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW101_U2
Description:	Student is able to carry out algebraic calculations with matrices. Student can determine the matrix rank and solve the linear algebraic systems. Student can calculate eigenvalues and eigenvectors.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW101_U2
Description:	Student is able to carry out algebraic calculations with matrices. Student can determine the matrix rank and solve the linear algebraic systems. Student can calculate eigenvalues and eigenvectors.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW101_U4
Description:	Student can describe mathematically lines and planes in space and investigate geometric relations between them.
Verification:	Exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW101_U4
Description:	Student can describe mathematically lines and planes in space and investigate geometric relations between them.
Verification:	Exam.

Table 3. Learning outcomes	
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW101_U5
Description:	Student can draw the second-surface using its canonic equation. Student can determine parameters of curves and the Frenet trihedron.
Verification:	Exam
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW101_U5
Description:	Student can draw the second-surface using its canonic equation. Student can determine parameters of curves and the Frenet trihedron.
Verification:	Exam
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW1013_U3
Description:	Student is able to verify linear independence of vectors and check whether a set of vectors forms a linear space basis.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW1013_U3
Description:	Student is able to verify linear independence of vectors and check whether a set of vectors forms a linear space basis.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	

Description of course

Code of course	ANW102	
Name of course	Calculus I	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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	Andrzej Fryszkowski, Professor	
B. General characteristic of the course		
Block of courses	Power 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	High school mathematics.	
Limit of students	150	
C. Effects of education and manner of teaching		
Purpose of course	To convey and reinforce the knowledge on real number sequences, functions of one variable, the constant e , one-variable differential and integral calculus, definite and improper integrals, and their application, to acquire thorough understanding of basic concepts and computational processes, and to master skills of using them, to acquire the skill of correct mathematical reasoning and inference.	
Effects of education	See Table 4.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	45h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	1. Real sequences . Definition of sequence limit - convergent and divergent sequences. Indeterminate forms. Squeezing theorem. The constant e . 2. Function domain and counterdomain. Inversion and composition of functions. Elementary functions - linear, quadratic and rational functions. Properties of the exponential and logarithmic functions. Even and odd functions. Periodic functions. Trigonometric and cyclometric functions and their properties. 3. Function limit at a given point and at infinity. Horizontal, vertical and oblique asymptotes. Function continuity at a point and in the interval. One-sided continuity. Properties of continuous functions. 4. Function increment. Definition of the derivative of a function at a given point and its geometric interpretation. Derivatives of some	

Description of course

	<p>common functions. The derivative of a sum, a product and a quotient of functions. The derivative of a composition. Tangent and normal lines at a point to a curve $f(x)$. 5. De l'Hospital's rule. Function differential. Higher order derivatives and differentials. Taylor and MacLaurin formulas - approximate values of expressions. 6. Function extrema, necessary and sufficient condition. Rolle's theorem. The Lagrange Mean Value theorem. And its implications. 7. Derivatives of higher order with the use to identify extrema. Inflection points. Concave and convex functions. Necessary and sufficient conditions for inflection points. Examining the function and plotting its graph. 8. Indefinite integral - definition; antiderivative; integral of some common functions; properties. Techniques of integration. 9. Properties of definite integrals. The Fundamental Theorem of Calculus. Integration by parts and by substitution for definite integrals. 10. Definite integrals: definition and geometrical interpretation. Improper integrals of the first and the second kind. Applications of integrals; computing areas of planar figures, arc length of the curves, surface areas, volumes of revolved solids. 11. Convergence of an R^2 sequences. Functions of two variables. Heines definition for function limit. 12. Gradient of a function at a point. Higher order partial derivatives. Taylor formula with the second and higher order. 13. Differential. Computing approximate values of expressions. Local extrema and necessary condition for them. Sufficient condition for an extremum. Functions of three variables: partial and directional derivatives and differentials. Taylor formula with the second order differential. 14. Implicit functions of one variable. Implicit function derivatives of first and second order. Extrema of implicit functions. Conditional extrema of the functions of two and three variables. Parametric representation of the two and three dimensional curves. Some common surfaces: sphere, cylinder, cone, paraboloid, hyperboloid. Planar regions in polar coordinates. Frenet trihedron.</p>
Methods of evaluation	50% continuous assesment based on laboratory work and tests, 50% written final exam.
Methods of verification of effects of education Exam	See Table 4. yes
Literature	Recommended texts (reading): 1. Thomas "Calculus" . 2. Robert A. Adams, Calculus. A complete course. 3. Thomas G. Finney: Calculus, ed. Addison-Wesley.

Description of course

Website of the course	-
D. Student's activity	
Number of ECTS credits	7
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 80, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 45 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 45 hours; • work on homework (solving tasks) - 20 hours; • preparation for class tests - 15 hours; • preparation for the final examination - 15 hours. TOTAL = 175 hours
Number of ECTS credits on the course with direct participation of academic teacher	3,5 ECTS credits - number of hours that require the presence of a teacher - 80, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 45 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	-
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Table 4. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW102_W1
Description:	Student knows basic concepts of the analysis such that a metric space, convergence in a metric space, metric space transformations and their properties.
Verification:	Class tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW102_W2
Description:	Student knows fundamentals of the differential calculus of single-variable functions.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW102_W3
Description:	Student knows fundamentals of the integral calculus of single-variable functions, including the first and the second theorems of the integral calculus.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW102_W4
Description:	Student knows fundamentals of the multi-variable differential calculus, including the concept of a partial derivative, a directional

Table 4. Learning outcomes	
	derivative and a gradient.
Verification:	Tests and exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW102_U1
Description:	Student can work with the elementary functions of a single variable, determine proper and improper limits of functions, investigate continuity properties of functions.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW102_U1
Description:	Student can work with the elementary functions of a single variable, determine proper and improper limits of functions, investigate continuity properties of functions.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW102_U2
Description:	Student can calculate derivatives of single-variable function (also derivatives of composite functions), determine monotonicity and extremal points, determine an equation of a line tangent to a function's graph, use the de l'Hospital rule to evaluate function limits.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW102_U2
Description:	Student can calculate derivatives of single-variable function (also derivatives of composite functions), determine monotonicity and extremal points, determine an equation of a line tangent to a function's graph, use the de l'Hospital rule to evaluate function limits.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW102_U3
Description:	Student can evaluate indetermined integrals (antiderivatives) using the integration by part and integration by substitution methods. Student knows how to evaluate integrals of rational functions.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11

Table 4. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANW102_U3
Description:	Student can evaluate indetermined integrals (antiderivatives) using the integration by part and integration by substitution methods. Student knows hot to evaluate integrals of rational functions.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW102_U4
Description:	Student can calculate determined integrals and use them in physics and geometry. Student is able to evaluate simple improper integrals.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW102_U4
Description:	Student can calculate determined integrals and use them in physics and geometry. Student is able to evaluate simple improper integrals.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW102_U5
Description:	Student can calculate derivatives of multiply-variable functions, including partial derivatives of composite functions. Student can determine the directional derivative.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW102_U5
Description:	Student can calculate derivatives of multiply-variable functions, including partial derivatives of composite functions. Student can determine the directional derivative.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW102_U6
Description:	Student is able to find extrema of functions of two variables and the plane tangent to the surface plot of such function. Student knows how to use the implicit function theorem.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	

Table 4. Learning outcomes	
Code of effect:	ANW102_U6
Description:	Student is able to find extrema of functions of two variables and the plane tangent to the surface plot of such function. Student knows how to use the implicit function theorem.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW102_K1
Description:	Student is aware of necessity of self-study and thoroughness and exactitude.
Verification:	Homework, exam.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANW106
Name of course	Computer Science I
Version of course	2013

A. Place of the course in system of studies

Level of education	First 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	Power 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	winter semester
Preliminary requirements	Basic knowledge in math at the highschool level.
Limit of students	80 - lecture, 12- lab group

C. Effects of education and manner of teaching

Purpose of course	To familiarize the students with computer science and in particular with programming in computer language C.	
Effects of education	See Table 5.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	30h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Basic information related to operating systems and computer networks. Word-processing and spreadsheets used in typical engineering applications. Programming language C - variables and their types, arithmetical and logical operations, control statements, functions, tables and pointers, structures. Input and Output. Code examples. Basic algorithms (sorting), simple numerical methods. Practical programming skills.	
Methods of evaluation	2 tests (60 points), lab. continuous assignment (20 points), lab. project (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).	
Methods of verification of effects of education	See Table 5.	
Exam	no	
Literature	Recommended texts (reading): Oualline, Steve, Practical C Programming, O Reilly, 1991, http://publications.gbdirect.co.uk/c_book/ .	
Website of the course	http://c-cfd.meil.pw.edu.pl/ccfd/index.php?item=6	

D. Student's activity

Number of ECTS credits	5
Number of hours of student's work to achieve	Number of hours that require the presence of a

Description of course

effects of education	teacher : 70 hours, including: a) lecture – 30 hours, b) labs – 30 hours, c) consultations – 10 hours. The number of hours of independent work of student: 55 hours, including: a) 20 hours. – preparation for labs and lectures, b) 10 hours – homework, c) 20 hours – preparation for 2 colloquia. Total: 125 hours.
Number of ECTS credits on the course with direct participation of academic teacher	ECTS 3 credits - 70 hours, including: a) lecture – 30 hours, b) labs – 30 hours, c) consultations – 10 hours.
Number of ECTS credits on practical activities on the course	ECTS 2 credits – 55 hours including: a) 30 hours – labs, b) 15 hours – preparation for the labs, c) 10 hours – homework.

E. Additional information

Notes	
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Table 5. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW106_W1
Description:	Student has basic knowledge in the C language programming.
Verification:	2 tests and assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	

Code of effect:	ANW106_W2
Description:	Student has a basic knowledge about the usage of an operational system.
Verification:	2 tests and assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ANW106_U1
Description:	Student has skills to write a simple computer program in C language.
Verification:	2 tests, assesment of the progress/activity in lab tutorilas, evaluation of a home project.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	

Code of effect:	ANW106_U1
Description:	Student has skills to write a simple computer program in C language.
Verification:	2 tests, assesment of the progress/activity in lab tutorilas, evaluation of a home project.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	

Code of effect:	ANW106_U2
Description:	Student is able to solve a simple mathematical problem using his own computer program written in C language.
Verification:	
Field of study related learning outcomes	
Area of study related learning outcomes	

Table 5. Learning outcomes	
Verification:	2 tests, assesment of the progress/activity in lab tutorilas, evaluation of a home project.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW106_U2
Description:	Student is able to solve a simple mathematical problem using his own computer program written in C language.
Verification:	2 tests, assesment of the progress/activity in lab tutorilas, evaluation of a home project.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW106_U3
Description:	Student can use basic and advanced functions of at editing program and a calculation spreadsheet.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW106_U3
Description:	Student can use basic and advanced functions of at editing program and a calculation spreadsheet.
Verification:	Assessment of progress/activity in lab tutorials.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW106_U4
Description:	Using computers tools and methods, a student is able to solve a simple mathematical or technical problem.
Verification:	Home project.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW106_U4
Description:	Using computers tools and methods, a student is able to solve a simple mathematical or technical problem.
Verification:	Home project.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	

Description of course

Code of course	ANW105	
Name of course	Engineering Graphics	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Witold M. MIRSKI	
B. General characteristic of the course		
Block of courses	Power 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	winter semester	
Preliminary requirements	Base information from high school.	
Limit of students	70 students on the lecture and 12 students for one teacher on practise.	
C. Effects of education and manner of teaching		
Purpose of course	Create the orthogonal projection of spatial geometrical forms onto adequate projection plane. Teaching spatial imagination. The skill of rational use of space.	
Effects of education	See Table 6.	
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	Basic information about the axonometric projection. Introduction to the descriptive geometry using the Monges method. Projection of such simply geometric elements, like; points, straight lines, planes and spatial relationships between them. Common elements of them. Auxiliary-view method. Projection of revolution. Projection of surfaces of basic geometric shapes: rectangular prisms, cylinders, cones and spheres. Cross-sections and points of intersections. Intersection lines of such shapes. Creating of components of complex objects on the base of two-dimensional sketch using a Computer Aided Design three-dimensional system (CAD-3D).	
Methods of evaluation	Positive results of tests as well as home and class work.	
Methods of verification of effects of education	See Table 6.	
Exam	no	
Literature	1. George C. Beakley, Ernst G. Chilton Introduction to Engineering Design and Graphics.	

Description of course

Website of the course	http://www.meil.pw.edu.pl/zpk/ZPK/Dydaktyka/
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 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 : • systematic preparation for classes - 10 hours; • work on homework – 10 hours; • preparation for class tests - 5 hours. TOTAL - 57 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 32, 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	1,5 ECTS credits - 37 hours, including: a) systematic preparation for classes - 10 hours; b) work on homework - 10 hours; c) attendance at the exercises -15 hours; d) consultancy meetings - 2 hours.
E. Additional information	
Notes	
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Table 6. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW105_W1
Description:	Student knows the basics of creating a drawing axonometric.
Verification:	Controlled own work - axonometric drawing.
Field of study related learning outcomes	E1_W29
Area of study related learning outcomes	
Code of effect:	ANW105_W2
Description:	Student knows the rules of mapping geometric elements on several viewpoints.
Verification:	Tests
Field of study related learning outcomes	E1_W29
Area of study related learning outcomes	
Code of effect:	ANW105_W3
Description:	Student knows the rules of creation and mapping of solids and second degree surfaces.
Verification:	Short tests.
Field of study related learning outcomes	E1_W29
Area of study related learning outcomes	
Code of effect:	ANW105_W4
Description:	It has a basic knowledge of drawing the lines penetrate.
Verification:	Test.
Field of study related learning outcomes	E1_W29
Area of study related learning outcomes	

Table 6. Learning outcomes	
General academic profile - skills	
Code of effect:	ANW105_U1
Description:	Student is able to do an isometric drawing.
Verification:	Controlled own work - axonometric drawing.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW105_U2
Description:	Student can reproduce the geometric elements and geometric relationships that occur between them.
Verification:	Short tests.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW105_U3
Description:	Student can reproduce and analyze the rotation.
Verification:	Short tests.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW105_U4
Description:	Can create and map second degree surfaces
Verification:	Short tests.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW105_U5
Description:	Can draw lines penetrate the surface.
Verification:	Test.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	

Description of course

Code of course	ANW104	
Name of course	Engineering Physics	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	Hanna Jędrzejuk, PhD, Eng.	
B. General characteristic of the course		
Block of courses	Power 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	minimum 15.	
C. Effects of education and manner of teaching		
Purpose of course	Recollection of the basic laws and principles of the fields of physics being most important in the programme of our Faculty.	
Effects of education	See Table 7.	
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	Mechanics: mass, momentum, moment of momentum, and energy conservation laws in translatory and rotary motion. Field theory: gravity field; electrostatic field; magnetic field. Thermodynamics: intensive quantities, perfect gas, gas processes; extensive quantities, first law of thermodynamics; thermodynamic cycles, second law of thermodynamics. Hydrodynamics: continuity law; Bernoulli equation.	
Methods of evaluation	Class attendance (exercises) and two tests in the middle and at the end of the semester, both tests have to be passed.	
Methods of verification of effects of education	See Table 7.	
Exam	no	
Literature	1. Halliday, D., Resnick, R., and Walker, J.: Fundamentals of Physics, John Wiley & Sons, Inc., 2001. 2. Young, H. D., and Freedman, R. A.: University Physics, Pearson Addison-Wesley, 2008.	
Website of the course	http://www.meil.pw.edu.pl/pl/content/download/9193/53415/file/air_inz.pdf	
D. Student's activity		
Number of ECTS credits	3	

Description of course

Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 48, including: a) attendance at the lectures -15 hours; b) attendance at the exercises -30 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 20 hours; • preparing for tests - 10 hours; • preparing for final test - 10 hours. TOTAL - 88 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 48, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 30 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	Topics help in understanding the fundamentals of physics, and are the minimum in the course of further study.
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Table 7. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW104_W01
Description:	The student knows the basic physical quantities, he/she is able to convert units, he/she can distinguish scalar and vector and can perform basic operations on them. The student understands the concept of a physical system can determine the fundamental interactions. The student knows and understands the basic principles and issues of the kinematics and dynamics of the motion (including simplified particle and a rigid body).
Verification:	Test 01.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW104_W01
Description:	The student knows the basic physical quantities, he/she is able to convert units, he/she can distinguish scalar and vector and can perform basic operations on them. The student understands the concept of a physical system can determine the fundamental interactions. The student knows and understands the basic principles and issues of the kinematics and dynamics of the motion (including simplified particle and a rigid body).
Verification:	Test 01.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	

Table 7. Learning outcomes	
Code of effect:	ANW104_W02
Description:	The student knows and understands the basic concept of the gravitational field.
Verification:	Test 01.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW104_W02
Description:	The student knows and understands the basic concept of the gravitational field.
Verification:	Test 01.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANW104_W03
Description:	The student knows and understands the basic concept of the electrostatic field.
Verification:	Test 01
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW104_W03
Description:	The student knows and understands the basic concept of the electrostatic field.
Verification:	Test 01
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANW104_W04
Description:	The student knows and understands the basic concept of a magnetic field.
Verification:	Test 01.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANW104_W04
Description:	The student knows and understands the basic concept of a magnetic field.
Verification:	Test 01.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW104_W05
Description:	Student distinguishes macroscopic and microscopic extensive and intensive physical quantities as well. He/she knows the concept of an ideal gas. He/she knows the basic law of the thermodynamics. He / she can distinguish the basic thermodynamic processes.
Verification:	Test 02.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW104_W05
Description:	Student distinguishes macroscopic and microscopic extensive and intensive physical quantities as well. He/she knows the concept of an ideal gas. He/she knows the basic law of the thermodynamics. He / she can distinguish the basic thermodynamic processes.
Verification:	Test 02.

Table 7. Learning outcomes	
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANW104_W05
Description:	Student distinguishes macroscopic and microscopic extensive and intensive physical quantities as well. He/she knows the concept of an ideal gas. He/she knows the basic law of the thermodynamics. He / she can distinguish the basic thermodynamic processes.
Verification:	Test 02.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW104_W05
Description:	Student distinguishes macroscopic and microscopic extensive and intensive physical quantities as well. He/she knows the concept of an ideal gas. He/she knows the basic law of the thermodynamics. He / she can distinguish the basic thermodynamic processes.
Verification:	Test 02.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW104_W05
Description:	Student distinguishes macroscopic and microscopic extensive and intensive physical quantities as well. He/she knows the concept of an ideal gas. He/she knows the basic law of the thermodynamics. He / she can distinguish the basic thermodynamic processes.
Verification:	Test 02.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANW104_W06
Description:	The student knows the basic concepts and laws in hydrodynamics.
Verification:	Test 01.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANW104_W06
Description:	The student knows the basic concepts and laws in hydrodynamics.
Verification:	Test 01.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW104_W06
Description:	The student knows the basic concepts and laws in hydrodynamics.
Verification:	Test 01.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW104_W06
Description:	The student knows the basic concepts and laws in hydrodynamics.
Verification:	Test 01.

Table 7. Learning outcomes	
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANW104_W06
Description:	The student knows the basic concepts and laws in hydrodynamics.
Verification:	Test 01.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW104_U01
Description:	The student is able to identify basic physical quantities and distinguish the scalar and vector quantities.
Verification:	Test 01.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U01
Description:	The student is able to identify basic physical quantities and distinguish the scalar and vector quantities.
Verification:	Test 01.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U01
Description:	The student is able to identify basic physical quantities and distinguish the scalar and vector quantities.
Verification:	Test 01.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U01
Description:	The student is able to identify basic physical quantities and distinguish the scalar and vector quantities.
Verification:	Test 01.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U02
Description:	Student is able to define the analyzed system from the environment, and describe the processes taking place in it. He can also apply the laws of motion to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U02
Description:	Student is able to define the analyzed system from the environment, and describe the processes taking place in it. He can also apply the laws of motion to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U02

Table 7. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANW104_U02
Description:	Student is able to define the analyzed system from the environment, and describe the processes taking place in it. He can also apply the laws of motion to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U02
Description:	Student is able to define the analyzed system from the environment, and describe the processes taking place in it. He can also apply the laws of motion to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U03
Description:	The student can determine the momentum, momemnt of momentum, moment of inertia and apply the appropriate conservation laws to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U03
Description:	The student can determine the momentum, momemnt of momentum, moment of inertia and apply the appropriate conservation laws to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U03
Description:	The student can determine the momentum, momemnt of momentum, moment of inertia and apply the appropriate conservation laws to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U03
Description:	The student can determine the momentum, momemnt of momentum, moment of inertia and apply the appropriate conservation laws to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U04
Description:	The student can describe the translational and rotational motion, and identify the potential

Table 7. Learning outcomes	
	energy. Has/she is able to use the energy conservation law to solve engineering problems.
Verification:	Test 01
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U04
Description:	The student can describe the translational and rotational motion, and identify the potential energy. Has/she is able to use the energy conservation law to solve engineering problems.
Verification:	Test 01
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U04
Description:	The student can describe the translational and rotational motion, and identify the potential energy. Has/she is able to use the energy conservation law to solve engineering problems.
Verification:	Test 01
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U04
Description:	The student can describe the translational and rotational motion, and identify the potential energy. Has/she is able to use the energy conservation law to solve engineering problems.
Verification:	Test 01
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U05
Description:	Student can correctly interpretate the theory of the gravitational field and is able to use the knowledge in engineering issues.
Verification:	Test 01.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U05
Description:	Student can correctly interpretate the theory of the gravitational field and is able to use the knowledge in engineering issues.
Verification:	Test 01.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U05
Description:	Student can correctly interpretate the theory of the gravitational field and is able to use the knowledge in engineering issues.
Verification:	Test 01.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U06
Description:	The student is able to correctly interpret the phenomena in the electrostatic field and are able to solve engineering problems.

Table 7. Learning outcomes	
Verification:	Test 01.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U06
Description:	The student is able to correctly interpret the phenomena in the electrostatic field and are able to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U06
Description:	The student is able to correctly interpret the phenomena in the electrostatic field and are able to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U06
Description:	The student is able to correctly interpret the phenomena in the electrostatic field and are able to solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U07
Description:	The student is able to correctly describe the phenomena occurring in the magnetic field, and solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U07
Description:	The student is able to correctly describe the phenomena occurring in the magnetic field, and solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U07
Description:	The student is able to correctly describe the phenomena occurring in the magnetic field, and solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U07
Description:	The student is able to correctly describe the phenomena occurring in the magnetic field, and solve engineering problems.
Verification:	Test 01.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U08
Description:	The student is able to determine the intensive

Table 7. Learning outcomes	
	physical quantities, and is able to distinguish macroscopic and microscopic description. He/she can use the ideal gas model, and can apply the Clapeyron's and Dalton's laws to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U08
Description:	The student is able to determine the intensive physical quantities, and is able to distinguish macroscopic and microscopic description. He/she can use the ideal gas model, and can apply the Clapeyron's and Dalton's laws to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U08
Description:	The student is able to determine the intensive physical quantities, and is able to distinguish macroscopic and microscopic description. He/she can use the ideal gas model, and can apply the Clapeyron's and Dalton's laws to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U08
Description:	The student is able to determine the intensive physical quantities, and is able to distinguish macroscopic and microscopic description. He/she can use the ideal gas model, and can apply the Clapeyron's and Dalton's laws to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U09
Description:	The student can describe the basic gas processes. He/she can determine the extensive physical quantities and has the ability to apply the first law of thermodynamics to solve the engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U09
Description:	The student can describe the basic gas processes. He/she can determine the extensive physical quantities and has the ability to apply the first law of thermodynamics to solve the engineering problems.
Verification:	Test 02.

Table 7. Learning outcomes	
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U09
Description:	The student can describe the basic gas processes. He/she can determine the extensive physical quantities and has the ability to apply the first law of thermodynamics to solve the engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U09
Description:	The student can describe the basic gas processes. He/she can determine the extensive physical quantities and has the ability to apply the first law of thermodynamics to solve the engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U10
Description:	The student can describe the basic thermodynamic cycles, has the ability to use the second law of thermodynamics to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANW104_U10
Description:	The student can describe the basic thermodynamic cycles, has the ability to use the second law of thermodynamics to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U10
Description:	The student can describe the basic thermodynamic cycles, has the ability to use the second law of thermodynamics to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U10
Description:	The student can describe the basic thermodynamic cycles, has the ability to use the second law of thermodynamics to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U11
Description:	The student is able to describe the flow of fluids.

Table 7. Learning outcomes	
	He/she knows how to apply the continuity and Bernoulli's equations to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW104_U11
Description:	The student is able to describe the flow of fluids. He/she knows how to apply the continuity and Bernoulli's equations to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW104_U11
Description:	The student is able to describe the flow of fluids. He/she knows how to apply the continuity and Bernoulli's equations to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW104_U11
Description:	The student is able to describe the flow of fluids. He/she knows how to apply the continuity and Bernoulli's equations to solve engineering problems.
Verification:	Test 02.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW104_K01
Description:	The student is able to interpret correctly the basic concepts and apply the knowledge to solve engineering problems.
Verification:	Test 01, test 02.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANW104_K01
Description:	The student is able to interpret correctly the basic concepts and apply the knowledge to solve engineering problems.
Verification:	Test 01, test 02.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	ANW104_K01
Description:	The student is able to interpret correctly the basic concepts and apply the knowledge to solve engineering problems.
Verification:	Test 01, test 02.
Field of study related learning outcomes	E1_K06
Area of study related learning outcomes	
Code of effect:	ANW104_K01
Description:	The student is able to interpret correctly the

Table 7. Learning outcomes

	basic concepts and apply the knowledge to solve engineering problems.
Verification:	Test 01, test 02.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANW109	
Name of course	Environment Protection	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	Nikolaj Uzunow, PhD, Eng., assistant professor	
B. General characteristic of the course		
Block of courses	Power 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	Secondary school certificate exam in physics and mathematics.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	Basic knowledge of the environment protection problems.	
Effects of education	See Table 8.	
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	Objectives of the environment protection policy. National, European, and global environment protection legal system. Human health vs. technical and economical problems. Mechanisms and instruments of the environment protection policy. Air protection. Greenhouse gases, European Trading System. Water and soil protection. Waste utilisation. Protection against noise and vibration. Radiation protection.	
Methods of evaluation	The assessment is based on two tests, held in the middle and at the end of the semester. The tests consist of several questions to be answered. Students have to obtain positive grades on both tests. The final grade is calculated as an average from the two tests.	
Methods of verification of effects of education	See Table 8.	
Exam	no	
Literature	No relevant issues.	
Website of the course		
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 - 33, including: a) attendance at the lectures-30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 15 hours; • preparing for tests -10 hours. TOTAL: 58 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 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	
Notes	
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Table 8. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW109_W1
Description:	Student has knowledge about main areas of environmental protection (air, water, soil etc).
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANW109_W1
Description:	Student has knowledge about main areas of environmental protection (air, water, soil etc).
Verification:	Test.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANW109_W2
Description:	Student has knowledge about main pollutants of environment as well as sources of them.
Verification:	Test.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANW109_W2
Description:	Student has knowledge about main pollutants of environment as well as sources of them.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANW109_W2
Description:	Student has knowledge about main pollutants of environment as well as sources of them.
Verification:	Test.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANW109_W3
Description:	Student has knowledge about climate changes.
Verification:	Test.
Field of study related learning outcomes	E1_W31

Table 8. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANW109_W4
Description:	Student has knowledge about the global warming and ozone depletion mechanisms.
Verification:	Test.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANW109_W5
Description:	Student has knowledge about fossil fuel power plants (one of the main sources of environmental pollution).
Verification:	Test.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANW109_W5
Description:	Student has knowledge about fossil fuel power plants (one of the main sources of environmental pollution).
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANW109_W6
Description:	Student has knowledge about renewable energy sources.
Verification:	Test.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW109_U1
Description:	Student is able to specify main areas of environmental protection and their pollutants as well as sources of them.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANW109_U2
Description:	Student is able to specify impact of demographic and technical development on the environmental pollution.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANW109_U3
Description:	Student is able to specify evidences of climate change.
Verification:	Test.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANW109_U3
Description:	Student is able to specify evidences of climate change.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	

Table 8. Learning outcomes	
Code of effect:	ANW109_U4
Description:	Student is able to specify and describe types of fossil fuel power plant, renewable energy sources and nuclear power plants.
Verification:	Test.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANW109_U4
Description:	Student is able to specify and describe types of fossil fuel power plant, renewable energy sources and nuclear power plants.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANW109_U4
Description:	Student is able to specify and describe types of fossil fuel power plant, renewable energy sources and nuclear power plants.
Verification:	Test.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW109_K1
Description:	Student is able to assess the impact of energy on the environment.
Verification:	Test.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANW109_K1
Description:	Student is able to assess the impact of energy on the environment.
Verification:	Test.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	

Description of course

Code of course	ANW71	
Name of course	Health and Safety Training	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	College of Physical Education and Sport.	
Coordinator of course	Teacher at College of Physical Education and Sport.	
B. General characteristic of the course		
Block of courses	Power 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		
C. Effects of education and manner of teaching		
Purpose of course	The development of physical activity of students. Detailed data contains syllabus of specific course.	
Effects of education	See Table 9.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The exercise program offer by College of Physical Education and Sport.	
Methods of evaluation	According to the rules of classes developed by College of Physical Education and Sport.	
Methods of verification of effects of education	See Table 9.	
Exam	no	
Literature		
Website of the course		
D. Student's activity		
Number of ECTS credits	0	
Number of hours of student's work to achieve effects of education	Participation in classes - 30 hours.	
Number of ECTS credits on the course with direct participation of academic teacher		
Number of ECTS credits on practical activities on the course	0.0 ECTS credit (30 hours of classes, without ECTS).	
E. Additional information		
Notes		
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Table 9. Learning outcomes

Description of course

Code of course	ANW 107										
Name of course	Materials I										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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	Piotr Czarnocki, PhD, Eng.										
B. General characteristic of the course											
Block of courses	Power 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	-										
C. Effects of education and manner of teaching											
Purpose of course	To gain fundamental engineering knowledge about various structures of engineering materials to be able to understand their mechanical properties.										
Effects of education	See Table 10.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Important mechanical properties of metals and polymers definitions, measures and related most important tests. Background of material structure: crystal structures, defects and imperfections, polymer chains and polymerisation. Phase transformations and equilibrium diagrams. Heat treatment of ferrous metals, and aluminum and titanium alloys. Background of fiber reinforced composite materials. Corrosion and corrosion prevention.										
Methods of evaluation	100% assessment based on four tests.										
Methods of verification of effects of education	See Table 10.										
Exam	no										
Literature	1) Book 1: J.F. Shackelford, „Introduction to Material Science for Engineers”. 2) Book 2: W. D. Callister Jr., “Materials Science and Engineering An Introduction”.										
Website of the course											
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 - 32, including: a) attendance at the lectures-30 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 10 hours; • preparing for tests -16 hours. TOTAL: 58 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits – number of hours that require the presence of a teacher - 32, including: a) attendance at the lectures-30 hours; b) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
Notes	
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Table 10. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW 107_W1
Description:	He knows the characteristics of the main groups of materials, ie. metal, polymer, ceramic and composite materials including, among others, level indicators of strength, wear resistance and prices.
Verification:	Colloquium
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_W2
Description:	He knows the relations between the structure of materials and their properties.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_W3
Description:	Knows the specific characteristics of each group of materials and possibilities of their modification.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ML.ANW 107_U1
Description:	Knows how on the basis of knowledge and literature sources to formulate the requirements for material for a specific application.
Verification:	Colloquium
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_U1
Description:	Knows how on the basis of knowledge and literature sources to formulate the requirements for material for a specific application.

Table 10. Learning outcomes	
Verification:	Colloquium
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_U2
Description:	He use databases of materials and use methodology of material selection.
Verification:	Colloquium.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_U2
Description:	He use databases of materials and use methodology of material selection.
Verification:	Colloquium.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_U3
Description:	He knows how to choose heat treatment for select group of materials.
Verification:	Colloquium.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW 107_U3
Description:	He knows how to choose heat treatment for select group of materials.
Verification:	Colloquium.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

Description of course

Code of course	ANW108	
Name of course	Mechanics I	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	Elżbieta Jarzębowska, PhD, Eng.	
B. General characteristic of the course		
Block of courses	Power 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	winter semester	
Preliminary requirements	Students are required skills in vector calculus.	
Limit of students	80 per lecture room	
C. Effects of education and manner of teaching		
Purpose of course	Let students acquire basics in theory in statics and acquire skills in numerical problems solving in statics.	
Effects of education	See Table 11.	
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	Fundamental concepts and principles of statics. Equilibrium of a particle: forces in a plane and in space. Equilibrium of a rigid body in two and three dimensions: external and internal forces, reactions and constraints, equivalent systems of forces, moment of a force about a point and about an axis, reduction of a force system to one force and one couple (wrench). Statically determinate and indeterminate systems. Dry friction. Geometry of masses: centre of mass/gravity, areal and mass moments of inertia.	
Methods of evaluation	3 written tests during semester.	
Methods of verification of effects of education	See Table 11.	
Exam	no	
Literature	Recommended texts (reading): 1. Ferdinand P. Beer, E. Russell Johnston, Jr. (in last editions + three other co-authors): Vector Mechanics for Engineers STATICS, McGraw-Hill, Inc., any edition, last one 2004. 2.R.C. Hibbeler: Engineering Mechanics STATICS, Pearson, any edition, last one 2004. 3. Any academic textbook (engineering course) on General Mechanics, part: Statics. 4.	

Description of course

	Solving of problems, in addition to the above textbooks: 4a) Fogiel M. (editor): THE MECHANICS PROBLEM SOLVER. A Complete Solution Guide to Any Textbook. Redearch and Education Association (REA), 1992. 4b) COLLECTION OF PROBLEMS IN MECHANICS, in Russian, and in Polish as: I. Mieszczerski: ZBIÓR ZADAŃ Z MECHANIKI, PWN, many editions; solutions to this COLLECTION ... in German (author Neuber H., VEB Verlag, Berlin 1962, 1963), and in Polish as: Romuald Romicki: ROZWIĄZANIA ZADAŃ Z MECHANIKI ZBIORU I. W. MIESZCZERSKIEGO, PWN, many editions.
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 - 33, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 20 hours; • preparing for tests - 24 hours. TOTAL: 77 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 11. Learning outcomes

General academic profile - knowledge	
Code of effect:	ANW108_W1
Description:	Acquired knowledge in: basic principles in statics, including force system types acting upon mechanical systems and methods of a force system reduction.
Verification:	Written tests.
Field of study related learning outcomes	E1_W04
Area of study related learning outcomes	
Code of effect:	ANW108_W2
Description:	Students know basic methods of a mechanical system equilibrium determination for various types of supports and constraints.
Verification:	Written tests.
Field of study related learning outcomes	E1_W04
Area of study related learning outcomes	

Table 11. Learning outcomes	
Code of effect:	ANW108_W3
Description:	Students learn how to generate free body diagrams and determination of equilibrium conditions for a mechanical system.
Verification:	Written tests.
Field of study related learning outcomes	E1_W04
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW108_U1
Description:	Students can reduce an arbitrary force system for a single force and a force/couple system.
Verification:	Written tests.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW108_U2
Description:	Students can generate a free body diagram of a system and determine its equilibrium conditions.
Verification:	Written tests.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	

Description of course

Code of course	ML. ANW117	
Name of course	Economics	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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 Administration and Social Sciences	
Coordinator of course	prof. dr hab. Janusz Gudowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	HES Courses	
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	Communication in English.	
Limit of students	100	
C. Effects of education and manner of teaching		
Purpose of course	Learning the fundamental micr- and macroeconomics.	
Effects of education	See Table 12.	
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	Economics as the science. The sense of processes of production. The ideas of wealth and its sources. The sense of value. The essence of economic growth. Quantitative and qualitative aspects of economic growth. The level of life. The idea of development. Notions: market-supply-demand; elasticities measures; types of goods, the theory of consumer. Types of market; theory of competition; the state contribution to market economy. Genesis of contemporary macroeconomics. The conflict between demand and neoliberal approach. The essence of the main today's schools of economics. The main research interest in contemporary economics. Searching the new paradigm. Neoclassical, post-Keynes and institutional economics. Development economics. Ecologic approach in economics.	
Methods of evaluation	Colloquium.	
Methods of verification of effects of education	See Table 12.	
Exam	no	
Literature	P.A. Samuelson, W.D. Nordhaus, Introduction to economics (latest issue).	
Website of the course	-	

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 - 31, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 1 hours. 2) The number of hours of independent work of student: studying literature; preparing presentation of selected issue; preparing to final test - 20 hours. TOTAL: 51 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 - 31, 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

Notes	-
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Table 12. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW117_W1
Description:	Student gets basic knowledge necessary to understand social, economic, legal and other non-technical conditions of engineering.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ML.ANW117_U1
Description:	Student may use an information coming from database or other sources, also in English, may interpret data, make conclusions and judgement.
Verification:	Presentation of selected topic.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	

General academic profile - social competences

Code of effect:	ML.ANW117_K1
Description:	Student understands the need for continuous learning to enlarge professional and personal competences. Students is conscious of responsibility in joint tasks.
Verification:	Presentation, discussion
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ML.ANW117_K2
Description:	Able to think and act in an entrepreneurial way.
Verification:	Presentation, discussion.
Field of study related learning outcomes	E1_K06
Area of study related learning outcomes	

Description of course

Code of course	ANHES_2	
Name of course	HES Elective Course 2	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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 Administration and Social Sciences.	
Coordinator of course	Academic teachers of the Faculty of Administration and Social Sciences. Detailed data contains syllabus of specific course.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	HES Courses	
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	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 13.	
Form of didactic studies and number of hours per semester	Lecture	450h
	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 13.	
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	2	
Number of hours of student's work to achieve effects of education	Number of hours that require the presence of a teacher ~30 lectures. The number of hours of independent work of student ~30.	
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 lectures.	
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 13. Learning outcomes

Description of course

Code of course	ANJ1/ANPL1										
Name of course	Foreign/Polish Language 1										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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	SJO PW										
Coordinator of course	mgr Marta Szpak										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Languages										
Type of course	Compulsory										
Language of course	polski										
Nominal semester	2 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	-										
Limit of students	12-24										
C. Effects of education and manner of teaching											
Purpose of course	Achieving general competence in Polish at the A1 level, in particular the following language skills: listening comprehension of numerals, politeness structures and simple questions. Interaction in the social context. Ability to write simple words in Polish. Attempting to use the language in everyday life. Maintaining contact - nie rozumiem, proszę powtórzyć, proszę mówić wolniej. After completing his course the students will be able to: introduce themselves (name, surname, country), make contact (Cześć, jak się masz?), read in Polish and pronounce all sounds quite correctly. They will know numerals to 1000, basic politeness structures, names of most common food products. They will be able to ask for directions, do basic shopping.										
Effects of education	See Table 14.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>30h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	30h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	30h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	1. Greetings, my name is..., etc. 2. Alphabet, pronunciation exercises, social phrases. 3. Formal and informal social phrases in Polish. 4. Numbers 1-20, words and phrases useful in the city, phonetic exercises. 5. At the airport, greetings-continuation. 6. How are you? Maintaining conversation. 7. Spelling. Asking to repeat and speak slowly. 8. Phonetic exercises. Days of the week, numbers 20-100. 9. Asking for directions,										

Description of course

	<p>part 1: names of buildings at WUT, basic academic language (dean's office, department etc.). 10. At a photocopy centre, topping up a mobile phone. 11. Numbers 100-1000, exercises: what's your phone number, simple mathematical operations. 12. Classroom language, numbers - practice. Phonetic exercises. 13. Numbers 100-1000 - practice. 14. Personal details. Documents. 15. Verb to be and personal pronouns. 16. The conjugation -m, -sz. 17. Giving the personal details and address. 18. At a party - words and expressions, polite requests, verbs to eat, to drink.. 19. Revision: numbers, greetings, social language. 20. Names of objects in the city, directions. 21. Asking for directions - vocabulary, dialogue. Verb to know. 22. Asking for giving directions - practising. 23. Grammar: gender of nouns. 24. Names of basic food products. 25. Specifics of the Polish cuisine - presentation. 26. What is it? Fruits and vegetables. 27. Asking for food products. 28. Revision. 29. Mid-term test. 30. Mid-term test.</p>
Methods of evaluation	<p>Attendance (two absences are allowed) Passing all tests Completing 90 % of homework assignments In-class participation Passing the module test (weight of the mark for the module test in the final grade: 50%)</p>
Methods of verification of effects of education	<p>See Table 14.</p>
Exam	<p>no</p>
Literature	<p>Recommended texts: Obligatory: Piotrowska-Rola E. Porębska M., Polski jest cool, Lublin 2013 Supplementary materials: 1. Kowalska M., Polish in 4 weeks REA, Warszawa 2009 2. Lachowicz J., Podsiadły J., Ten, ta, to. Ćwiczenia nie tylko gramatyczne dla cudzoziemców, wyd. WING 2001 3. Machowska J., Gramatyka? Dlaczego nie?! Ćwiczenia gramatyczne dla poziomu A1, Universitas, Kraków 2010, 4. Madelska L., Discovering Polish. A Learner's Grammar / Polnisch entdecken. Eine Lerngrammatik / Odkrywamy język polski. Gramatyka dla uczących (się) języka polskiego jako obcego, Prolog, Kraków 2008 5. Polish for foreigners. Audio Course (CD), Warszawa, Edgard 2006 6. Seretny A., A co to takiego? Obrazkowy słownik języka polskiego, Universitas, Kraków 2008 http://www.oneness.vu.lt/ www.poland.gov.pl http://e-polish.eu/main/dictionary/definition.html www.e-polish.eu</p>
Website of the course	<p>http://www.sjo.pw.edu.pl/anglojez_info_en.php</p>
D. Student's activity	
Number of ECTS credits	<p>2</p>
Number of hours of student's work to achieve effects of education	<p>1) Number of hours that require the presence of a teacher - 35, including: a) attendance at the</p>

Description of course

	exercises - 30 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 15 hours; • work on homework (solving tasks) - 15 hours. Total -2 ECTS credits.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit.
Number of ECTS credits on practical activities on the course	2 ECTS credits.

E. Additional information

Notes	
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Table 14. Learning outcomes

General academic profile - knowledge

Code of effect:	W_1
Description:	Has a very basic resource of words and simple expressions related to personal and individual, specific situations. Shows limited mastery of a few simple grammatical structures and sentence patterns.
Verification:	Work on the lesson, homeworks, test.
Field of study related learning outcomes	
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	U_1
Description:	Student can fill out forms with personal data as name, address, citizenship. Student can write with hearing unknown word. The student understands the familiar names and words and very simple sentences, for example. on the information boards on the shops and facilities of general interest. The student can take part in the conversation, provided that other person talks slowly and reiterates its of expression. Student is able to pronounce the Polish sounds.
Verification:	Assessment of the work of the student as part of lesson
Field of study related learning outcomes	
Area of study related learning outcomes	

Description of course

Code of course	ANWF2	
Name of course	Physical Education and Sport 2	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	College of Physical Education and Sport.	
Coordinator of course	Teacher at College of Physical Education and Sport.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Physical Education and Sports	
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 development of physical activity of students. Detailed data contains syllabus of specific course.	
Effects of education	See Table 15.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The exercise program offer by College of Physical Education and Sport.	
Methods of evaluation	According to the rules of classes developed by College of Physical Education and Sport.	
Methods of verification of effects of education	See Table 15.	
Exam	no	
Literature		
Website of the course		
D. Student's activity		
Number of ECTS credits	0	
Number of hours of student's work to achieve effects of education	Participation in classes - 30 hours.	
Number of ECTS credits on the course with direct participation of academic teacher	0.0 ECTS credit (30 hours of classes, without ECTS).	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes		
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Table 15. Learning outcomes

Description of course

Code of course	ANW90	
Name of course	Calculus II	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	Andrzej Fryszkowski, Professor	
B. General characteristic of the course		
Block of courses	Power 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	Calculus I.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	1. To convey and reinforce the knowledge on definite integrals (proper and improper) and their applications, series (numeric and functional), functions of many variables (sets, limits and continuity, multivariable calculus), ordinary differential equations, Frenet trihedron, line and surface integrals, Green, Stokes and Gauss Theorems. 2. To acquire thorough understanding of basic concepts and computational processes and to master skills of using them (labs) and to master the skill of correct mathematical reasoning and inference.	
Effects of education	See Table 16.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	First order ordinary differential equation. General and particular solutions. Initial value conditions. Existence and uniqueness. Separable equation and transformation a differential equation to that form. Linear equations of the first order. General solution. Solving nonhomogenous linear differential equations by the method of integrating factor and the method of variation of a parameter. Linear equations of the higher order. General and particular solutions. Initial value problems. Linear equation of the second order transformable to equation of the first order. Method of trial functions for nonhomogenous equation of the m-	

Description of course

	th order with constant coefficients. Double integral on a rectangle; integrability theorem. Mean value and integral mean value theorem. Double integral and iterated integral. Double integral on a standard domain. The Fubini theorem. Change of variable in a double integral. Region mapping: Jacobian determinant. Double integral in polar coordinates. Application of double integral to computation of areas and volumes of figures and solids. Double integral application: surface area of a frustum. Triple integral on parallelepiped. Fubini theorem for triple integral on standard solids (standard 3D domains). Changing of variables. Geometric application of a triple integral - volumes of solids, centers of mass. Line integrals. Green Theorem. Potentials. Work of a vector field.
Methods of evaluation	50% continuous assesment based on laboratory work and tests, 50% written final exam.
Methods of verification of effects of education	See Table 16.
Exam	yes
Literature	Recommended texts (reading): 1. Thomas "Calculus" 2. Robert A. Adams, Calculus. A complete course 3. Thomas G. Finney: Calculus, ed. Addison-Wesley
Website of the course	

D. Student's activity

Number of ECTS credits	5
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 64, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 30 hours; c) consultancy meetings - 4 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 41 hours; • work on homework (solving tasks) - 10 hours; • preparation for written tests - 15 hours; • preparation for the final examination - 15 hours. TOTAL - 145 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,5 ECTS credits - number of hours that require the presence of a teacher - 34, including: a) attendance at the lectures- 30 hours; b) attendance at the exercises - 30 hours; c) consultancy meetings - 4 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:	ANW90_W1
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Table 16. Learning outcomes	
Description:	Student knows theoretical foundations of the theory of ordinary differential equations.
Verification:	Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW90_W2
Description:	Student knows methods of solution of 1st-order ODEs and n-th order linear ODEs.
Verification:	Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW90_W3
Description:	Student knows selected solution methods for systems of ODEs, in particular the elimination and matrix methods.
Verification:	Exam
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW90_W4
Description:	Student has essential knowledge in the area of integral calculus of functions with 2 or 3 variables. Student knows applications of double and triple integrals in geometry and physics.
Verification:	Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW90_W5
Description:	Student has basic knowledge about curvilinear integrals and their applications in geometry and physics. Student knows basic concepts in vector analysis.
Verification:	Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW90_U1
Description:	Student can solve basic 1st-order ODEs and investigate uniqueness of the solution of the Cauchy problem.
Verification:	Activity/progress during tutorials. Exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW90_U1
Description:	Student can solve basic 1st-order ODEs and investigate uniqueness of the solution of the Cauchy problem.
Verification:	Activity/progress during tutorials. Exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW90_U2
Description:	Student has skills to determine the fundamental system for an ODE with constant coefficients and the Euler equation. Student can use the prediction method and the method of variation of

Table 16. Learning outcomes	
Verification:	parameters. Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW90_U2
Description:	Student has skills to determine the fundamental system for an ODE with constant coefficients and the Euler equation. Student can use the prediction method and the method of variation of parameters.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW90_U3
Description:	Student can solve a system of linear ODEs using the method of elimination and/or the matrix method.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW90_U3
Description:	Student can solve a system of linear ODEs using the method of elimination and/or the matrix method.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW90_U4
Description:	Student can evaluate double and triple integrals, also using the polar and spherical coordinates.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW90_U4
Description:	Student can evaluate double and triple integrals, also using the polar and spherical coordinates.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW90_U5
Description:	Student can calculate curvilinear integrals and applied them in geometry and physics. Student can determine the potential of a vector field and use it in evaluation of the oriented curvilinear integral.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U12

Table 16. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANW90_U5
Description:	Student can calculate curvilinear integrals and applied them in geometry and physics. Student can determine the potential of a vector field and use it in evaluation of the oriented curvilinear integral.
Verification:	Assessment of activity and progress during tutorials, tests and exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW90_K1
Description:	Student is aware of necessity of self-study and thoroughness and exactitude.
Verification:	Homework, exam.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANW114	
Name of course	Computer Science II	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Jacek Szumbariski, prof. PW	
B. General characteristic of the course		
Block of courses	Power 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	Basic skills in algebra and mathematical analysis on the level corresponding to the 1st-semester engineering courses, basic programming skills in C or C++.	
Limit of students	60	
C. Effects of education and manner of teaching		
Purpose of course	Development of basic knowledge and practical skills in the area of numerical techniques applied to the problems like: post-processing of measurement data and numerical analysis of simple dynamical systems.	
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	1. Contents (lectures programme): Polynomial interpolation: Lagrange and Newton methods, Runge effect and Chebyshev nodes. 2. Least-squares approximation: formulation and geometrical interpretation, the method of normal equations, the method of orthogonal polynomials. 3. Numerical integration: the trapezoidal and Simpson methods, the Gauss-Legendre method. 4. Numerical solution of initial-value problems for ordinary differential equations: transformation to the standard form, the Euler method and convergence analysis, single-step higher-order methods, the standard RK4 method, problem of the time step adaptation. 5. Cubic spline interpolation: formulation, end-point conditions, 3-diagonal systems and the Thomas algorithm. Method of Gauss Elimination: formulation, method	

Description of course

Methods of evaluation	with pivoting, LU factorization and its applications. 2 tests on theoretical part, work and progress of each student are evaluated in the framework of the point system, individual semester project.
Methods of verification of effects of education	See Table 17.
Exam	no
Literature	1. Recommended texts (reading): Lecture notes provided by the course instructor. 2. Heinbockel J.H.: Numerical methods in Scientific Computing. Trafford Publishing, 2006. Numerical Recipes in C++, 3rd Ed., Cambridge UP, 2007
Website of the course	Didactic materials at http://c-cfd.meil.pw.edu.pl/ccfd/index.php?item=6 (restricted access)

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 lectures -14 hours; b) attendance at the labs - 16 hours; c) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: <ul style="list-style-type: none"> • preparation to each laboratory meeting - 7*1h = 7h; • preparation for the tests (2 during the course) - 2*5 h = 10h; • work on the individual home project and report - 10 h. TOTAL: 59 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1.5 ECTS credits - number of hours that require the presence of a teacher - 32, including: a) attendance at the lectures-14 hours; b) attendance at the labs - 16 hours; c) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	1.5 ECTS

E. Additional information

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Table 17. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK114_W1
Description:	Student has elementary knowledge about formulation and solution methods of polynomial interpolation and approximation problems. Student knows the concept of interpolation by spline functions.
Verification:	Tests no.1 and 2, lab tutorial.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK114_W1
Description:	Student has elementary knowledge about formulation and solution methods of polynomial interpolation and approximation problems. Student knows the concept of interpolation by

Table 17. Learning outcomes	
	spline functions.
Verification:	Tests no.1 and 2, lab tutorial.
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	
Code of effect:	ANK114_W2
Description:	Student is acquainted with the basic numerical algorithms for approximate evaluation of determined integrals.
Verification:	Test no. 1, lab ex. 2
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK114_W2
Description:	Student is acquainted with the basic numerical algorithms for approximate evaluation of determined integrals.
Verification:	Test no. 1, lab ex. 2
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	
Code of effect:	ANK114_W3
Description:	Student has basic knowledge in the area of elementary algorithms applied to a nonlinear algebraic equation and to systems of linear equations (elimination methods).
Verification:	Tests no.1 and 2, lab ex. 3 and 6.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK114_W3
Description:	Student has basic knowledge in the area of elementary algorithms applied to a nonlinear algebraic equation and to systems of linear equations (elimination methods).
Verification:	Tests no.1 and 2, lab ex. 3 and 6.
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	
Code of effect:	ANK114_W4
Description:	Student has acquired elementary knowledge related to concepts and basic numerical techniques applied to initial value problems formulated for ordinary differential equations.
Verification:	Test no.2, lab ex. 4 and 5.
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	
Code of effect:	ANK114_W4
Description:	Student has acquired elementary knowledge related to concepts and basic numerical techniques applied to initial value problems formulated for ordinary differential equations.
Verification:	Test no.2, lab ex. 4 and 5.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK114_U1
Description:	Student is able to describe basic features of known algorithms and illustrate them using

Table 17. Learning outcomes	
	adequate examples.
Verification:	Tests no.1 and 2
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK114_U1
Description:	Student is able to describe basic features of known algorithms and illustrate them using adequate examples.
Verification:	Tests no.1 and 2
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANK114_U2
Description:	Using provided library routines, a student is able to implement selected numerical algorithms in the form of computer codes written in a high-level programming language.
Verification:	Lab meetings, evaluation of a home project.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK114_U2
Description:	Using provided library routines, a student is able to implement selected numerical algorithms in the form of computer codes written in a high-level programming language.
Verification:	Lab meetings, evaluation of a home project.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANK114_U3
Description:	Using a provided programming environment, a student is able to run the computer codes implementing selected numerical algorithms and to verify correctness of the obtained results.
Verification:	Lab meetings, evaluation of a home project.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK114_U3
Description:	Using a provided programming environment, a student is able to run the computer codes implementing selected numerical algorithms and to verify correctness of the obtained results.
Verification:	Lab meetings, evaluation of a home project.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANK114_U4
Description:	Student has skills to solve by him/herself a simple problem in the area of scientific computing or mechanics, perform critical analysis of an obtained solution and prepare a report in an electronic form.
Verification:	Lab meetings, evaluation of a home project.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK114_U4
Description:	Student has skills to solve by him/herself a

Table 17. Learning outcomes

	simple problem in the area of scientific computing or mechanics, perform critical analysis of an obtained solution and prepare a report in an electronic form.
Verification:	Lab meetings, evaluation of a home project.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	

Description of course

Code of course	ANW 113	
Name of course	Electric Circuits I	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Tadeusz Skoczowski, Ph.D., El. Eng.	
B. General characteristic of the course		
Block of courses	Power 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	Mathematics, Physics.	
Limit of students	The lecture - 60 students, exercises - 30 students.	
C. Effects of education and manner of teaching		
Purpose of course	To be able to use fundamental laws of linear electric circuits to solve electric dc ac circuits. Know how to analyse electric circuits containing independent and dependent sources using loop and nodal techniques. Know how to analyse electric circuits using additional techniques e.g. superposition, source transformation, Thevenin and Norton equivalent circuits. To get familiar with calculation of electric power and energy in dc and ac electric circuits. To be able to analyse first- and second order transient circuits. To understand variable-frequency performance of basic elements, resonant circuits and passive filters.	
Effects of education	See Table 18.	
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	Basic concepts of electric field and magnetic field. Role of Electromagnetic Field Theory. Electromagnetic Field Quantities. Properties of Electrostatic Fields. Gauss Law. Conservation Law. Electric Potential. Electric Fields for a System of Charges. Capacitance. Dielectrics. Electric Flux Density. Electric Potential for a System of Charges. Electrostatic Energy. Magnetic Force. Magnetostatics in Free Space. Magnetic Vector Potential. Biot-Savart Law. Faradays Law of Induction. Time Harmonic Fields. Basic Electric Circuit Concept. System of Units. Basic Quantities.	

Description of course

	<p>Circuit Elements. Analysis of Resistive Circuits. Element Constraints. Connection Constraints. Combined Constraints. Ohms Law. Kirchhoffs Laws. Single Loop Circuits. Single-Node-Pair Circuits. Circuits with Series Parallel Combinations of Resistor. Wye-Delta Transformation. Circuit Reduction. Equivalent Circuits. Voltage and Current Division.. Circuits with Dependant Sources. Resistors for Electronics. Computer-Aided Circuit Analysis. Loop and Nodal Techniques. Nodal analysis. Loop analysis. Additional Techniques. Superposition. Network. Linearity Properties. Thevenins and Nortons Theorems. Maximum Power Transfer. Signal Waveforms. Step Waveform. Exponential Waveform. Sinusoidal Waveform. Composite Waveforms. Waveform Partial Descriptors. Energy Storage Elements. Capacitors. Inductors. Capacitors and Inductors Combinations. Equivalent Capacitance and Inductance. Analysis of First- and Second-Order Transient Circuits. First-Order Circuits. RC and RL Circuits. First-Order Circuit Step Response. Initial and Final Conditions. First-Order Circuit Sinusoidal Response. Second-Order Circuits. Series RLC Circuit. Parallel RLC Circuit. Second-Order Circuit Step Response. Other Second-Order Circuits. AC Circuits Analysis Techniques. Sinusoids. Sinusoidal and Complex Forcing Function. Phasors. Phasor Relationship for Circuits Elements. Impedance. Admittance. Phasor Diagrams. Basic analysis Using Kirchhoffs Laws. Analysis Techniques. Power Calculations in AC Circuits. Instantaneous Power. Average Power. Maximum Average Power Transfer. RMS Values. Power Factor. AC Power. Complex Power. Power Factor Correction. Single-Phase Three-Wire Circuits. Home Power. Poly-Phase Circuits. Resonant Circuits. Analysis of Magnetically Coupled Networks. Mutual Inductance. Dot Convention. Energy Analysis. Ideal Transformer. Transformer Equivalent Circuits. Analysis of Three-Phase Circuits. Three-Phase Circuits. Three-Phase Connections. Power Relationship. Power Factor Correction. Variable-Frequency Circuits. Variable-frequency-Response Analysis. Sinusoidal Frequency Analysis. Bode Plots. Resonant Circuits. Passive Filters. Electrical Safety Considerations. Electric shock protection.</p>
Methods of evaluation	Two colloquia, final examine.
Methods of verification of effects of education	See Table 18.
Exam	yes
Literature	Recommended texts (reading): 1. Irwin J. D., Nelms R. M.: Basic Engineering Circuit Analysis, Willey, 9th edition. Further Readings: 1. Griffiths

Description of course

	D.J.: Introduction to Electrodynamics, Prentice Hall, 3rd edition. 2. Dorf R.C., Svoboda J.A.: Introduction to Electric Circuits, 7th edition. 3. Svoboda J.A.: Worked Examples from the Electric Circuit Study Applets, Willey, 2006. 4. Thomas R. E., Rosa A.J., Toussaint G.J.: The Analysis and Design of Linear Circuits, Willy, 2009, 6th edition.
Website of the course	http://estudia.meil.pw.edu.pl/
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 - 30 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • work on homework (solving tasks) - 10 hours; • preparation for colloquia - 10 hours; • preparation for the final examination - 5 hours. TOTAL: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
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Table 18. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANK113_W1
Description:	Student has the knowledge on how to apply mathematics, basic sciences, and engineering to solve problems encompassing electric circuits.
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ML.ANK113_W2
Description:	Student knows how to formulate and describe in mathematical terms problems related to electric and magnetictcs circuits.
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ML.ANK113_W3
Description:	Student knows how to apply the fundamental laws of electric circuit to compute basic electric quantities (current, voltage, powers).
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_W02

Table 18. Learning outcomes	
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ML.ANK113_U1
Description:	Student has the ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing electric circuits.
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
Code of effect:	ML.ANK113_U2
Description:	Student has the ability to identify and formulate a problem related to electric circuits.
Verification:	Colloquium 1. Colloquium 2 Exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ML.ANK113_U2
Description:	Student has the ability to identify and formulate a problem related to electric circuits.
Verification:	Colloquium 1. Colloquium 2 Exam.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
Code of effect:	ML.ANK113_U3
Description:	Student has the ability to apply the fundamental laws of electric circuit to compute basic electric quantities (current, voltage, powers).
Verification:	Colloquium 2. Exam.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
Code of effect:	ML.ANK113_U3
Description:	Student has the ability to apply the fundamental laws of electric circuit to compute basic electric quantities (current, voltage, powers).
Verification:	Colloquium 2. Exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	

Description of course

Code of course	ANW118										
Name of course	Engineering Graphics - CAD1										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Witold M.Mirski										
B. General characteristic of the course											
Block of courses	Power 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	Base information concerning the orthogonal projection of spatial geometrical forms onto adequate projection plane (Engineering Graphics).										
Limit of students	Group of 12 students for one teacher.										
C. Effects of education and manner of teaching											
Purpose of course	The skill of making views of machines element based on the real object according to the rules of International Standards (ISO) and reading of the technical drawing.										
Effects of education	See Table 19.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>30h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	30h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	30h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Introduction to technical drawing. Part view and axonometric projection of machines element based on the real object. Technical drawing of assemblies and parts with thread. Threaded and keyed joints. Technical drawing of gears. Assembly drawing of machines elements based on the real object. Part views based on assembly drawing. Introduction to CAD-2D system. Enjoyment of the computer library of CAD-2D system.										
Methods of evaluation	Positive results of tests as well as home and class work.										
Methods of verification of effects of education	See Table 19.										
Exam	no										
Literature	1. George C. Beakley, Ernst G. Chilton Introduction to Engineering Design and Graphics. 2. International Standards (Polish Standards).										
Website of the course	http://www.meil.pw.edu.pl/zpk/ZPK/Dydaktyka/										
D. Student's activity											

Description of course

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 - 35, including: a) attendance at the exercises - 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 25 hours; • work on homework - 15 hours; • preparation for tests - 4 hours; TOTAL - 79 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 35, including: a) attendance at the exercises - 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits - 75 hours , including: a) attendance at the exercises - 30 hours; b) consultancy meetings - 5 hours; c) systematic preparation for classes - 25 hours; d) work on homework - 15 hours.

E. Additional information

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Table 19. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW118_W1
Description:	Student knows the rules of the working detail drawing.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_W30
Area of study related learning outcomes	
Code of effect:	ANW118_W2
Description:	Student knows the rules of the surface roughness notation.
Verification:	Controlled self-work of students: ZK1W2-ZK1W4, ZK1U1-ZK1U5.
Field of study related learning outcomes	E1_W30
Area of study related learning outcomes	
Code of effect:	ANW118_W3
Description:	Student understands the necessity of using Polish Standards for the Technical Drawing and ISO Standards.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_W30
Area of study related learning outcomes	
Code of effect:	ANW118_W4
Description:	Student knows the rules of the working assembly drawing.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_W30
Area of study related learning outcomes	
Code of effect:	ANW118_W5
Description:	Student has the basic knowledge of creating the

Table 19. Learning outcomes	
	documentation using 2D-CAD systems.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_W30
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW118_U1
Description:	Student is able to make the working detail drawing from nature.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW118_U2
Description:	Student can use Polish Standards and ISO Standards.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW118_U2
Description:	Student can use Polish Standards and ISO Standards.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW118_U3
Description:	Student is able to make the technical drawing of the thread joint, keyed joint and gear joint.
Verification:	Controlled self-work of students: ZK1W2-ZK1W4, ZK1U1-ZK1U5.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW118_U4
Description:	Student can make an assembly drawing.
Verification:	Controlled self-work of students: ZK1W2-ZK1W4, ZK1U1-ZK1U5.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW118_U5
Description:	Student is able to make a detail drawing based on an assembly drawing.
Verification:	Test: ZK1W1, ZK1U1-ZK1U3, ZK1U5.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW118_U6
Description:	Student can make a detail drawing using a 2D-CAD system.
Verification:	Controlled self-work of students: ZK1W5, ZK1U1-ZK1U6.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	

Description of course

Code of course	ANW115										
Name of course	Mechanics II										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Elżbieta Jarzębowska, prof. PW										
B. General characteristic of the course											
Block of courses	Power 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	Students are required some basic skills in differential calculus.										
Limit of students	80 per lecture room										
C. Effects of education and manner of teaching											
Purpose of course	The goal is to teach students basic theory in vector mechanics, i.e. basics in kinematics and dynamics, as well as formulating and solving numerical problems in these areas.										
Effects of education	See Table 20.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>30h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	30h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	30h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Kinematics (geometry of motion): equations of motion of a particle in various reference frames. Motions of a rigid body: translation; rotation about a fixed axis; plane motion, including motion of a particle relative to a moving frame. Dynamics (Kinetics): dynamic equations of motion of a particle in various reference frames. Concepts of linear and angular momentum and theorems about the rate of change of linear momentum and angular momentum. Concept of energy of a particle, a system of particles and a rigid body. Dynamic equations of translation, rotation about a fixed axis, and plane motion for a rigid body. Determination of dynamic reactions in rotation about fixed axes.										
Methods of evaluation	3 written tests during semester and a final written exam.										
Methods of verification of effects of education	See Table 20.										
Exam	yes										
Literature	Recommended texts (reading): 1. Ferdinand P.										

Description of course

	Beer, E. Russell Johnston, Jr. (in last editions + three other co-authors): Vector Mechanics for Engineers STATICS, McGraw-Hill, Inc., any edition, last one 2004. 2.R.C. Hibbeler: Engineering Mechanics STATICS, Pearson, any edition, last one 2004. 3. Any academic textbook (engineering course) on General Mechanics, part: Statics. 4. Solving of problems, in addition to the above textbooks: 4a) Fogiel M. (editor): THE MECHANICS PROBLEM SOLVER. A Complete Solution Guide to Any Textbook. Redearch and Education Association (REA), 1992. 4b) COLLECTION OF PROBLEMS IN MECHANICS, in Russian, and in Polish as: I. Mieszczerski: ZBIÓR ZADAŃ Z MECHANIKI, PWN, many editions; solutions to this COLLECTION ... in German (author Neuber H., VEB Verlag, Berlin 1962, 1963), and in Polish as: Romuald Romicki: ROZWIĄZANIA ZADAŃ Z MECHANIKI ZBIORU I. W. MIESZCZERSKIEGO, PWN, many editions.
Website of the course	-
D. Student's activity	
Number of ECTS credits	5
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 64, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 30 hours; c) consultancy meetings - 4 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 30 hours; • preparing for tests -24 hours; • Preparing for exam -15 hours. TOTAL: 133 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,5 ECTS credits - number of hours that require the presence of a teacher - 64, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises -30 hours; c) consultancy meetings - 4 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 20. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW115_W1
Description:	Students get knowledge in energy methods of analysis of dynamics of a particle, set od particles and a rigid body.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W04
Area of study related learning outcomes	

General academic profile - skills

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Table 20. Learning outcomes	
Code of effect:	ANW115_U1
Description:	Students can determine kinematic characteristics for particles and rigid bodies w.r.t. inertial and non-inertial frames.
Verification:	Written test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW115_U2
Description:	Students can generate physical and mathematical models of simple mechanical systems.
Verification:	Written test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW115_U2
Description:	Students can generate physical and mathematical models of simple mechanical systems.
Verification:	Written test.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW115_U3
Description:	Students can determine potential and kinetic energies of parts of a mechanical system and determine their velocities and positions based upon the energy information.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW115_K1
Description:	Students get understand the place of knowledge and resarch, and the role of an engineer in society.
Verification:	Written test.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ANW115_K1
Description:	Students get understand the place of knowledge and resarch, and the role of an engineer in society.
Verification:	Written test.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Description of course

Code of course	ML.ANW117	
Name of course	Mechanics of Structures I	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Jakub Pawlicki	
B. General characteristic of the course		
Block of courses	Power 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	Mechanics I - Statics.	
Limit of students	min 15	
C. Effects of education and manner of teaching		
Purpose of course	To learn fundamentals of deformable bodies mechanics: stress, strain, material behavior as a introduction to structural analysis and design for static loads. Presenting concepts of statical structural analysis: equilibrium conditions, stress-strain relation (Hookes law) and structure deformation. Develop knowledge for strength analysis of one-dimensional structures in basic load cases: tension-compression, torsion and bending.	
Effects of education	See Table 21.	
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	Introduction: material solid, concepts of mechanics of structures: equilibrium, deformation behavior models. Fundamentals: internal and external forces, stresses strains and displacements. Idealization of the material (elastic, plastic, elastic-plastic,, visco elastic, visco-plastic), idealization of the structure and idealization of the geometry of strains. General principles of structural analysis. Analysis of stresses and strains. General Hookes low, plane stress and plane strain. Safety criteria: Huber-Mises criterion, maximum shear-stress criterion, concept of equivalent stress. Geometric properties of plane areas: moment of inertia, polar moment of inertia, product of inertia. One-dimensional	

Description of course

	problems of linear structures: tension and compression, torsion and bending of bars. Determination of stresses and displacements, safety evaluation. Elastic buckling of columns.
Methods of evaluation	Tests, home works, examination.
Methods of verification of effects of education	See Table 21.
Exam	yes
Literature	Recommended texts (reading): 1) Roy Craig Jr. "Mechanics of Materials". 2) John Hearn "Mechanics of Structures". 3) Documentation on http:// - Will be provided by lecturer. Further Readings: - Will be provided by lecturer.
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 - 30 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student • systematic preparation for classes - 15 hours; • work on homework - 24 hours; • preparation for tests - 12 hours; • preparation for exam - 10 hours. TOTAL: 111 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 21. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW117_W1
Description:	Well-grounded in mechanics of solids.
Verification:	Proficiency test,exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ML.ANW117_W2
Description:	Well-grounded in mechanics and stress analysis of beam and bar structures.
Verification:	Proficiency test.
Field of study related learning outcomes	E1_W04
Area of study related learning outcomes	
Code of effect:	ML.ANW117_W3
Description:	Fundamentals of column buckling.
Verification:	Proficiency test, exam.
Field of study related learning outcomes	E1_W04

Table 21. Learning outcomes	
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ML.ANW117_U1
Description:	Representing real structures by beam and bar models.
Verification:	Proficiency test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ML.ANW117_U2
Description:	Determining force resultants distributions for beam and bar structures.
Verification:	Proficiency test, exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ML.ANW117_U3
Description:	Applying strength hypothesis. Computation of equivalent stress. Checking stress condition.
Verification:	Proficiency test, exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ML.ANW117_U4
Description:	Computation of displacement field for bar and beam structures.
Verification:	Proficiency test, homework, exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ML.ANW117_U5
Description:	Computation of critical loads of column structures by linear buckling analysis.
Verification:	Proficiency test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	

Description of course

Code of course	ANW116										
Name of course	Thermodynamics I										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Piotr Furmański										
B. General characteristic of the course											
Block of courses	Power 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	Basic calculus.										
Limit of students	-										
C. Effects of education and manner of teaching											
Purpose of course	Knowledge of basic laws governing energy conversion and ways to determine quality of different energy conversion processes. Knowledge of the fundamentals of thermodynamics applied to combustion processes.										
Effects of education	See Table 22.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>30h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	30h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	30h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Lecture: Thermodynamic system and its properties, thermodynamic functions, irreversible and reversible transformations, microscopic and macroscopic energy, internal energy. Energy interactions (work, heat, energy exchange accompanying mass flow). Enthalpy. 1st Law of Thermodynamics for open system. Special cases (closed system, steady state, cycles). Thermal efficiency of engines and Coefficient of performance (COP) for refrigerators and heat pumps. Entropy and its features. Balance of entropy for open systems. Entropy generation and 2nd Law of Thermodynamics. Carnot cycle. Thermodynamic equilibrium and its types. Conditions for thermal, mechanical and phase equilibrium. Chemical potential. Simple substance. Diagrams of state. Thermal expansion and isothermal compressibility. Thermodynamic functions for simple substances. Special cases of simple substances (incompressible substance,										

Description of course

	<p>perfect gas). Thermodynamic functions for incompressible substances and perfect gases. Specific heats of the perfect gases. Characteristic transformations of perfect gases (polytropic process, throttling). Fundamentals of thermodynamics in combustion. Stoichiometric and nonstoichiometric reactions. Air excess ratio. Mass balance of reactants. Standard state. Thermal effects of combustion. Exercises: Examples of thermodynamic analysis of processes based on the 1st Law of Thermodynamics. Determination of a system state after transformations as well as amount and form of energy exchanged between the system and the surroundings. Calculation of efficiency of different engine cycles and COP of refrigerators and heat pumps. Examples of thermodynamic analysis based on the entropy balance. Thermodynamic transformations in systems containing incompressible substances, vapours and perfect gases. Determination of an amount of air needed for combustion, composition of combustion products and the maximum temperature of combustion.</p>
Methods of evaluation	4 tests, practical and theoretical exams, point system.
Methods of verification of effects of education	See Table 22.
Exam	yes
Literature	Recommended texts (reading): 1) Y.A. Cengel, M.A. Boles: "Thermodynamics. An Engineering Approach, McGraw Hill. 2) Materials for students placed on website.
Website of the course	
D. Student's activity	
Number of ECTS credits	5
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 63, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 30 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • systematic preparation for classes (tasks solving) - 20 hours; • preparation for tests - 20 hours; • preparation for exam - 15 hours. TOTAL: 118 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,5 ECTS credits - number of hours that require the presence of a teacher - 63, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 30 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	

Description of course

Notes	
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Table 22. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW116_W1
Description:	The student acquires knowledge about relations between thermodynamic functions a measurable thermodynamic properties.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ML.ANW116_W2
Description:	The student knows balances of energy, entropy, thermodynamic principles and ways of their application.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ML.ANW116_W3
Description:	He knows the ways of determining the thermodynamic functions describing substances.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ML.ANW116_W4
Description:	The student knows methods of evaluation of process effectiveness basing on thermodynamic principles.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ML.ANW116_W4
Description:	The student knows methods of evaluation of process effectiveness basing on thermodynamic principles.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ML.ANW116_W4
Description:	The student knows methods of evaluation of process effectiveness basing on thermodynamic principles.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ML.ANW116_U1
Description:	The student is able to find in databases values of properties and thermodynamic functions.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	

Table 22. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ML.ANW116_U2
Description:	The student is able to find in literature and internet information related to thermodynamic problems and energy conversion in different processes.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ML.ANW116_U3
Description:	The student is able to describe simple processes basing on thermodynamics methods taking in account both steady and transient states of these processes.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ML.ANW116_U4
Description:	The student is able to predict how variation in the measurable properties affects the proces and effectiveness of energy conversion.
Verification:	Written tests, exam.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	

Description of course

Code of course	ANJ2/ANPL2	
Name of course	Foreign Language 2	
Version of course	2014.	
A. Place of the course in system of studies		
Level of education	First 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	The Foreign Language Centre	
Coordinator of course	For details, refer to the syllabus of the course.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Languages	
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	For details, refer to the syllabus of the course.	
Limit of students	For details, refer to the syllabus of the course.	
C. Effects of education and manner of teaching		
Purpose of course	For details, refer to the syllabus of the course.	
Effects of education	See Table 23.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	For details, refer to the syllabus of the course.	
Methods of evaluation	For details, refer to the syllabus of the course.	
Methods of verification of effects of education	See Table 23.	
Exam	no	
Literature	For details, refer to the syllabus of the course.	
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	Number of hours that require the presence of a teacher ~30 exercises hours. The number of hours of independent work of student ~30.	
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit.	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes	Detailed information about the effects of teaching presents a course syllabus.	
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Table 23. Learning outcomes

Description of course

Code of course	ANJ2/ANPL2										
Name of course	Foreign/Polish Language 2										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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	SJO PW										
Coordinator of course	mgr Marta Szpak										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Languages										
Type of course	Compulsory										
Language of course	polski										
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	Achieving general competence in Polish at the A1 level, in particular the following language skills: listening comprehension - ability to interact at a shop, at the restaurant, order food products. Talking about everyday activities and hobbies. Practise the pronunciation.										
Effects of education	See Table 24.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>30h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	30h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	30h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	1. The idea of cases, how to translate Polish sentences. 2. Typical Polish products, simple word formatting (e.g.: tomato - tomato soup). 3. Poproszę herbatę - introduction of the accusative case. 4. What do you eat for breakfast, lunch, dinner? 5. Simple word formation (e.g.: tomato - tomato soup). 6. At the grocery - dialogue. 7. "In the shop" - dialogue practice. 8. At the café. 9. At the restaurant - dialogues. 10. At the restaurant - ordering a meal. 11. Ordering pizza and pierogi - giving simple data: address, phone. 12. A workshop: going out - asking for directions, buying food at a local shop, at a fast-food outlet. 13. Colours and basic adjectives. 14. Describing objects and people. 15. Plural of nouns - food products. 16. Plural of nouns and adjectives in nominative case. 17. At the railway station. 18. At the railway station. 19. At the post office. 20. Easter traditions in Poland. 21. Easter traditions in										

Description of course

	Poland. 22. What are you doing? Introduction to the present tense. 23. What do you like to do? How often do you...? 24. 4 types of conjugations. 25. Verbs you already know - "international" verbs. 26. What do you like doing? Hobbies. 27. Verb practice. 28. Revision. 29. End-of-term test. 30. End-of term test.
Methods of evaluation	Attendance (two absences are allowed) Passing all tests Completing 90 % of homework assignments In-class participation Passing the module test (weight of the mark for the module test in the final grade: 50%)
Methods of verification of effects of education	See Table 24.
Exam	no
Literature	Recommended texts: Obligatory: Piotrowska-Rola E. Porębska M., Polski jest cool, Lublin 2013 Supplementary materials: 1. Kowalska M., Polish in 4 weeks REA, Warszawa 2009 2. Lachowicz J., Podsiadły J., Ten, ta, to. Ćwiczenia nie tylko gramatyczne dla cudzoziemców, wyd. WING 2001 3. Machowska J., Gramatyka? Dlaczego nie?! Ćwiczenia gramatyczne dla poziomu A1, Universitas, Kraków 2010, 4. Madelska L., Discovering Polish. A Learner's Grammar / Polnisch entdecken. Eine Lerngrammatik / Odkrywamy język polski. Gramatyka dla uczących (się) języka polskiego jako obcego, Prolog, Kraków 2008 5. Polish for foreigners. Audio Course (CD), Warszawa, Edgard 2006 6. Seretny A., A co to takiego? Obrazkowy słownik języka polskiego, Universitas, Kraków 2008 http://www.oneness.vu.lt/ www.poland.gov.pl http://e-polish.eu/main/dictionary/definition.html www.e-polish.eu
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	-
Number of ECTS credits on the course with direct participation of academic teacher	1) Number of hours that require the presence of a teacher - 35, including: a) attendance at the exercises - 30 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 15 hours; • work on homework (solving tasks) - 15 hours. Total -2 ECTS credits.
Number of ECTS credits on practical activities on the course	1 ECTS credit.
E. Additional information	
Notes	-
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Table 24. Learning outcomes

General academic profile - knowledge

Code of effect:	W_1
Description:	The person using the language to understand speech and frequently used expressions in terms of topics, related to the life daily.
Verification:	Test, assessment of student work in class.
Field of study related learning outcomes	
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	U_1
Description:	Can write short, simple notes, or messages, the resulting ad hoc needs. Can write a simple letter private, for example. thanking someone for something. Can communicate in simple, routine communication situations, requiring only the direct Exchange of information on familiar and typical. Can in a simple way to describe its origin and the environment in which it lives, and move the case, linked with the most important needs of daily life.
Verification:	Evaluation of homework, test, assessment of the work of the student during the lesson.
Field of study related learning outcomes	
Area of study related learning outcomes	

Description of course

Code of course	ANWF3	
Name of course	Physical Education and Sport 3	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	College of Physical Education and Sport.	
Coordinator of course	Teacher at College of Physical Education and Sport.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Physical Education and Sports	
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 development of physical activity of students. Detailed data contains syllabus of specific course.	
Effects of education	See Table 25.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The exercise program offer by College of Physical Education and Sport.	
Methods of evaluation	According to the rules of classes developed by College of Physical Education and Sport.	
Methods of verification of effects of education	See Table 25.	
Exam	no	
Literature		
Website of the course		
D. Student's activity		
Number of ECTS credits	0	
Number of hours of student's work to achieve effects of education	Participation in classes - 30 hours.	
Number of ECTS credits on the course with direct participation of academic teacher	0.0 ECTS credit (30 hours of classes, without ECTS).	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes		
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Table 25. Learning outcomes

Description of course

Code of course	ANW123
Name of course	Basics of Automation and Control 1
Version of course	2013
A. Place of the course in system of studies	
Level of education	First 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, Division of Theory of Machines and Robots
Coordinator of course	dr inż. Paweł Malczyk
B. General characteristic of the course	
Block of courses	Power 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	Calculus 1 (ML.ANW102); Calculus 2 (ML.ANW90);
Limit of students	-
C. Effects of education and manner of teaching	
Purpose of course	<p>1. Remember the basic structure of feedback control systems and understand the purpose of its components. Be able to offer some illustrative examples of control systems in engineering fields.</p> <p>2. Be able to recognize that ordinary differential equations (ODEs) can describe the dynamic behavior of physical systems.</p> <p>3. Understand the application of Laplace transforms and their role in solving ODEs and obtaining transfer functions.</p> <p>4. Be able to linearize a nonlinear algebraic and ODEs through the use of Taylor series expansion.</p> <p>5. Be able to calculate and interpret the time-responses of linear dynamic systems.</p> <p>6. Understand the concepts of state variables, state differential equations, and output equations. Know how to calculate the transfer function from a state variable model, and vice versa.</p> <p>7. Be aware of block diagrams and be able to transform them.</p> <p>8. Be aware of frequency spectrum of continuous-time signals.</p> <p>9. Understand the powerful concept of frequency response and its role in control system design.</p> <p>10. Understand the differences between controlling the transient response and the steadystate response of a system.</p> <p>11. Be aware of key test signals used in controls and of the resulting transient response characteristics of basic linear dynamic systems.</p> <p>12. Understand the concept of absolute, relative stability, and</p>

Description of course

	<p>bounded-input, bounded-output stability of dynamic systems.
 13. Know how to apply Routh-Hurwitz stability criteria to determine absolute and parametric stability of linear systems.
 14. Understand the Nyquist stability criteria and the role of Nyquist and Bode plots.
 15. Be capable of analyzing the relative stability and performance of feedback control system using frequency response methods considering phase and gain margin.
 16. Be familiar with time-domain and frequency domain performance specifications.
 17. Be able to choose and apply P, PD, PI, and PID controllers to improve the system performance.
 18. Recognize the improvements afforded by feedback in reducing system sensitivity to parameter changes, disturbance rejections, and measurement noise attenuation.</p>										
Effects of education	See Table 26.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	<p>1. Introduction to control systems
 2. The Laplace transform and its applications.
 3. Transfer function and dynamic response.
 4. Control systems analysis in state space.
 5. Block diagrams of dynamic systems.
 6. Frequency analysis of continuous-time signals.
 7. Introduction to the frequency response methods.
 8. Basic linear dynamical systems.
 9. Stability analysis of linear control systems.
 10. Stability in the frequency domain.
 11. The performance of feedback control systems.
 12. Introduction to PID controllers.</p>										
Methods of evaluation	<p>1. Two tests including both computational and theoretical problems.
 2. Two graded homework assignments.
 The details of the grading policy are published on the course website.</p>										
Methods of verification of effects of education	See Table 26.										
Exam	no										
Literature	<p>1. K. Ogata. Modern Control Engineering, Prentice Hall, 3rd Edition, 1997.
 2. R. Dorf, R. Bishop. Modern Control Systems, Pearson Prentice Hall, 11th Edition, 2008.
 3. K. Astrom, R. Murray. Feedback Systems. An Introduction for Scientists and Engineers, Princeton University Press, 2008.
 4. N. Nise. Control Systems Engineering, John Wiley and Sons, 6th Edition, 2011.
 5. G. Franklin, J.</p>										

Description of course

	Powell, A. Emami-Naeini. Feedback Control of Dynamic Systems, Prentice Hall, 4th Edition, 2002. 6. User's guides: Matlab Control System Toolbox.
Website of the course	http://ztmir.meil.pw.edu.pl/web/eng/Teaching/Offered-Courses2/Basics-of-Automation-and-Control-I

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) lectures - 30 hours; b) tutorials -15 hours; c) office hours - 5 hours. 2) The number of hours of independent work of a student: • systematic preparation for the lectures - 25 hours; • systematic preparation for the tutorials - 25 hours; TOTAL: 100 hours (4ECTS).
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 50 including: a) lectures - 30 hours; b) tutorials -15 hours; c) office hours - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 26. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW123_W1
Description:	Have a knowledge of the Laplace transform and associated theorems.
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW123_W1
Description:	Have a knowledge of the Laplace transform and associated theorems.
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANW123_W2
Description:	Have a knowledge of the transfer function and the sinusoidal transfer function for the linear time-invariant system.
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW123_W2
Description:	Have a knowledge of the transfer function and the sinusoidal transfer function for the linear time-invariant system.
Verification:	Test 1, Homework 1.

Table 26. Learning outcomes	
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANW123_W3
Description:	Have a knowledge of the feedback loop, open- and closed-loop control systems.
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW123_W3
Description:	Have a knowledge of the feedback loop, open- and closed-loop control systems.
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANW123_W4
Description:	Have a knowledge of the stability theorem of linear time-invariant systems.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANW123_W4
Description:	Have a knowledge of the stability theorem of linear time-invariant systems.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW123_W5
Description:	Have a knowledge of chosen stability criteria for linear time-invariant systems.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW123_W5
Description:	Have a knowledge of chosen stability criteria for linear time-invariant systems.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANW123_W6
Description:	Have a knowledge of PID controllers and its basic applications.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW123_W6
Description:	Have a knowledge of PID controllers and its basic applications.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW123_U1
Description:	Can apply Laplace transform for chosen technical signal.

Table 26. Learning outcomes	
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW123_U2
Description:	Can determine the response of a linear time-invariant system due to the chosen input signal.
Verification:	Test 1, Homework 1.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW123_U3
Description:	Can apply various stability criteria for linear time-invariant systems.
Verification:	Test 2.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW123_U4
Description:	Can specify basic performance indices for the dynamic response.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_U26
Area of study related learning outcomes	
Code of effect:	ANW123_U5
Description:	Can describe at least one of the PID controller tuning rules.
Verification:	Test 2, Homework 2.
Field of study related learning outcomes	E1_U26
Area of study related learning outcomes	

Description of course

Code of course	ANK317										
Name of course	Electric circuits 2										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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	mgr inż. Paweł Błaszczuk										
B. General characteristic of the course											
Block of courses	Power 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	winter semester										
Preliminary requirements	Electric Circuits I										
Limit of students	30										
C. Effects of education and manner of teaching											
Purpose of course	Further enhancement of the theory of electric circuits and development of related practical skills. Learning methods of electrical measurements, including power and electrical energy measurements being of value in industrial energy management. Learning principles of maintenance of selected electric power devices.										
Effects of education	See Table 27.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>30h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	30h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	30h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Various methods of impedance measurement. Investigation of nonlinear elements. Investigation of inductive coils with different ferromagnetic materials. Power and energy measurement in one- and three phase networks. Transformer test. Induction machine test. Electric shock protection.										
Methods of evaluation	Test before each experiment proving required knowledge. Active participation in carrying out experiments. Preparation of laboratory reports and their successful presentation. Design of a simple electrical circuit and its numerical simulation.										
Methods of verification of effects of education	See Table 27.										
Exam	no										
Literature	Recommended texts (reading): Irwin J. D., Nelms R. M.: Basic Engineering Circuit Analysis, Willey, 10th edition. Further Readings: 1. Griffiths D.J.: Introduction to Electrodynamics, Prentice Hall, 3rd										

Description of course

	edition. Dorf R.C., Svoboda J.A.: Introduction to Electric Circuits, 7th edition. Svoboda J.A.: Worked Examples from the Electric Circuit Study Applets, Willey, 2006. 2. Thomas R. E., Rosa A.J., Toussaint G.J.: The Analysis and Design of Linear Circuits, Willy, 2009, 6th edition.
Website of the course	http://itc.pw.edu.pl/IT/Moodle-materialy-dla-studentow

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: • systematic preparation for classes - 10 hours; • prepare laboratory reports - 15 hours. TOTAL: 57 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 32, 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 - 57 hours, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 10 hours; • prepare laboratory reports - 15 hours.

E. Additional information

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Table 27. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK317_W1
Description:	Student has enhanced knowledge and practical skills on electric circuits, electric machines and electric shock protection, and knows practical electric measurement methods, including basic tests of electric machines.
Verification:	Test before each experiment proving required knowledge. Active participation in carrying out experiments. Preparation of laboratory reports and their successful presentation. Design of a simple electrical circuit and its numerical simulation.
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ANK317_U1
Description:	Student can prepare and carry out experiments, and prepare report on made measurements of selected electric circuits and electric machines.

Table 27. Learning outcomes	
Verification:	Test before each experiment proving required knowledge. Active participation in carrying out experiments. Preparation of laboratory reports and their successful presentation. Design of a simple electrical circuit and its numerical simulation.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK317_U2
Description:	Student can design, compute and numerically model a simple electric circuit.
Verification:	Student designs a simply electric circuits and demonstrates it numerical simulation.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK317_K1
Description:	Student working in a team can prepare an experiment, carry it out, and prepare report from the experiment made.
Verification:	Preparation of laboratory reports and their successful presentation. Design of a simple electrical circuit and its numerical simulation.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ANW122										
Name of course	Fluid Mechanics I										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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. Jacek Szumbariski, prof. PW										
B. General characteristic of the course											
Block of courses	Power 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	winter semester										
Preliminary requirements	Solid knowledge of the fundamentals of linear algebra, analytical geometry and mathematical analysis on the level typical for the first-year mathematical courses run in technical universities.										
Limit of students	60										
C. Effects of education and manner of teaching											
Purpose of course	Good knowledge of the fundamental concepts and principles of the Fluid Mechanics, skills in solving basic problems in fluid statics and dynamics of an ideal and viscous liquid.										
Effects of education	See Table 28.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	1. Contents (lectures programme): Fluid as a continuous medium 2. Elements of fluid statics: equilibrium equations and condition, manometers, fluid reaction on the solid walls, the Archimedes law. 3. Fluid kinematics: Lagrangian and Eulerian descriptions, vector field of the fluid velocity, trajectories of fluid elements and streamlines, the streamfunction, vorticity and related theorems, tensor description of the fluid deformation. 4. Principle of mass conservations and the continuity equation. 5. Dynamics of continuum: tensor description of stress in fluid, the linear momentum principle and general equation of motion, the principle of angular momentum and the symmetry of the stress tensor. 6. Viscous fluids: rheological model of the Newtonian fluid, Navier-Stokes Equation, problem of the boundary conditions,										

Description of course

	examples of analytical solutions. 7. Model of an ideal fluid: Euler equation, first integral of Bernoulli and Cauchy-Lagrange, some applications. 8. Integral form of the momentum principle and its application to determination of the reaction force exerted on immersed bodies. Aerodynamic coefficients. 9. Flow similitude. 10. Elements of hydraulics: motion of a viscous liquid in pipes, Bernoulli Equation with pressure-loss terms. 11. Introduction to the boundary layer theory: Prandtl's equation, the layer thickness, The Blasius solution, integral von Karman equation, boundary layer separation. Elementary introduction to the theory of turbulent flows: physical characteristics of a turbulent flow, the laminar-turbulent transition, averaging procedure and the Reynolds Equations, the closure problem.
Methods of evaluation	2 tests in the tutorial part, the final exam.
Methods of verification of effects of education	See Table 28.
Exam	yes
Literature	1. Kundu P.K., Cohen I.M.: Fluid Mechanics. Elsevier Academic Press, 3rd Ed. (2004) or newer. 2. Aris R.: Vectors, tensors and the basic equations of Fluid Mechanics. Dover Publications Inc., 1989.
Website of the course	Didactic materials at http://c-cfd.meil.pw.edu.pl/ccfd/index.php?item=6 (restricted access)

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 - 48, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • systematic preparation for classes, solving tasks - 20 hours; • preparation for written tests - 15 hours; • preparation for the final examination - 20 hours. TOTAL: 103 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 48, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	1.5 ECTS credits.

E. Additional information

Notes	-
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Table 28. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW122_W1
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Table 28. Learning outcomes	
Description:	Students knows theoretical foundations of fluid statics and kinematics.
Verification:	Test 1, final exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW122_W1
Description:	Students knows theoretical foundations of fluid statics and kinematics.
Verification:	Test 1, final exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW122_W2
Description:	Student acquired basic knowledge on formulation of conservation laws for fluids, governing equations and determination of aero/hydrodynamic forces.
Verification:	Test 1 and 2, final exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW122_W2
Description:	Student acquired basic knowledge on formulation of conservation laws for fluids, governing equations and determination of aero/hydrodynamic forces.
Verification:	Test 1 and 2, final exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW122_W3
Description:	Student acquired basic knowledge on the Newtonian fluid model, on the basic engineering methods for laminar and turbulent flows in ducts, and on the concept and criteria of dynamic flow similarity.
Verification:	Test 2, final exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW122_W3
Description:	Student acquired basic knowledge on the Newtonian fluid model, on the basic engineering methods for laminar and turbulent flows in ducts, and on the concept and criteria of dynamic flow similarity.
Verification:	Test 2, final exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW122_W4
Description:	Student knows fundamentals theoretical facts and methods in the area of gas dynamics.
Verification:	Final exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW122_W4
Description:	Student knows fundamentals theoretical facts and methods in the area of gas dynamics.

Table 28. Learning outcomes	
Verification:	Final exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW122_U1
Description:	Student can solve simple problems in fluid statics.
Verification:	Test 1, final exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U1
Description:	Student can solve simple problems in fluid statics.
Verification:	Test 1, final exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U1
Description:	Student can solve simple problems in fluid statics.
Verification:	Test 1, final exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U2
Description:	Using methods of algebra and analysis, student is able to compute kinematic characteristics of fluid motion.
Verification:	Final exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U2
Description:	Using methods of algebra and analysis, student is able to compute kinematic characteristics of fluid motion.
Verification:	Final exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U2
Description:	Using methods of algebra and analysis, student is able to compute kinematic characteristics of fluid motion.
Verification:	Final exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U3
Description:	Student can solve simple problems for ideal and real liquid flows using the basic or generalized Bernoulli equation.
Verification:	Test 1 and 2, final exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U3
Description:	Student can solve simple problems for ideal and real liquid flows using the basic or generalized Bernoulli equation.

Table 28. Learning outcomes	
Verification:	Test 1 and 2, final exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U3
Description:	Student can solve simple problems for ideal and real liquid flows using the basic or generalized Bernoulli equation.
Verification:	Test 1 and 2, final exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U4
Description:	Using the integral form of the Linear Momentum Principle student is able to determine aero/hydrodynamic reactions in simple cases.
Verification:	Test 2, final exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U4
Description:	Using the integral form of the Linear Momentum Principle student is able to determine aero/hydrodynamic reactions in simple cases.
Verification:	Test 2, final exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U4
Description:	Using the integral form of the Linear Momentum Principle student is able to determine aero/hydrodynamic reactions in simple cases.
Verification:	Test 2, final exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U5
Description:	Student is able to perform a simple analysis of flow similarity and to predict the form of the physical law using dimensional arguments.
Verification:	Final exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U5
Description:	Student is able to perform a simple analysis of flow similarity and to predict the form of the physical law using dimensional arguments.
Verification:	Final exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U5
Description:	Student is able to perform a simple analysis of flow similarity and to predict the form of the physical law using dimensional arguments.
Verification:	Final exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U6
Description:	Student is able to solve simple problems in gas

Table 28. Learning outcomes	
	dynamics using the energy equation, isentropic relations, or basic results concerning the normal shock wave.
Verification:	Final exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U6
Description:	Student is able to solve simple problems in gas dynamics using the energy equation, isentropic relations, or basic results concerning the normal shock wave.
Verification:	Final exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U6
Description:	Student is able to solve simple problems in gas dynamics using the energy equation, isentropic relations, or basic results concerning the normal shock wave.
Verification:	Final exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	

Description of course

Code of course	ANK423										
Name of course	Heat Transfer 1										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Piotr Furmański										
B. General characteristic of the course											
Block of courses	Power 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	winter semester										
Preliminary requirements	Thermodynamics I.										
Limit of students											
C. Effects of education and manner of teaching											
Purpose of course	Knowledge of the basic and complex heat transfer modes and their mathematical description. Thermal properties of materials. Steady and transient heat conduction. Forced and natural heat convection. Heat convection with phase change - condensation and boiling. Fundamentals of radiative heat transfer.										
Effects of education	See Table 29.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>15h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	15h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	15h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	<p>Lectures: 1. Basic and complex modes of heat transfer. 2. Heat conduction. Heat conduction through a thin-wal structures (fins). Thermal resistances. 3. Transient heat conduction.Characteristic features of heat conduction for limiting values of Biot and Fourier similarity numbers. 4. Heat convection. Convective heat transfer coefficient and ways of its determination. Similarity theory in heat transfer. Correlation equations. 5. Forced convection in internal and external flows. 6. Natural convection in channels, open and closed spaces. 7. Heat transfer accompanying phase change. Characteristic features of heat transfer at condensation and boiling. 8. Fundamentals of thermal radiation and radiative heat transfer.</p> <p>Tutorials: 1. Temperature and heat transfer calculations for simple geometries of solids for</p>										

Description of course

	heat conduction in steady state. 2. Temperature and heat transfer calculations for simple geometries of solids for heat conduction in transient state. 3. Determination of the convective heat transfer coefficient, heat flux and temperature distribution for nonisothermal internal flow of fluids. 4. Determination of the convective heat transfer coefficient and heat flux for nonisothermal external flow of fluids. 5. Determination of the convective heat transfer coefficient, heat flux for natural convection in open and closed spaces. 6. Determination of the convective heat transfer coefficient, heat flux and an amount of the new phase formed for condensation and boiling. 7. Calculation of radiative heat transfer between grey and diffuse surfaces.
Methods of evaluation	2 tests, practical and theoretical exams, point system of evaluation.
Methods of verification of effects of education	See Table 29.
Exam	yes
Literature	1) Cengel Y.A.: "Heat Transfer; A Practical Approach", McGraw Hill. 2) Materials for students placed on website.
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 - 35, including: a) attendance at the lectures -15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes, solving tasks - 20 hours; • preparation for tests - 10 hours; • preparation for the final examination - 10 hours. TOTAL: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 35, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 29. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK423_W1
Description:	The student knows basic and complex modes of heat transfer, basic notions used in heat transfer

Table 29. Learning outcomes	
	and methods of formulation and solution of heat transfer problems.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANK423_W2
Description:	The student knows relations between heat transfer and thermodynamics.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK423_W3
Description:	The student knows relations between convective heat transfer and fluid mechanics including relations between friction and convective heat transfer coefficients.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK423_W4
Description:	The students knows how heat transfer affects energetic effectiveness of processes.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANK423_W5
Description:	The students knows which heat transfer processes and in what a way affect operation of appliances used in conventional power engineering.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANK423_W6
Description:	The student knows which modes of heat transfer and in what a way affect operation of appliances used in power engineering based on renewable energy sources.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK423_U1
Description:	The student is able to solve simple problems in heat transfer related to determination of temperature distribution in steady and transient states.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_U21
Area of study related learning outcomes	
Code of effect:	ANK423_U2
Description:	The student is able to apply basic notions, terminology and units used in heat transfer.
Verification:	Tests, exam.

Table 29. Learning outcomes	
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANK423_U3
Description:	The student is able to find information about thermal properties of substances indispensable in calculations on heat transfer.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANK423_U4
Description:	The student is able to recognize basic and complex heat transfer modes in different processes and formulate mathematical models used in determination of temperature and heat flux distributions.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	

Description of course

Code of course	ANW124										
Name of course	Machine Design I										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Stanisław Bogdański; profesor PW										
B. General characteristic of the course											
Block of courses	Power 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	winter semester										
Preliminary requirements	Materials I, Mechanics I, Mechanics of Structures I.										
Limit of students	70										
C. Effects of education and manner of teaching											
Purpose of course	To gain an understanding of design philosophies and to learn how to incorporate into the process of design the earlier-studied principles of strength of materials, materials science, mechanics, etc. To learn the fundamentals of designing for static and fatigue loading with the use of simple machine elements (joints, fasteners, beams and shafts) as the examples.										
Effects of education	See Table 30.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>15h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	15h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	15h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Introduction to design: design process, problem formulation and calculation, experimental tests, the engineering model, factors of safety and design codes, patents and standards, safety regulations, limiting conditions, optimization and evaluation criteria. Static failure theories Fatigue failure theories: fatigue failure models, fatigue loads, notches and stress concentrations, designing for high-cycle fatigue, designing for fully reversed and fluctuating stresses. Modelling and calculations in selected areas of machine design: welded, riveted and cemented joints, fasteners, interference fits.										
Methods of evaluation	Continuous assessment during the whole semester. Three regular tests organized during the semester plus one additional as the test for improvement at the end of semester. See the										

Description of course

	regulations for the course at WWW: http://meil.pw.edu.pl/zpk/ZPK/Dydaktyka/Regulaminy-zajec-dydaktycznych .
Methods of verification of effects of education	See Table 30.
Exam	no
Literature	1. Machine Design, An Integrated Approach, Fourth edition, by Robert L. Norton, Prentice Hall 2010. 2. Machine Elements in Mechanics and Design Fourth Edition, by Robert L. Mott, Prentice Hall 2006. 3. Design of Machine Elements seventh edition, by M.F. Spotts and T.E. Shoup, Prentice Hall 1998.
Website of the course	http://meil.pw.edu.pl/zpk/ZPK/Dydaktyka/Materialy-dla-studentow-Files-for-students

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 - 33, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student • systematic preparation for classes, solving tasks - 30 hours; • preparation for tests - 12 hours; TOTAL: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

Notes	
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Table 30. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW124_W1
Description:	He/She is familiar with the general and detailed principles and procedures of machine design.
Verification:	Test
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW124_W2
Description:	He/She is familiar with the main reasons of wear and failures of components of machines and mechanical devices.
Verification:	Test
Field of study related learning outcomes	E1_W04
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ANW124_U1
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Table 30. Learning outcomes	
Description:	He/She is able to use correctly basic concepts, names and units, which are typical for machine design. In particular such as: durability, loading capacity, ultimate and fatigue strength, safety factor, allowable stress, limiting condition, deterministic and probabilistic modelling, reliability and safety.
Verification:	Test
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW124_U1
Description:	He/She is able to use correctly basic concepts, names and units, which are typical for machine design. In particular such as: durability, loading capacity, ultimate and fatigue strength, safety factor, allowable stress, limiting condition, deterministic and probabilistic modelling, reliability and safety.
Verification:	Test
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANW124_U1
Description:	He/She is able to use correctly basic concepts, names and units, which are typical for machine design. In particular such as: durability, loading capacity, ultimate and fatigue strength, safety factor, allowable stress, limiting condition, deterministic and probabilistic modelling, reliability and safety.
Verification:	Test
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW124_U1
Description:	He/She is able to use correctly basic concepts, names and units, which are typical for machine design. In particular such as: durability, loading capacity, ultimate and fatigue strength, safety factor, allowable stress, limiting condition, deterministic and probabilistic modelling, reliability and safety.
Verification:	Test
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANW124_U2
Description:	He/She is able to perceive the physical limitations (concerning mainly the strength, elasticity, durability and heat resistance of materials) and non physical related to economy, and standardisation as well as that resulting from an incomplete knowledge of engineers and imperfect tools being in their disposal.
Verification:	Test
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	

Table 30. Learning outcomes	
Code of effect:	ANW124_U2
Description:	He/She is able to perceive the physical limitations (concerning mainly the strength, elasticity, durability and heat resistance of materials) and non physical related to economy, and standardisation as well as that resulting from an incomplete knowledge of engineers and imperfect tools being in their disposal.
Verification:	Test
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW124_U3
Description:	He/She is able to formulate limiting conditions, which are essential for completing calculations in designing simple mechanical devices.
Verification:	Test
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW124_U3
Description:	He/She is able to formulate limiting conditions, which are essential for completing calculations in designing simple mechanical devices.
Verification:	Test
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW124_U3
Description:	He/She is able to formulate limiting conditions, which are essential for completing calculations in designing simple mechanical devices.
Verification:	Test
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW124_U4
Description:	He/She is able to build simple models of states and phenomena typical for machines, mechanical devices and structures, which are necessary for performing engineering calculations, among others the models of: stresses and deflections, fatigue and failure, properties of materials and machine components as well as their dependence on the manufacturing techniques.
Verification:	Test
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW124_U4
Description:	He/She is able to build simple models of states and phenomena typical for machines, mechanical devices and structures, which are necessary for performing engineering calculations, among others the models of: stresses and deflections, fatigue and failure, properties of materials and machine components as well as their dependence on the

Table 30. Learning outcomes	
	manufacturing techniques.
Verification:	Test
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANW124_U5
Description:	He/She knows how to perform engineering analysis (calculations) necessary for estimating fatigue strength and durability of simple components of machines, devices and structures
Verification:	Test
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW124_U5
Description:	He/She knows how to perform engineering analysis (calculations) necessary for estimating fatigue strength and durability of simple components of machines, devices and structures
Verification:	Test
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW124_U5
Description:	He/She knows how to perform engineering analysis (calculations) necessary for estimating fatigue strength and durability of simple components of machines, devices and structures
Verification:	Test
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW124_U6
Description:	He/She knows how to design and perform all necessary calculations for the following simple connections: welded, riveted, cemented, screw fastened, keyed and splined.
Verification:	Test
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	

Description of course

Code of course	ANK405	
Name of course	Theory of Heat Machines	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Wojciech Bujalski, prof. PW.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	polski	
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	?	
Effects of education	See Table 31.	
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	?	
Methods of evaluation	?	
Methods of verification of effects of education	See Table 31.	
Exam	yes	
Literature	?	
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		
Number of ECTS credits on the course with direct participation of academic teacher		
Number of ECTS credits on practical activities on the course		
E. Additional information		
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Table 31. Learning outcomes

General academic profile - knowledge

Code of effect:	EW1
Description:	student zna podstawy termodynamiczne maszyn cieplnych
Verification:	zadania na zajęciach, test końcowy

Table 31. Learning outcomes	
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	EW1
Description:	student zna podstawy termodynamiczne maszyn cieplnych
Verification:	zadania na zajęciach, test końcowy
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	EW1
Description:	student zna podstawy termodynamiczne maszyn cieplnych
Verification:	zadania na zajęciach, test końcowy
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	EW1
Description:	student zna podstawy termodynamiczne maszyn cieplnych
Verification:	zadania na zajęciach, test końcowy
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	EW2
Description:	student zna podstawy obiegów cieplnych
Verification:	zadania na zajęciach, test końcowy
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	EW3
Description:	student zna podstawowe układy energetyczne
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	EW3
Description:	student zna podstawowe układy energetyczne
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	EW4
Description:	student zna zagadnienia bilansowania układów
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	EW4
Description:	student zna zagadnienia bilansowania układów
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	EW4
Description:	student zna zagadnienia bilansowania układów
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	EU1
Description:	student umie bilansować mszyny i układy cieplne
Verification:	zadania na zajęciach, test

Table 31. Learning outcomes	
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	EU1
Description:	student umie bilansować maszyny i układy ciepłe
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	EU1
Description:	student umie bilansować maszyny i układy ciepłe
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	EU1
Description:	student umie bilansować maszyny i układy ciepłe
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student umie analizować przemiany termodynamiczne
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student umie analizować przemiany termodynamiczne
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student umie analizować przemiany termodynamiczne
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student umie analizować przemiany termodynamiczne
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U23
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student umie przedstawić uproszczony schemat obiegu cieplnego i zna działanie poszczególnych elementów
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student umie przedstawić uproszczony schemat obiegu cieplnego i zna działanie poszczególnych elementów
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U22

Table 31. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student umie przedstawić uproszczony schemat obiegu cieplnego i zna działanie poszczególnych elementów
Verification:	zadania na zajęciach, test
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	EK1
Description:	student umie przedstawić podstawowe zagalenia układów energetycznych dla osób bez wykształcenia związanego z energetyką
Verification:	zadania
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	EK1
Description:	student umie przedstawić podstawowe zagalenia układów energetycznych dla osób bez wykształcenia związanego z energetyką
Verification:	zadania
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	
Code of effect:	EK2
Description:	student umie pracowac w grupie
Verification:	zadania na zajęciach
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	EK2
Description:	student umie pracowac w grupie
Verification:	zadania na zajęciach
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

Description of course

Code of course	ANK411
Name of course	Thermodynamics 2
Version of course	2013

A. Place of the course in system of studies

Level of education	First 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	mgr inż. Adam Rajewski, mgr inż. Adam Dominiak

B. General characteristic of the course

Block of courses	Power 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	Thermodynamics 1.
Limit of students	12 students in one group

C. Effects of education and manner of teaching

Purpose of course	Practical demonstration of measurement devices and methods for measurement of basic thermodynamic parameters and properties. Measurement and calculation of energy balance components for typical technical devices (piston compressor, IC engine, air conditioner).	
Effects of education	See Table 32.	
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	Thermometers and temperature measurements. Manometers and pressure measurements. Combustion gasses analysis. Orsat apparatus. Measurement of heating values for gaseous fuel. Measurement of higher heating value for coal. Measurements of humid air properties and processes. Energy balance for piston compressor. Energy balance for compression ignition engine. Investigation of cooling cycle (air conditioner).	
Methods of evaluation	reports from exercises, short tests after each exercise and final test.	
Methods of verification of effects of education	See Table 32.	
Exam	no	
Literature	1. Thermodynamics Laboratory Manual. 2. Cengel Y. A., Boles M.A.: Thermodynamics. An engineering approach., Mc Graw Hill.	

Website of the course

D. Student's activity

Number of ECTS credits	3
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Description of course

Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 33, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • preparation to exercises: 15 hours; • preparation of reports: 15 hours; • preparation to tests: 15 hours. TOTAL: 78 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits - 75 hours, including: • attendance at the labs - 30 hours; • preparation to exercises: 15 hours; • preparation of reports: 15 hours; • preparation to tests: 15 hours.

E. Additional information

Notes	
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Table 32. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK411_W1
Description:	Student has knowledge in the construction of thermometers, pressure gauges and hygrometers and methods of measuring temperature, pressure, and determining the properties of moist air.
Verification:	Written test and final test.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK411_W2
Description:	Student has knowledge in determination of the lower and higher heating value of solid and gaseous fuels and analysis of the exhaust gases.
Verification:	Written tests and final test.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK411_W3
Description:	Student has knowledge in making energy balance of the internal combustion engine, reciprocating compressor and compressor refrigerator.
Verification:	Written tests and final test.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK411_W3
Description:	Student has knowledge in making energy balance of the internal combustion engine, reciprocating compressor and compressor refrigerator.
Verification:	Written tests and final test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	

Table 32. Learning outcomes	
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK411_U1
Description:	Student is able to perform properly temperature and pressure measurements with use of different devices and determine humid air properties.
Verification:	Reports from labs.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK411_U2
Description:	Student is able to determine experimentally the lower and higher heating value of solid and gaseous fuels and perform an analysis of the exhaust gases at the Orsat apparatus.
Verification:	Reports from labs.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK411_U3
Description:	Student can perform proper measurements and make energy balance of the internal combustion engine and a reciprocating compressor.
Verification:	Reports from labs.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK411_U4
Description:	Student can perform proper measurements and make energy balance of the refrigerating cycle.
Verification:	Reports from labs.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	

Description of course

Code of course	ANK413	
Name of course	Thermodynamics 3	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Piotr Furmański	
B. General characteristic of the course		
Block of courses	Power 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	winter semester	
Preliminary requirements	Thermodynamics I	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	Knowledge of the maximum (minimum) available work, basis of exergy analysis, determination of thermodynamic functions for multi-component systems including ideal mixtures. Thermodynamic transformation of moist gases. Thermodynamic equilibrium in multi-component systems, fundamentals of chemical thermodynamics and electrochemical reactions. Chemical equilibrium.	
Effects of education	See Table 33.	
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: 1. Maximum available work. Exergy. Balance of exergy. Exergy losses. The Second Law Efficiency. 2. Thermodynamic functions for multi-component systems. 3. Real and ideal solutions. Partial properties. Graphical interpretation of partial properties for binary solutions. 4. Ideal mixtures. Mixtures of perfect gases. Moist gases. 5. Thermodynamic equilibrium in multicomponent, multi-phase systems. 6. Chemical potential and fugacity. Gibbs rule. Henry's and Raoult's laws. 7. Chemically reacting systems. 8. The 3rd Law of Thermodynamics. 9. Thermodynamic analysis of electrochemical reactions. 10. Chemical equilibrium and fundamentals of chemical kinetics. Tutorials: 1. Examples of exergy analysis of processes in simple and multi-component	

Description of course

	systems. 2. Transformation of the moist air. 3. Thermodynamic basis of separation of components in multi-component mixtures. 4. Examples of application of chemical thermodynamics to batteries and fuel cells. 5. Analysis of influence of temperature and pressure on equilibrium of chemically reacting systems.
Methods of evaluation	2 tests, practical and theoretical exams, point system of evaluation.
Methods of verification of effects of education	See Table 33.
Exam	yes
Literature	1) Cengel Y.A., Boles M.A.: "Thermodynamics. An Engineering Approach", McGraw Hill. 2) Bejan A.: "Advanced Engineering Thermodynamics", John Wiley & Sons. 3) Materials for students placed on website.
Website of the course	www.itc.pw.edu.pl
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 - 35, including: a) attendance at the lectures- 15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes (tasks solving) - 10 hours; • preparation for tests - 15 hours; • preparation for exam - 15 hours. TOTAL: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 35, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 33. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK413_W1
Description:	The student knows ways of determining properties of simple multi-component systems including ideal mixtures.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK413_W2
Description:	The student knows how to find properties of simple multi-component systems including ideal mixtures.

Table 33. Learning outcomes	
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK413_W3
Description:	The student knows exergy balance and its objective of its application in an analysis of processes.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK413_W4
Description:	The student possesses the basic knowledge related thermodynamic fundamentals of chemical processes including combustion.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANK413_W5
Description:	The student knows thermodynamic fundamentals of fuel cells operation and hydrogen utilization as a energy source.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANK413_W6
Description:	The student knows thermodynamic fundamentals of the perspective methods of energy conversion based on osmosis phenomenon and generation of electric energy in multi-component systems.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK413_U1
Description:	The student is able to find in literature and in internet informations related to thermodynamic properties of multi-component systems.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK413_U2
Description:	The student is able to describe, using methods of classical thermodynamics, processes occurring in multi-component systems including chemical reactions.
Verification:	Tests, exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANK413_U3
Description:	The student is able to expand his/her knowledge related to application of thermodynamics in analysis of different processes and devices operation.
Verification:	Tests, exam.

Table 33. Learning outcomes

Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

Description of course

Code of course	ANJ3	
Name of course	Foreign Language 3	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	The Foreign Language Centre	
Coordinator of course	For details, refer to the syllabus of the course.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Languages	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	For details, refer to the syllabus of the course.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	For details, refer to the syllabus of the course.	
Effects of education	See Table 34.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	For details, refer to the syllabus of the course.	
Methods of evaluation	For details, refer to the syllabus of the course.	
Methods of verification of effects of education	See Table 34.	
Exam	no	
Literature	For details, refer to the syllabus of the course.	
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	Number of hours that require the presence of a teacher ~30 exercises hours. The number of hours of independent work of student ~30.	
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit.	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes	Detailed information about the effects of teaching presents a course syllabus.	
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Table 34. Learning outcomes

Description of course

Code of course	ANWF4	
Name of course	Physical Education and Sport 4	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	College of Physical Education and Sport.	
Coordinator of course	Teacher at College of Physical Education and Sport.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Physical Education and Sports	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (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 development of physical activity of students. Detailed data contains syllabus of specific course.	
Effects of education	See Table 35.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The exercise program offer by College of Physical Education and Sport.	
Methods of evaluation	According to the rules of classes developed by College of Physical Education and Sport.	
Methods of verification of effects of education	See Table 35.	
Exam	no	
Literature		
Website of the course		
D. Student's activity		
Number of ECTS credits	0	
Number of hours of student's work to achieve effects of education	Participation in classes - 30 hours.	
Number of ECTS credits on the course with direct participation of academic teacher	0.0 ECTS credit (30 hours of classes, without ECTS).	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes		
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Table 35. Learning outcomes

Description of course

Code of course	ANK380	
Name of course	Combustion and Fuels	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Rudolf Klemens	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Student should have basic knowledge in the field of chemical kinetics, differential equations, thermodynamics and fluid mechanics.	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	To obtain knowledge in the field of: basic properties of fuels and combustible mixtures; mechanisms of combustion and flame propagation including thermal dissociation; methods of limitation of emission of toxic combustion products, dynamics of development and suppression of industrial explosions.	
Effects of education	See Table 36.	
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	Basic properties of fuels and combustible mixtures; exploitation and processing of fossil fuels, bio-fuels, toxic properties of fuels and their combustion products, thermal and chain theory of self ignition; forced ignition; diffusion combustion-laminar and turbulent; kinetic combustion-laminar and turbulent; flame stabilization; mechanism of combustion of solid fuel particles and fuel droplets; combustion in technical facilities - burners and combustion chambers, transition from deflagration to detonation, detonation combustion; explosion parameters of combustible mixtures; passive and active methods of explosion suppression. The social emphasis is on the problem connected with combustion of different fuels.	

Description of course

Methods of evaluation	The subject is completed on the basis of the written test.
Methods of verification of effects of education	See Table 36.
Exam	no
Literature	1. Jerzy Chomiak "Combustion: A study in theory, fact and application", Gordon and Breach Science Publisher, 1990. 2. John H.S. Lee "The detonation phenomenon", Cambridge University Press, 2008. 3. Ryszard Wilk "Low-emission combustion", Wydawnictwa Politechniki Śląskiej, Gliwice, 2002. 4. Kenneth Kuo "Principles of Combustion", 5. John Wiley and Sons; Rolf Eckhoff "Dust Explosions in the Process Industries" Butterworth and Heinemann. 6. J. Warnatz, U. Maas, R. Dibble "Combustion", Springer. 7. Forman A. Williams "Combustion Theory" The Benjamin/Cummings Publishing Company Inc. 8. J. Jarosiński, B. Veysiere: "Combustion Phenomena, Selected Mechanisms of Flame Formation, Propagation and Extinction", CRC Press, Taylor and Francis Group.
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 - 33, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student - 45, including: • systematic preparation for classes (tasks solving) - 15 hours; • homer work: 15 hours; • preparation for tests - 15 hours. TOTAL: 78 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits – number of hours that require the presence of a teacher - 33, including: a) attendance at the lectures- 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	As the subject is of an interdisciplinary character and is not based on a particular text book, students participation in lectures is highly recommended. The students absent from the lectures usually find it later difficult to comprehend courses in physical- chemical phenomena presented during the lectures and definitely attain poorer results at subject completion.
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Table 36. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK380_W1
Description:	Student has basic knowledge in the field of kinetics of chemical reactions, mechanisms of ignition and flame propagation in the mixtures of different fuels with air and in gas-dynamics of combustion.
Verification:	Written test.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	

Code of effect:	ANK380_W1
Description:	Student has basic knowledge in the field of kinetics of chemical reactions, mechanisms of ignition and flame propagation in the mixtures of different fuels with air and in gas-dynamics of combustion.
Verification:	Written test.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	

Code of effect:	ANK380_W1
Description:	Student has basic knowledge in the field of kinetics of chemical reactions, mechanisms of ignition and flame propagation in the mixtures of different fuels with air and in gas-dynamics of combustion.
Verification:	Written test.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	

Code of effect:	ANK380_W2
Description:	Student has knowledge in the field of fire and explosion hazard in industry.
Verification:	Written test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	

Code of effect:	ANK380_W3
Description:	Student knows the properties of fuels and combustible mixtures including the bio-fuels and alternative fuels.
Verification:	Written test.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ANK380_U1
Description:	Student can organize the combustion process taking into consideration the maximal efficiency and minimal air pollution.
Verification:	Written test.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	

Code of effect:	ANK380_U2
Description:	Student can determine a toxic properties of combustion products.
Verification:	Written test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	

Table 36. Learning outcomes	
Code of effect:	ANK380_U3
Description:	Student is able to determine the explosion hazard in different industrial installations and can suggest an application of proper explosion suppression system.
Verification:	Written test.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANK380_U4
Description:	Student can make calculations on the basic parameters of combustion processes, for instance: combustion temperature, oxidizer demand for combustion, coefficient of excess oxidizer, mass and volume of combustion products.
Verification:	Written test.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANK380_U4
Description:	Student can make calculations on the basic parameters of combustion processes, for instance: combustion temperature, oxidizer demand for combustion, coefficient of excess oxidizer, mass and volume of combustion products.
Verification:	Written test.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	

Description of course

Code of course	ANK333										
Name of course	Electric Machines 1										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Tadeusz Skoczowski										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	4 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	ANW113 Electric Circuits 1. ANK317 Electric Circuits 2.										
Limit of students	The lecture - 60 students, Exercises - 15 students										
C. Effects of education and manner of teaching											
Purpose of course	Knowledge and understanding of construction and principles of operation of transformers and rotating electric machines employed in industry. Knowledge on speed control techniques of rotating electrical machines. Understanding the principles of electric energy generators used in power stations. Mastering the application of power electronics in supply of electric machines.										
Effects of education	See Table 37.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>15h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	15h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	15h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	ELECTRICITY. Distinction between sources and loads. Sign notation. Graph of an alternating voltage. Positive and negative currents. Sinusoidal voltage. Effective value of an ac voltage. Phasor representation. Harmonics. Energy in an inductor. Energy in a capacitor. CIRCUITS AND EQUATIONS. Kirchhoff's voltage law. Kirchhoff's voltage law. Kirchhoff's current law. Currents, impedances, and associated. Kirchhoff's laws and ac circuits. THREE-PHASE CIRCUITS. Polyphase systems. Single-phase generator. Power output of a single-phase generator. Two-phase generator. Power output of a 2-phase generator. Three-phase generator. Power output of a 3-phase generator. Wye connection. Voltage relationships. Delta connection. Power transmitted by a 3-phase line.										

Description of course

Active, reactive and apparent power in 3-phase circuits. Solving 3-phase circuits. Industrial loads . Phase sequence. Determining the phase sequence. Power measurement in ac circuits. Power measurement in 3-phase, 3-wire circuits. Power measurement in 3-phase, 4- wire circuits. Varmeter. Single-phase to 3-phase transformation. ELECTROMAGNETISM. Magnetic field intensity H and flux density. B-H curve of vacuum. B-H curve of a magnetic material. Determining the relative. Permeability. Faraday's law of electromagnetic. Induction. Voltage induced in a conductor. Lorentz force on a conductor. Direction of the force acting on a straight conductor. Residual flux density and coercive force. Hysteresis loop. Hysteresis loss. Hysteresis losses caused by rotation. Eddy currents. Eddy currents in a stationary iron core. Eddy-current losses in a revolving core. Current in an inductor. SYSTEM OF UNITES. Base and derived units of the SI. Definitions of base units. Definitions of derived units. Multiples and submultiples of SI units. Commonly used units. FUNDAMENTALS OF MECHANICS AND HEAT. Force. Torque. Mechanical work. Power. Power of a motor. Transformation of energy. Efficiency of a machine. Kinetic energy of linear motion. Kinetic energy of rotation, moment of inertia. Torque, inertia and change in speed. Speed of a motor/load system. Power flow in a mechanically coupled system . Motor driving a load having inertia. Electric motors driving linear motion loads. Heat and temperature . Temperature scales . Heat required to raise the temperature of a body transmission of heat. Heat transfer by conduction. Heat transfer by convection. Calculating the losses by convection. Heat transfer by radiation. Calculating radiation losses. DIRECT-CURRENT GENERATORS. Generating an ac voltage. Direct-current generator. Difference between ac and dc generators. Improving the waveshape. Induced voltage. Neutral zones. Value of the induced voltage. Generator under load: the energy conversion process. Armature reaction. Commutating poles. Separately excited generator. No-load operation and saturation curve. Shunt generator. Controlling the voltage of a shunt generator. Equivalent circuit. Separately excited generator under load. Shunt generator under load. Compound generator. Differential compound generator. Load characteristics. Generator specifications. Construction of Direct-Current Generators. Field. Armature. Commutator and

Description of course

brushes. Details of a multipole generator. Ideal commutation process. Practical commutation process. DIRECT-CURRENT MOTORS. Counter-electromotive force (cemf). Acceleration of the motor. Mechanical power and torque 98Speed of rotation. Armature speed control. Field speed control. Shunt motor under load. Series motor. Series motor speed control 105. Applications of the series motor. Compound motor. Reversing the direction of rotation. Starting a shunt motor. Face-plate starter. Stopping a motor. Dynamic braking. Plugging. Dynamic braking and mechanical time constant. Armature reaction. Flux distortion due to armature reaction. Commutating poles. Compensating winding. Basics of variable speed control. Permanent magnet motors. IDEAL TRANSFORMER. Voltage induced in a coil. Applied voltage and induced voltage. Elementary transformer. Polarity of a transformer. Properties of polarity marks. Ideal transformer at no-load; voltage ratio. Ideal transformer under load; current ratio. Impedance ratio. Shifting impedances from secondary to primary and vice versa. PRACTICAL TRANSFORMERS. Ideal transformer with an imperfect core. Ideal transformer with loose. Coupling. Primary and secondary leakage. Reactance. Equivalent circuit of a practical. Transformer. Construction of a power. Transformer. Standard terminal markings. Polarity tests. Transformer taps. Losses and transformer rating. No-load saturation curve. Cooling methods. Simplifying the equivalent circuit. Voltage regulation. Measuring transformer impedances. Introducing the per unit method. Impedance of a transformer. Typical per-unit impedances. Transformers in parallel. SPECIAL TRANSFORMERS. Dual-voltage distribution transformer. Autotransformer . Conventional transformer connected as an autotransformer. Voltage transformers. Current transformers. Opening the secondary of a CT can be dangerous. Toroidal current transformers. Variable autotransformer. High-impedance transformers. Induction heating transformers. High-frequency transformers. THREE-PHASE TRANSFORMERS. Basic properties of 3-phase transformer banks. Delta-delta connection. Delta-wye connection. Wye-delta connection. Wye-wye connection. Open-delta connection. Three-phase transformers. Step-up and step-down autotransformer. Phase-shift principle. Three-phase to 2-phase transformation. Phase-shift transformer. Calculations involving 3-phase transformers. Polarity marking of 3-phase

Description of course

transformers. THREE-PHASE INDUCTION MOTORS. Principal components. Principle of operation . The rotating field. Direction of rotation. Number of poles-synchronous. Speed. Starting characteristics of a squirrel-cage. Motor. Acceleration of the rotor-slip. Motor under load. Voltage and frequency induced in the. Rotor. Characteristics of squirrel-cage induction. Motors. Estimating the currents in an induction. Motor. Active power flow. Torque versus speed curve. Effect of rotor resistance. Wound-rotor motor. Three-phase windings. Sector motor. Linear induction motor. Traveling waves. Properties of a linear induction motor. Magnetic levitation. Selection and Application of Three Phase Induction Motors. Standardization and classification of. induction motors. Classification according to environment. and cooling methods. Classification according to electrical and. mechanical properties. Choice of motor speed. Two-speed motors. Induction motor characteristics under various load conditions. Starting an induction motor. Plugging an induction motor. Braking with direct current. Abnormal conditions. Mechanical overload. Line voltage changes. Single-phasing. Frequency variation. Induction motor operating as a. generator. Complete torque-speed characteristic of an induction machine. Features of a wound-rotor induction motor. Start-up of high-inertia loads. Variable-speed drives. Frequency converter. EQUIVALENT CIRCUIT OF THE INDUCTION. MOTOR. The wound-rotor induction motor. Power relationship. Phasor diagram of the induction. Motor. Breakdown torque and speed. Equivalent circuit of two practical. Motors. Calculation of the breakdown. Torque. Torque-speed curve and other. Characteristics. Properties of an asynchronous. Generator. Tests to determine the equivalent. circuit. SYNCHRONOUS GENERATORS. Commercial synchronous generators. Number of poles. Main features of the stator. Main features of the rotor. Field excitation and excitors. Brushless excitation. Factors affecting the size of synchronous. Generators. No-load saturation curve. Synchronous reactance-equivalent circuit of an ac generator. Determining the value of X_s . Base impedance, per-unit X_s . Short-circuit ratio. Synchronous generator under load. Regulation curves. Synchronization of a generator. Synchronous generator on an infinite. Bus. Infinite bus-effect of varying the exciting current. Infinite bus-effect of varying the mechanical torque. Physical interpretation of

Description of course

alternator. Behavior. Active power delivered by the generator. Control of active power. Transient reactance. Power transfer between two sources. Efficiency, power, and size of electrical machines. SYNCHRONOUS MOTORS. Construction. Starting a synchronous motor. Pull-in torque. Motor under load-general. Description. Motor under load-simple. Calculations. Power and torque. Mechanical and electrical angles. Reluctance torque. Losses and efficiency of a synchronous motor. Excitation and reactive power. Power factor rating. V-curves. Stopping synchronous motors. Synchronous motor versus the induction motor. Synchronous capacitor. SINGLE-PHASE MOTORS. Construction of a single-phase induction motor. Synchronous speed. Torque-speed characteristic. Principle of operation. Locked-rotor torque. Resistance split-phase motor. Capacitor-start motor. Efficiency and power factor of single-phase induction motors. Vibration of single-phase motors. Capacitor-run motor. Reversing the direction of rotation. Shaded-pole motor. Universal motor. Hysteresis motor. Synchronous reluctance motor. Synchro drive. Equivalent Circuit of a Single-Phase Motor. Magnetomotive force distribution. Revolving mmfs in a single-phase motor. Deducing the circuit diagram of a single-phase motor. STEPPER MOTORS. Introduction. Elementary stepper motor. Effect of inertia. Effect of a mechanical load. Torque versus current. Start-stop stepping rate. Slew speed. Ramping. Types of stepper motors. Motor windings and associated. Drives. High-speed operation. Modifying the time constant. Bi-level drive. Instability and resonance. BASICS OF INDUSTRIAL MOTOR CONTROL. Introduction. Control devices. Normally-open and normally-closed contacts. Relay coil exciting current. Control diagrams. Starting methods. Manual across-the-line starters. Magnetic across-the-line starters. Inching and jogging. Reversing the direction of rotation. Plugging. Reduced-voltage starting. Primary resistance starting. Autotransformer starting. Other starting methods. Cam switches. Electric Drives. Fundamentals of electric drives. Typical torque-speed curves. Shape of the torque-speed curve. Current-speed curves. Regenerative braking. FUNDAMENTAL ELEMENTS OF POWER ELECTRONICS. Potential level. Voltage across some circuit elements. Diode And Diode Circuits. The diode. Main characteristics of a diode. Battery charger with series resistor. Battery charger with series

Description of course

inductor. Single-phase bridge rectifier . Filters. Three-phase, -3-pulse diode rectifier. Three-phase, -6-pulse rectifier. Effective line current, fundamental line current. Distortion power factor. Displacement power factor, total power factor. Harmonic content and THD. Thyristor and Thyristor Circuits. Thyristor. Principles of gate firing. Power gain of a thyristor. Current interruption and forced. commutation. Basic thyristor power circuits. Controlled rectifier supplying a passive load. Controlled rectifier supplying an active load. Line-commutated inverter. ac static switch. Cycloconverter. Three-phase, -pulse controllable. converter. Basic principle of operation. Three-phase, -pulse rectifier feeding an. active load. Delayed triggering-rectifier mode. Delayed triggering-inverter mode. Triggering range. Equivalent circuit of a converter. Currents in a -phase, -pulse. converter. Power factor. Commutation overlap. Extinction angle. dc-to-dc Switching Converters. Semiconductor switches. dc-to-dc switching converter. Rapid switching. Impedance transformation. Basic -quadrant dc-to-dc converter. Two-quadrant electronic converter. Four-quadrant dc-to-dc converter. Switching losses. dc-to-ac Switching Converters. dc-to-ac rectangular wave converter. dc-to-ac converter with pulse-width. modulation. dc-to-ac sine wave converter. Generating a sine wave. Creating the PWM pulse train. dc-to-ac -phase converter. ELECTRONIC CONTROL OF DIRECTCURRENT MOTORS. First quadrant speed control. Two-quadrant control-field reversal. Two-quadrant control-armature reversal. Two-quadrant control-two converters. Four-quadrant control-two converters. with circulating current. Two-quadrant control with positive torque. Four-quadrant drive. Six-pulse converter with freewheeling. diode. Half-bridge converter dc traction. Motor drive using a dc-to-dc switching converter. Introduction to brushless dc motors. Commutator replaced by reversing switches. Synchronous motor as a brushless dc machine. Standard synchronous motor and brushless dc machine. Practical application of a brushless dc motor. ELECTRONIC CONTROL OF ALTERNATING CURRENT MOTORS . Types of ac drives. Synchronous motor drive using current-source dc link. Synchronous motor and cycloconverter. Cycloconverter voltage and frequency control. Squirrel-cage induction motor with cycloconverter. Squirrel-cage motor and static voltage. controller. Soft-starting cage

Description of course

	<p>motors. Self-Commutated Inverters. Self-commutated inverters for cage motors. Current-source self-commutated frequency converter (rectangular wave). Voltage-source self-commutated frequency converter (rectangular wave). Chopper speed control of a wound-rotor induction motor. Recovering power in a wound-rotor induction motor. Pulse-Width Modulation Drives. Review of pulse-width modulation. Pulse-width modulation and induction motors. Torque and Speed Control of Induction Motors. dc motor and flux orientation. Slip speed, flux orientation, and torque. Features of variable-speed control – constant torque mode. Features of variable-speed control – constant horsepower mode. Features of variable-speed control – generator mode. Induction motor and its equivalent circuit. Equivalent circuit of a practical motor. Volts per hertz of a practical motor. Speed and torque control of induction. motors. Carrier frequencies. Dynamic control of induction. motors. Principle of flux vector control. Variable-speed drive and electric traction. Principal components. Operating mode of the -3-phase converter. Operating mode of the single-phase converter. Direct Torque Control. Controlling the flux and torque by hysteresis. Controlling the speed. Producing a magnetic field in a 2-phase motor. Producing a rotating field. Controlling the magnetic flux. Controlling the speed of rotation. Programming logic of the switching procedure. Instantaneous slip and production of torque. Control of 3-phase motors. Schematic diagram of a DTC.</p>
Methods of evaluation	Two assessments, final exam, home project.
Methods of verification of effects of education	See Table 37.
Exam	yes
Literature	<p>Recommended texts (reading): Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006. Further Readings: 1. Bonal J.: Variable speed electric drives. Promethee. Schneider Electric. 1999. tom1-3. 2. Boldea I., Nasar S.A.: Electric drives, CRC Press, 1999. 3. Chiasson J.: Modeling and high-performance control of electric machines, IEEE Series on Power Engineering, A John Wiley and Sons, Inc., 2005. 4. Hindmarsh J.: Electrical machines and their applications. Pergamon International Library, 1985. 5. Hindmarsh J.: Electrical machines and drives. Worked examples. Pergamon International Library, 1985.</p>
Website of the course	http://estudia.meil.pw.edu.pl/
D. Student's activity	
Number of ECTS credits	3

Description of course

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 -15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for tests (tasks solving) - 20 hours; • homer work - 10 hours; • preparation for exam - 10 hours. TOTAL: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 35, including: a) attendance at the lectures -15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

Notes	
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Table 37. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK333_W1
Description:	Student knows how to apply basic electromagnetic laws to understand principles of operation of transformers and electric machines used in industry.
Verification:	Colloquium 1. Exam.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK333_W1
Description:	Student knows how to apply basic electromagnetic laws to understand principles of operation of transformers and electric machines used in industry.
Verification:	Colloquium 1. Exam.
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	
Code of effect:	ANK333_W2
Description:	Student understands the rules of selection of transformers and electric machines used in power industry.
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	
Code of effect:	ANK333_W2
Description:	Student understands the rules of selection of transformers and electric machines used in power industry.
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
Code of effect:	ANK333_W3

Table 37. Learning outcomes	
Description:	Students knows the fundamentals of electric drives and power electronics.
Verification:	Colloquium 2. Egzam.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK333_U1
Description:	Student can select electric machine to specific industrial purpose.
Verification:	Colloquium, exam.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
Code of effect:	ANK333_U2
Description:	Student can select transformer to specific industrial purpose.
Verification:	Colloquium 1. Exam.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
Code of effect:	ANK333_U3
Description:	Student can compute energy efficiency of transformer or electric machine.
Verification:	Colloquium 1. Exam.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK333_K1
Description:	Student can select transformer or electric machines working in a group.
Verification:	Home project.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ANK381	
Name of course	Electric Power Systems	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Tadeusz Skoczkowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	ANW113 Electric Circuits 1 ANK317 Electric Circuits 2	
Limit of students	60	
C. Effects of education and manner of teaching		
Purpose of course	To understand the conversion from primary energy sources to electric energy. To understand the work of power generators in the power system. To get familiar with the transmission and distribution networks and their basic components. To understand the monitoring, co-ordination and control of electric power networks. To understand the utilization of electric energy (industrial, commercial and residential loads). To understand the principles of power system control (power, voltage, frequency). To highlight future power system.	
Effects of education	See Table 38.	
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	GENERATION OF ELECTRICAL ENERGY. Demand of an electrical system. Location of the generating stations. Types of generating stations. Controlling the power balance between generator and load. Advantage of interconnected systems. Conditions during an outage. Frequency and electric clocks. HYDROPOWER GENERATING STATIONS. Available hydro power. Types of hydropower stations. Makeup of a hydropower plant. Pumped-storage installation. THERMAL GENERATING STATIONS. Makeup of a thermal generating. station . Turbines . Condenser . Cooling towers . Boiler-feed	

Description of course

pump . Energy flow diagram for a steam. plant . Thermal stations and the. environment . NUCLEAR GENERATING STATIONS. Composition of an atomic nucleus;. isotopes . The source of uranium . Energy released by atomic fission . Chain reaction . Types of nuclear reactors. Example of a light-water reactor . Example of a heavy-water reactor. Principle of the fast breeder reactor . Nuclear fusion. TRANSMISSION OF ELECTRICAL. ENERGY. Principal components of a power. distribution system. Types of power lines. Standard voltages. Components of a HV transmission line. Construction of a line. Galloping lines. Corona effect-radio interference. Pollution. Lightning strokes. Lightning arresters on buildings. Lightning and transmission lines. Basic impulse insulation level (BIL). Ground wires. Tower grounding. Fundamental objectives of a transmission line. Equivalent circuit of a line. Typical impedance values. Simplifying the equivalent circuit. Underground Cable. Voltage regulation and power transmission capability of transmission lines. Resistive line Inductive line. Compensated inductive line. Inductive line connecting two. systems. Review of power transmission. Choosing the line voltage. Methods of increasing the power. capacity. Extra-high-voltage lines. Power exchange between power centers . Practical example of power exchange. DISTRIBUTION OF ELECTRICAL. ENERGY. Substations. Substation equipment. Circuit breakers. Air-break switches. Disconnecting switches. Grounding switches. Surge arresters. Current-limiting reactors. Grounding transformer. Example of a substation. Medium-voltage distribution. Low-voltage distribution. Protection Of Medium-Voltage Distribution Systems. Coordination of the protective devices. Fused cutouts. Reclosers. Sectionalizers. Review of MV protection. LOW-VOLTAGE DISTRIBUTION. LV distribution system. Grounding electrical installations. Electric shock. Grounding of V and V/ V systems. Equipment grounding. Ground-fault circuit breaker. Rapid conductor heating - I²t factor. Role of fuses. Electrical installation in buildings. Principal components of an electrical installation. COST OF ELECTRICITY. Tariff based upon energy. Tariff based upon demand. Demand meter. Tariff based upon power factor. Typical rate structures. Demand controllers. Power factor correction. Measuring electrical energy (watthourmeter). Measuring three-phase energy and power. DIRECT-CURRENT TRANSMISSION.

Description of course

	<p>Features of dc transmission. Basic dc transmission system. Voltage, current, and power relationships. Power fluctuations on a dc line. Typical rectifier and inverter characteristic. Power control. Effect of voltage fluctuations. Bipolar transmission line. Power reversal. Components of a dc transmission line. Inductors and harmonic filters on the dc side (pulse converter). Converter transformers. Reactive power source. Harmonic filters on the ac side. Communications link. Ground electrode. Example of a monopolar converter station. Thyristor converter station. Typical installations.</p> <p>TRANSMISSION AND DISTRIBUTION</p> <p>TRANSMISSION POWER FLOW CONTROL. Basics of Power System Control. Active Power and Frequency Control. Voltage Control and Reactive Power. Control of Transported Power. Flexible AC Transmission Systems (FACTS). Thyristor-controlled series capacitor (TCSC). Vernier control. Static synchronous compensator. Eliminating the harmonics. Unified power flow controller (UPFC). Static frequency changer. Distribution Custom Power Products. Disturbances on distribution systems. PWM converters. Distribution system. Compensators and circuit analysis. Shunt compensator. Series compensator. HARMONICS. Harmonics and phasor diagrams. Effective value of a distorted wave. Crest factor and total harmonic distortion (THD). Harmonics and circuits. Displacement power factor and total power factor. Non-linear loads. Generating harmonics. Correcting the power factor. Generation of reactive power. Effect of Harmonics. Harmonic current in a capacitor. Harmonic currents in a conductor. Distorted voltage and flux in a coil. . Harmonic currents in a 3-phase, 4-wire distribution system. Harmonics and resonance. Harmonic filters. Harmonics in the supply network. Transformers and the K factor. Harmonic Analysis. Procedure of analyzing a periodic wave. FUTURE POWER SYSTEMS. Renewable Energy. Decentralized Or Distributed Generation. Power-electronic Interfaces. Energy Storage. Blackouts and Chaotic Phenomena.</p>
Methods of evaluation	Two tests, final exam.
Methods of verification of effects of education	See Table 38.
Exam	yes
Literature	Recommended texts (reading): Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006. Further Readings: Schavemaker P., Sluis L. Electrical power system essentials, Wiley, 2008.
Website of the course	http://estudia.meil.pw.edu.pl/
D. Student's activity	

Description of course

Number of ECTS credits	5
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 exercises -15 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 30 hours; • systematic preparation for tests (tasks solving) - 20 hours; • home work: 15 hours; • preparation for exam - 15 hours. TOTAL: 130 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures -30 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits.
E. Additional information	
Notes	
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Table 38. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK381_W1
Description:	Student knows and understands the principles of operation of power systems.
Verification:	Colloquium 1. Home project 1. Exam.
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	
Code of effect:	ANK381_W2
Description:	Student knows operation of typical electrical machines and power equipment, especially used in power stations.
Verification:	Colloquium 1. Home project 2. Exam.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
Code of effect:	ANK381_W3
Description:	Student knows basic rules of control of power systems, including systems with "smart grid" devices.
Verification:	Home project 1. Home project 2. Exam.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK381_U1
Description:	Student can carry out simple project of power system.
Verification:	Home project 1. Home project 2. Exam.
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
General academic profile - social competences	

Table 38. Learning outcomes

Code of effect:	ANK381_K1
Description:	Students understands the importance of power systems in the modern society and can value societal costs of their functioning.
Verification:	Colloquium 1. Colloquium 2. Exam.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Description of course

Code of course	ANW 135										
Name of course	Electronics 1										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Tadeusz Skoczkowski										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	4 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Electric Circuit I, Electric Circuit II.										
Limit of students	The lecture - 60 students, exercises - 30 students.										
C. Effects of education and manner of teaching											
Purpose of course	To obtain basic knowledge on analogue and digital electronic circuit. To understand the principle of operation, construction and characteristics of basic semiconductor devices. To learn the terminology of electronics. To understand the functions performed by typical analogue and digital components and circuits. To be able to analyse simple electronic circuit. To get familiar with troubleshooting in electronic circuits. To get familiar with manufactures specification sheets and application guidelines.										
Effects of education	See Table 39.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>15h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	15h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	15h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	ANALOGUE FUNDAMENTALS. Fundamental Solid-State Principles. Atom Theory. Doping. PN Junction. Bias. Diodes. PN-Junction Diode. Ideal Diode. Practical Diode Model. Other Practical Considerations. Complete Diode Model. Diode Specification Sheets. Zener Diodes. Zener Diode Specification Sheets. Light-Emitting Diodes (LEDs). Diode Testing. Common Diodes Applications. Basic Power Supply Circuits. Transformers. Half-Wave Rectifiers. Full-Wave Rectifiers. Full-Wave Bridge Rectifiers. Working with Rectifiers. Filters. Zener Voltage. Special Application. Regulators. Clippers, Clampers. Voltage Multipliers. Displays. Special application Diodes. Varactor Diodes.										

Description of course

Transient Suppressors and Constant-Current Diodes. Tunnel Diodes. Other Diodes. Bipolar Junction Transistors. Bipolar Junction Transistors (BJTs). Transistor Construction and Operation. Transistor Current and Voltage Ratings. Transistor Characteristic Curves. Transistor Specification Sheets. Transistor Testing. DC Biasing Circuits. DC Biasing. DC Load Line. Base Bias. Voltage-Divider Bias. Other Transistor Biasing Circuit. Introduction to Amplifiers. Amplifier Properties. BJT Amplifier Configurations. Amplifier Classifications. Decibels Common-Emitter Amplifiers. AC Concepts. Roles of Capacitors in Amplifiers. Common-Emitter AC Equivalent Circuit. Amplifier Gain. Gain and Impedance Calculations. Swamped Amplifiers. h-Parameters. Amplifier Trouble Shooting. Other BJT Amplifiers. Emitter Follower (Common-Collector Amplifier). Emitter Follower AC Analysis. Emitter Followers: Practical Considerations. Applications. Darlington Emitter-Follower. Common-Base Amplifier. Common-Base Applications. Power Amplifiers. AC Load Line. RC-Couple Class A Amplifiers. Transformer-Coupled Class A Amplifiers. Class B Amplifiers. Class AB Amplifiers (Diode Bias). Field-Effect Transistors. Introduction to JFETs. JFET Biasing Circuits. Common-Source Amplifier. Common-Drain Amplifier. Common-Gate Amplifier. Trouble Shooting JFET Circuits. JFET Specification Sheets. Applications. MOSFETs. D-MOSFETs. E-MOSFETs. Dual-Gate MOSFETs. Power MOSFETs. Complementary MOSFETs (CMOS). MOSFET Applications. Amplifier Frequency Response. Basic Concepts. BJT Amplifier Frequency Response. FET Amplifier Frequency Response. Multistage Amplifiers. Operational Amplifiers. Op-Amps: An Overview. Operation Overview. Differential Amplifiers and Op-Amp Specifications. Inverting Amplifiers. Non-inverting Amplifiers. Troubleshooting Basic Op-Amp Circuits. Op-Amp Frequency Response. Negative Feedback Additional Op-Amp Applications. Comparators Integrators and Differentiators Summing Amplifiers. Instrumentation Amplifiers Other Op-Amp Circuits. Tuned Amplifiers. Tuned Amplifier Characteristics. Active Filters: An Overview. Low-Pass and High-Pass Filters. Band-Pass and Notch Filters. Active Filter Applications. Discrete Tuned Amplifiers. Class C Amplifiers. Oscillators. Introduction Phase-Shift Oscillators. Wien-Bridge Oscillator. Colpitts Oscillator. Other LC Oscillators Crystal-Controlled Oscillators. Oscillator Troubleshooting. Solid-State Switching Circuits. Introductory Concepts. Basic Switching

Description of course

Circuits: Practical Considerations. Schmitt Triggers. Thyristor and Optoelectronics Devices. Introduction to Thyristors: Silicon Unilateral Switch (SUS). Silicon-Controlled Rectifiers (SCRs). Diacs and Triacs. Unijunction Transistors (UJTs). Discrete Photodetectors. Optoisolators and Optointerrupters. Discrete and Integrated Voltage Regulators. Voltage Regulation: An Overview. Series Voltage Regulators. Shunt Voltage Regulators. Linear IC Voltage Regulators. Switching Regulators. DIGITAL FUNDAMENTALS. Number Systems, Operations, and Codes. Decimal Numbers. Binary Numbers. Decimal-to-Binary Conversion. Binary Arithmetic. First and Second Complements of Binary Numbers Signed Numbers. Arithmetic Operations with Signed Numbers. Hexadecimal Numbers. Octal Numbers. Binary Coded Decimal (BCD). Digital Codes. Error Detection and Correction Codes. Logic Gates. Inverter. AND Gate. OR Gate. NAND Gate. NOR Gate. Exclusive-OR and Exclusive-NOR Boolean Algebra and Logic Simplification. Boolean Operations and Expressions. Laws and Rules of Boolean Algebra. DeMorgan's Theorem. Boolean Analysis of Logic Circuits. Simplification Using Boolean Algebra. Standard Forms of Boolean Expressions. Boolean Expressions and Truth Tables. Karnaugh Map. Karnaugh Map SOP Minimization. Karnaugh Map POS Minimization. Five-Variable Karnaugh Maps. Combinational Logic Analysis. Basic Combinational Logic Circuits. Implementing Combinational Logic. Universal Property of NAND and NOR Gates. Combinational Logic Using NAND and NOR Gates. Logic Circuit Operation with Pulse Waveform Inputs. Functions of Combinational Logic. Basic Adders. Parallel Binary Adders. Ripple Carry versus Look Ahead Carry. Comparators. Decoders. Encoders. Latches, Flip-Flops, and Timers. Latches. Edge-Triggered Flip-Flops. Flip-Flop Operating Characteristics Flip-Flop Applications. One-Shots. The 555 Timer. Counters. Asynchronous Counter Operation. Synchronous Counter Operation. Up/Down Synchronous Counters. Design of Synchronous Counters. Cascaded Counters. Counter Decoding. Counter Applications. Logic Symbols with Dependency Notation. Shift Registers. Basic Shift Register Functions. Serial In/Serial Out Shift Registers. Serial In/Parallel Out Shift Registers. Parallel In/Serial Out Shift Registers. Parallel In/Parallel Out Shift Registers. Bidirectional Shift Registers. Shift Register Counters. Shift Register Applications. Logic Symbols with Dependency

Description of course

	<p>Notation. Memory and Storage. Basics of Semiconductor Memory. Random-Access Memories (RAMs). Read-Only Memories (ROMs). Programmable ROMs (PROMs and EPROMs). Flash Memories. Memory Expansion. Special Types of Memories. Magnetic and Optical Storage. Introduction to Digital Signal Processing. Digital Signal Processing Basics. Converting Analog Signals to Digital. Analog-to-Digital Conversion Methods. Digital Signal Processor (DSP). Digital-to-Analog Conversion Method. Integrated Circuit Technologies. Basic Operational Characteristics and Parameters. CMOS Circuits. TTL Circuits. Practical Considerations in the Use of TTL. Comparison of CMOS and TTL Performance. Emitter-Coupled Logic (ECL) Circuits. PMOS, NMOS, and E2CMOS.</p>
Methods of evaluation	Lesson quizzes, homework project, final test.
Methods of verification of effects of education	See Table 39.
Exam	no
Literature	<ul style="list-style-type: none"> • Paynter R. T.: Introductory electronic devices and circuits, Person Prentice Hall, 7th edition. • Floyd T .L.: Digital Fundamentals Person Prentice Hall, 9th edition. Further Readings: • Irwin J. D., Nelms R. M.: Basic Engineering Circuit Analysis, Willey,8th edition. • Paynter R. T., Boydell B. J. T.: Electronics Technology Fundamentals Electron Flow Version and Conventional Flow Version, Person Prentice Hall, 2nd Edition. EWB MultiSim Student Edition Lite v.10. • Buchala D.M.: Experiments in Digital Fundamentals, Person Prentice Hall, 2006. • Boydell B. J. T.: Experiments in Digital Fundamentals, Person Prentice Hall,2005. • Mohan N., Undeland T.M. Robbins W.P.: Power Electronics, J. Wiley&Sons, Inc, 2003.
Website of the course	http://estudia.meil.pw.edu.pl/
D. Student's activity	
Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	<p>1) Number of hours that require the presence of a 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: • systematic preparation for classes, home work - 15 hours; • systematic preparation for final tests - 3 hours. TOTAL - 50 hours.</p>
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 32, 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	-

Description of course

E. Additional information

Notes	
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Table 39. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW135_W1
Description:	Student understands fundamentals, functions and limits of modern electronic devices and circuits.
Verification:	Lesson quizzes, final test.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	

Code of effect:	ANW135_W2
Description:	Student recognises and understands basic electronic circuits.
Verification:	Lesson quizzes, homework project, final test.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	

Code of effect:	ANW135_W3
Description:	Student has basic knowledge on application of simple electronic devices and circuits in power industry and electric drive.
Verification:	Lesson quizzes, homework project, final test.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ANW135_U1
Description:	Student knows how to select and design simple electronic circuits in power industry and electric drive.
Verification:	Lesson quizzes, homework project, final test.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	

Code of effect:	ANW135_U1
Description:	Student knows how to select and design simple electronic circuits in power industry and electric drive.
Verification:	Lesson quizzes, homework project, final test.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	

Code of effect:	ANW135_U1
Description:	Student knows how to select and design simple electronic circuits in power industry and electric drive.
Verification:	Lesson quizzes, homework project, final test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	

General academic profile - social competences

Code of effect:	ANW135_K1
Description:	Student understands and values the importance of electronics in engineering and modern life.

Table 39. Learning outcomes

Verification:	Lesson quizzes, homework project, final test.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Description of course

Code of course	ANK316										
Name of course	Electronics 2										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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. Krzysztof Rafał										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	4 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Electric circuit theory, attendance in Electronics 1.										
Limit of students	12										
C. Effects of education and manner of teaching											
Purpose of course	Learn practical methods of electronic circuit analysis. Learn the use of research equipment in Laboratory of electronics.										
Effects of education	See Table 40.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>15h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	15h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	15h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Laboratory: transistor amplifiers, operational amplifiers, sinusoidal signal generators, stabilized DC supplies, switched-mode power supplies, sequential and combinational logic circuits.										
Methods of evaluation	Passing every laboratory exercise. Homework: preparation for classes, during which student should prepare and use simple circuit for measurement of electronic circuit.										
Methods of verification of effects of education	See Table 40.										
Exam	no										
Literature	1. P. Horowitz, W. Hilll "The Art of Electronics". 2. V. Vodozov "Introduction to Electronic Engineering". 3. V. Vodozov "Introduction to Power Electronics". 4. N. Mohan "Power Electronics. A First Course".										
Website of the course	-										
D. Student's activity											
Number of ECTS credits	1										
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 labs - 15 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of										

Description of course

	student • systematic preparation for classes - 5 hours; • preparation of laboratory reports - 6 hours TOTAL: 29 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - number of hours that require the presence of a teacher - 18, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 3 hours .
Number of ECTS credits on practical activities on the course	1 ECTS credits - 28 hours, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student • systematic preparation for classes - 5 hours; • preparation of laboratory reports - 6 hours.

E. Additional information

Notes	
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Table 40. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK316_W1
Description:	Student knows properties of basic electronic components.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
Code of effect:	ANK316_W2
Description:	Student knows properties of basic electronic circuits.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
Code of effect:	ANK316_W3
Description:	Students has basic knowledge on electrical measurements.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
Code of effect:	ANK316_W4
Description:	Students has basic knowledge on electric circuits.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK316_U1
Description:	Student knows how to use measurement equipment (oscilloscope, waveform generator, power supply, multimeter).

Table 40. Learning outcomes	
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK316_U2
Description:	Student knows how to analyse phenomena in semiconductor devices.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK316_U4
Description:	Student knows how to use electronic equipment data sheets.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK316_U5
Description:	Student is able to design and implement a simple electronic circuit.
Verification:	Tests before and after laboratories, exercise reports.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	Tests before and after laboratories, exercise reports.
Description:	Student knows how to analyse electronic circuits in DC and AC domain.
Verification:	ANK316_U3
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	

Description of course

Code of course	ANK340										
Name of course	Fluid Mechanics 2										
Version of course	Wersja 1										
A. Place of the course in system of studies											
Level of education	First 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	mgr inż. Konrad Gumowski										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	4 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Basic informations from: Fluid Mechanics 1 (ML.ANW122).										
Limit of students	12										
C. Effects of education and manner of teaching											
Purpose of course	Familiarizing students with basic knowledge of the physics of fluids, and basic measurements techniques.										
Effects of education	See Table 41.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>15h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	15h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	15h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Measurement techniques for the flow-rate, velocity and pressure. 1) Thermo- and laser-anemometry. 2) Measurements of viscosity coefficient and hydraulic losses. 3) Flow visualisation techniques. 4) Pressure drop measurements. 5) Venturi flowmeters. 4) Pressure distribution and drag coefficient the on bluff bodies. 5) Aerodynamics coefficients on lifting surfaces.										
Methods of evaluation	Assessment method: e.g. 60% continuous assessment based on laboratory work, 40% tests.										
Methods of verification of effects of education	See Table 41.										
Exam	no										
Literature	1 - http://www.meil.pw.edu.pl/za/ZA/Dydaktyka/Fluid-Mechanics-2-Lab . 2 - F. White, Fluid Mechanics.										
Website of the course	http://www.meil.pw.edu.pl/za/ZA/Dydaktyka/Fluid-Mechanics-2-Lab										
D. Student's activity											
Number of ECTS credits	1										
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 - 17, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: - preparation of laboratory reports - 8 hours; - preparation for short tests. - 6 hours. TOTAL : 31 hours.
Number of ECTS credits on the course with direct participation of academic teacher	0,5 ECTS credits - number of hours that require the presence of a teacher - 17, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits - 31 hours , including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours; c) preparation of laboratory reports - 8 hours; d) preparation for short tests. - 6 hours.
E. Additional information	
Notes	Practical work: e.g. Project/laboratory classes, where students will design and implement a simple measurements of flow conditions and parameters.
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Table 41. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK340_W1
Description:	He knows the general principles of calibration of measuring instruments and error calculations.
Verification:	Test no. 1
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK340_W1
Description:	He knows the general principles of calibration of measuring instruments and error calculations.
Verification:	Test no. 1
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK340_W2
Description:	Has a basic knowledge how to measure the fluid velocity and pressure, and knows the construction of instruments used for this purpose.
Verification:	Tests no. 1, no.2
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK340_W3
Description:	He has knowledge of the flow rate measurement using a Venturi flow meter depending on the type of fluid.
Verification:	Test no. 3
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK340_W4

Table 41. Learning outcomes	
Description:	He understands reasons for its establishment hydraulic losses and the definitions of the coefficients of linear and local pressure losses.
Verification:	Test no. 4
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK340_W5
Description:	He knows the a variety of flow visualization methods in terms of speed subsonic and supersonic. He distinguishes between visualization methods for surface and volume
Verification:	Test no. 5
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK340_W6
Description:	He knows the basic methods of determination of the total drag on the way balance measurements and pressure resistance by measuring the pressure on the surface of the body.
Verification:	Test no. 5
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK340_U1
Description:	He knows how to define a common basis kit for performing calibration of devices for measuring the speed and pressure.
Verification:	Reports no. 1, 2
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U1
Description:	He knows how to define a common basis kit for performing calibration of devices for measuring the speed and pressure.
Verification:	Reports no. 1, 2
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U1
Description:	He knows how to define a common basis kit for performing calibration of devices for measuring the speed and pressure.
Verification:	Reports no. 1, 2
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK340_U2
Description:	Being able to measure the magnitude of such as velocity, static pressure and total pressure
Verification:	Reports no. 1, 2.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U2
Description:	Being able to measure the magnitude of such as velocity, static pressure and total pressure
Verification:	Reports no. 1, 2.

Table 41. Learning outcomes	
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U2
Description:	Being able to measure the magnitude of such as velocity, static pressure and total pressure
Verification:	Reports no. 1, 2.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK340_U3
Description:	He can determine the velocity and angular characteristics of a velocity probe
Verification:	Reports no. 1, 2.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U3
Description:	He can determine the velocity and angular characteristics of a velocity probe
Verification:	Reports no. 1, 2.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK340_U3
Description:	He can determine the velocity and angular characteristics of a velocity probe
Verification:	Reports no. 1, 2.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U4
Description:	Able to calculate the coefficient of linear hydraulic losses in laminar and turbulent flows.
Verification:	Report no. 3.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U4
Description:	Able to calculate the coefficient of linear hydraulic losses in laminar and turbulent flows.
Verification:	Report no. 3.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK340_U4
Description:	Able to calculate the coefficient of linear hydraulic losses in laminar and turbulent flows.
Verification:	Report no. 3.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U5
Description:	Has the ability to, using a computer spreadsheet, convert the data obtained during the measurements and draw graphs
Verification:	Reports
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U5
Description:	Has the ability to, using a computer spreadsheet, convert the data obtained during the

Table 41. Learning outcomes	
	measurements and draw graphs
Verification:	Reports
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U6
Description:	Able to interpret the results at the primary level
Verification:	Reports
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U6
Description:	Able to interpret the results at the primary level
Verification:	Reports
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK340_U6
Description:	Able to interpret the results at the primary level
Verification:	Reports
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U7
Description:	Being able to determine the type of fluid flow (laminar or turbulent) based on visualization.
Verification:	Report no. 5
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK340_U7
Description:	Being able to determine the type of fluid flow (laminar or turbulent) based on visualization.
Verification:	Report no. 5
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U7
Description:	Being able to determine the type of fluid flow (laminar or turbulent) based on visualization.
Verification:	Report no. 5
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK340_U8
Description:	Is able to propose a visualization method (surface or volume) depending on the expectations.
Verification:	Report no. 5
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK340_U8
Description:	Is able to propose a visualization method (surface or volume) depending on the expectations.
Verification:	Report no. 5
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK340_U8
Description:	Is able to propose a visualization method (surface or volume) depending on the

Table 41. Learning outcomes	
Verification:	expectations.
Field of study related learning outcomes	Report no. 5
Area of study related learning outcomes	E1_U10
General academic profile - social competences	
Code of effect:	ANK340_K1
Description:	Able to work and interact in a group, taking different roles in it.
Verification:	Preparation of reports.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ANK340_K2
Description:	Is able to define priorities for the task specified by yourself or others.
Verification:	Preparation of reports.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

Description of course

Code of course	ANK341	
Name of course	Fluid Mechanics 3	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Jacek Szumbariski, prof.PW	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	The general knowledge of the fluid mechanics fundamentals are assumed (Fluid Mechanics I or equivalent).	
Limit of students	60	
C. Effects of education and manner of teaching		
Purpose of course	To learn about essential concepts and theoretical methods of the compressible flow dynamics. To acquire practical skills in solving simple engineering problem in gas dynamics. To learn about basics of potential flows and boundary layer theory.	
Effects of education	See Table 42.	
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	1. Energy equation: derivation, interpretation of terms, dissipation function. 2. First integral of the energy equation, Crocco equation. 3. Dynamics of small disturbances, acoustic approximation, speed of sound and the Mach number. 4. Isentropic and adiabatic gas flow: basic relations, stagnation and critical parameters, examples of application. 5. The normal shock wave. 6. Stationary motion of an ideal gas in the duct with variable section. The Laval nozzle. 7. Stationary motion of the gas in the presence of heat transfer. 8. Stationary motion of the gas through the duct with friction. 9. One dimensional unsteady motion of a compressible fluid, method of characteristics and Riemann invariants, simple waves and emergence of shocks, examples of application. 10. Two-dimensional potential flow. 11. Elements of the	

Description of course

	boundary layer theory.
Methods of evaluation	Two class tests (solution of practical, computational problems; both should be passed) and the final exam (theory plus practical part).
Methods of verification of effects of education	See Table 42.
Exam	yes
Literature	1. Kundu P.K., Cohen I.M.: Fluid Mechanics, 3rd Ed. (or newer). Elsevir Academic Press, 2004. 2. Liepmann H.W., Roshko A.: Elements of Gas Dynamics. Dover Publications, Inc., 2001. 3. Krauze E.: Fluid mechanics. Springer, 2005 (available in electronic form in the main library of WUT).
Website of the course	Didactic materials at http://c-cfd.meil.pw.edu.pl/ccfd/index.php?item=6 (restricted access)

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) attendance at the lectures - 18 hours; b) attendance at the exercises - 12 hours. 2) The number of hours of independent work of student - 30: a) preparation for the class tests: 2*6 h = 12 hours; b) preparation for the examination (incl. consultancy) - 18 hours. Together ~60 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - number of hours that require the presence of a teacher - 30, including: a) attendance at the lectures - 18 hours; b) attendance at the exercises - 12 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credit (tutorial and preparation for the class tests).

E. Additional information

Notes	-
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Table 42. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW122_W1
Description:	Student knows basic concepts and thermodynamical relations connected to an idela gas motion.
Verification:	Test 1, exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW122_W1
Description:	Student knows basic concepts and thermodynamical relations connected to an idela gas motion.
Verification:	Test 1, exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	

Table 42. Learning outcomes	
Code of effect:	ANW122_W2
Description:	Student has acquired theoretical knowledge in the area of stationary gas flows (continuous and with a shock wave) in variable-section ducts. Student knows basic engineering 1D models of duct flows with friction or heat transfer.
Verification:	Test 1 and 2, exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANW122_W2
Description:	Student has acquired theoretical knowledge in the area of stationary gas flows (continuous and with a shock wave) in variable-section ducts. Student knows basic engineering 1D models of duct flows with friction or heat transfer.
Verification:	Test 1 and 2, exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW122_W3
Description:	Student has elementary knowledge about the method of characteristic used for wave phenomena in nonstationary flows of an ideal gas.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANW122_W4
Description:	Student has assimilated foundations of 2D potential flows and elements of the boundary layer theory.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW_U5
Description:	Student can explain the significance of the Kutta-Joukowski condition and determine (in simple cases) the flow circulation and the lift force.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW_U5
Description:	Student can explain the significance of the Kutta-Joukowski condition and determine (in simple cases) the flow circulation and the lift force.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW_U5
Description:	Student can explain the significance of the Kutta-Joukowski condition and determine (in simple cases) the flow circulation and the lift force.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	

Table 42. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANW122_U1
Description:	Student can determine motion parameters of an ideal gas using appropriate thermodynamic relations and the energy equation.
Verification:	Test 1.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U1
Description:	Student can determine motion parameters of an ideal gas using appropriate thermodynamic relations and the energy equation.
Verification:	Test 1.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U1
Description:	Student can determine motion parameters of an ideal gas using appropriate thermodynamic relations and the energy equation.
Verification:	Test 1.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U2
Description:	Student can solve simple problems concerning flow determination in Lavale nozzles and flows through ducts with heating/cooling or wall friction.
Verification:	Test 1.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U2
Description:	Student can solve simple problems concerning flow determination in Lavale nozzles and flows through ducts with heating/cooling or wall friction.
Verification:	Test 1.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U2
Description:	Student can solve simple problems concerning flow determination in Lavale nozzles and flows through ducts with heating/cooling or wall friction.
Verification:	Test 1.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U3
Description:	Student can solve simple cases of nonstationary 1D flows using the method of characteristics.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANW122_U3
Description:	Student can solve simple cases of nonstationary

Table 42. Learning outcomes	
	1D flows using the method of characteristics.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U3
Description:	Student can solve simple cases of nonstationary 1D flows using the method of characteristics.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U4
Description:	Student is able to calculate selected characteristics of a 2D boundary layer. Student can describe main features of the boundary layer separation phenomenon.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW122_U4
Description:	Student is able to calculate selected characteristics of a 2D boundary layer. Student can describe main features of the boundary layer separation phenomenon.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANW122_U4
Description:	Student is able to calculate selected characteristics of a 2D boundary layer. Student can describe main features of the boundary layer separation phenomenon.
Verification:	Test 2, exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK376	
Name of course	Fundamentals of Management	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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 Administration and Social Sciences	
Coordinator of course	Sylvia Michalska	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Optional	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	30	
C. Effects of education and manner of teaching		
Purpose of course	To learn about mechanisms, which are important for group creation, dynamics, relations between members in groups, methods of good communication, methods of making decisions. Student will also learn about classical management theories, manager's activities, goals of cooperation, communication and methods of solving problems.	
Effects of education	See Table 43.	
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	Contents (lecture's programme): • What is management? Most important theories in management. • Why people cooperate? What does it mean good or bad cooperation. Who is responsible for making cooperation effective and how to do it? • Stages of team building – social groups, relations in groups, emotions. • Manager's functions – different cultures – different approaches. • Manager's roles. • Management of quality – what is, why is important. • Communication in groups, problems, facilities, rules. • Manipulation – what is, how to avoid. • Negotiations – different types, tricks, rules. • Effectiveness – how to improve it, different theories and systems of work organization.	
Methods of evaluation	Course is a lecture, there are two tests (in the middle and in the end of the course).	

Description of course

Methods of verification of effects of education	See Table 43.
Exam	no
Literature	Recommended texts (reading): 1. McKay, M., Davis, M., & Fanning, P. Messages: The Communication Skills Book, Second Edition. 1995. Oakland, CA: New Harbinger Publications, Inc. 2. P. Hartley "Interpersonal communication". 3. E. Aronson "Social Animal". 4. Stephen R. Covey The Seven Habits of Highly Effective People. 5. Peter Drucker "On the Profession of Management". 6. R. Cialdini "Influence: science and practice".
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 - 31, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 1 hours. 2) The number of hours of independent work of student - work at home (lecture, preparation to tests) - 20 hours. Total - 51 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits, number of hours that require the presence of a teacher - 31, 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	
Notes	-
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Table 43. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW376_W01
Description:	Student has knowledge about classical theories of management, which were source of modern management theories.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ML.ANW376_W01
Description:	Student has knowledge about classical theories of management, which were source of modern management theories.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_W32
Area of study related learning outcomes	
Code of effect:	ML.ANW376_W02
Description:	Student has knowlegde about groups mechanisms, dynamic, can typologize them, can use this knowlege to analyze his current

Table 43. Learning outcomes	
Verification:	situation. Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ML.ANW376_W02
Description:	Student has knowlegde about groups mechanisms, dynamic, can typologize them, can use this knowlege to analyze his current situation.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_W32
Area of study related learning outcomes	
Code of effect:	ML.ANW376_W03
Description:	Student can name and recognize type of human relations, he can identify communication scheme, raltions in communication.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ML.ANW376_W03
Description:	Student can name and recognize type of human relations, he can identify communication scheme, raltions in communication.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_W32
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ML.ANW376_U01
Description:	Can observe and interpretate social behaviours in groups.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ML.ANW376_U01
Description:	Can observe and interpretate social behaviours in groups.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ML.ANW376_U02
Description:	Can in everyday's life use and apply knowledge about social behaviours.
Verification:	Two tests in the middle and in the end of the semester,
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW376_U03
Description:	Can discuss about management problems using

Table 43. Learning outcomes	
	basic vocabulary (management theory, psychology, sociology).
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ML.ANW376_U03
Description:	Can discuss about management problems using basic vocabulary (management theory, psychology, sociology).
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ML.ANW376_K01
Description:	Is conscious what are the consequences of being group member, can identify his role in the group.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K01
Description:	Is conscious what are the consequences of being group member, can identify his role in the group.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K01
Description:	Is conscious what are the consequences of being group member, can identify his role in the group.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K02
Description:	Can analyze and improve skills of human relation building, knows, that soft skills, connected with social relations are important in every type of professional activity.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K02
Description:	Can analyze and improve skills of human relation building, knows, that soft skills, connected with social relations are important in every type of professional activity.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Table 43. Learning outcomes	
Code of effect:	ML.ANW376_K02
Description:	Can analyze and improve skills of human relation building, knows, that soft skills, connected with social relations are important in every type of professional activity.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K03
Description:	Can recognize different social situations and relations and react adequately.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K03
Description:	Can recognize different social situations and relations and react adequately.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K03
Description:	Can recognize different social situations and relations and react adequately.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ML.ANW376_K03
Description:	Can recognize different social situations and relations and react adequately.
Verification:	Two tests in the middle and in the end of the semester.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

Description of course

Code of course	ANK424
Name of course	Heat Transfer 2
Version of course	2013.

A. Place of the course in system of studies

Level of education	First 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	mgr inż. Adam Dominiak

B. General characteristic of the course

Block of courses	Power Engineering
Group of courses	Specialization
Type of course	Compulsory
Language of course	angielski
Nominal semester	4 (r.a. 2019/2020)
Time of completion in the academic year	summer semester
Preliminary requirements	Thermodynamics II, Heat Transfer I.
Limit of students	12 students in one group

C. Effects of education and manner of teaching

Purpose of course	Practical demonstration of measurement devices and methods for determination of basic thermal properties of solids. Measurements of thermal conductivity, diffusivity, specific heat, convective heat transfer coefficients in natural and forced convection. Measurement of thermal contact resistance. Measurement of heat transfer coefficients in heat exchanger. Measurement of thermal characteristics of radiator.
Effects of education	See Table 44.

Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h

Contents of education	Measurements of thermal properties of solids (thermal conductivity, diffusivity, specific heat with use of steady-state and transient heat transfer methods. Measurements of convective heat transfer coefficients in natural and forced convection. Measurement of thermal contact resistance. Investigation of heat exchanger. Investigation of radiator.
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Methods of evaluation	Reports from exercises, final test.
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Methods of verification of effects of education	See Table 44.
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Exam	no
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Literature	1. Heat Transfer Laboratory Manual. 2. Cengel Y. A., Boles M.A.: Heat transfer. An engineering approach., Mc Graw Hill.
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Website of the course	
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D. Student's activity

Description of course

Number of ECTS credits	1
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 16, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 1 hours. 2) The number of hours of independent work of student • preparation to exercises - 7 hours; • preparation of reports - 4 hours; • preparation to final test - 4 hours. TOTAL: 31 hours.
Number of ECTS credits on the course with direct participation of academic teacher	0,6 ECTS credits - number of hours that require the presence of a teacher - 16, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 1 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credit - 30 hours including: a) preparation to exercises - 7 hours; b) laboratory exercises - 15 hours; c) preparation of reports - 4 hours; d) preparation to tests: 4 hours.

E. Additional information

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Table 44. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK424_W1
Description:	Student has knowledge in methods of measuring thermal conductivity, thermal diffusivity and specific heat of solids using steady and transient methods.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK424_W2
Description:	Has knowledge in determining heat transfer coefficient at free convection, forced convection and condensation.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK424_W2
Description:	Has knowledge in determining heat transfer coefficient at free convection, forced convection and condensation.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANK424_W3
Description:	Student knows theory of similarity and criterial equations for basic heat transfer problems.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK424_W3
Description:	Student knows theory of similarity and criterial

Table 44. Learning outcomes	
	equations for basic heat transfer problems.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANK424_W4
Description:	Student knows the rules of operation of heat exchangers and radiators.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK424_W4
Description:	Student knows the rules of operation of heat exchangers and radiators.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANK424_W5
Description:	Student has knowledge of measuring the thermal contact resistance and the factors that determine its value.
Verification:	Colloquium.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK424_U1
Description:	Student is able to perform measurements of thermal conductivity of insulators.
Verification:	Reports from exercises.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK424_U2
Description:	Student is able to perform measurements of heat transfer coefficient and thermal diffusivity using the method of regular regime.
Verification:	Reports from exercises.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK424_U3
Description:	Student is able to perform measurements of heat transfer coefficient at forced convection, determine the thermal contact resistance between solids and can test the effectiveness of radiator.
Verification:	Reports from exercises.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK424_U4
Description:	Student is able to perform analysis of measurement errors.
Verification:	Reports from exercises.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	

Description of course

Code of course	ANW125	
Name of course	Machine Design II	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Stanisław Bogdański; profesor PW.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	polski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Machine Design I.	
Limit of students	70	
C. Effects of education and manner of teaching		
Purpose of course	To present methods of analysis and design of various important machine elements and subassemblies as well as to explain their role and way of functioning in machines and systems. To make an introduction to surface failure phenomena and to the tooth gear, belt and chain drives.	
Effects of education	See Table 45.	
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	Screws and fasteners: theory of thread, stresses in threads, preloaded bolts under static and dynamic loading. Springs and flexible elements: accumulated energy, designing for minimum mass. Surface failure: surface geometry, friction and wear, surface fatigue, spherical and cylindrical contact. Machine subassemblies: sliding bearings, rolling element bearings, couplings (rigid and compliant couplings, flexible couplings), clutches and brakes (selection and specification, materials, disk clutches and brakes, drum brakes), basic features and selection of tooth gears and belt and chain drives.	
Methods of evaluation	Continuous assessment during the whole semester. Three regular tests organized during the semester plus one additional as the test for improvement at the end of semester.	
Methods of verification of effects of education	See Table 45.	

Description of course

Exam	yes
Literature	1. Machine Design An Integrated Approach, Fourth edition, by Robert L.Norton, Prentice Hall 2010. 2. Machine Elements in Mechanics and Design Fourth Edition, by Robert L. Mott, Prentice Hall 2006. 3. Design of Machine Elements seventh edition, by M.F.Spotts and T.E.Shoup, Prentice Hall 1998.
Website of the course	http://meil.pw.edu.pl/zpk/ZPK/Dydaktyka/Materialy-dla-studentow-Files-for-students

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 - 33, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student a) homework(completing the solutions of problems) -10 hours; b) reading the suggested literature -10 hours; c) regular preparations for classes, tests and exams-25 hours; TOTAL: 78 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 45. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW125_W1
Description:	He/She is familiar with the design of typical machines and machine subassemblies used especially in power transmission systems as well as components of different mechanical devices such as; screw mechanisms, rolling element bearings, sliding bearings, shafts and axles, springs, couplings, clutches and gears, etc. He is also familiar with the engineering challenges and problems accompanying the process of design.
Verification:	Test, exam.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANW125_W1
Description:	He/She is familiar with the design of typical machines and machine subassemblies used especially in power transmission systems as well as components of different mechanical devices such as; screw mechanisms, rolling element

Table 45. Learning outcomes	
	bearings, sliding bearings, shafts and axles, springs, couplings, clutches and gears, etc. He is also familiar with the engineering challenges and problems accompanying the process of design.
Verification:	Test, exam.
Field of study related learning outcomes	E1_W08
Area of study related learning outcomes	
Code of effect:	ANW125_W1
Description:	He/She is familiar with the design of typical machines and machine subassemblies used especially in power transmission systems as well as components of different mechanical devices such as; screw mechanisms, rolling element bearings, sliding bearings, shafts and axles, springs, couplings, clutches and gears, etc. He is also familiar with the engineering challenges and problems accompanying the process of design.
Verification:	Test, exam.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW125_U1
Description:	He/She is able to perceive and define the wider context of the analyzed detail problem including the context related to the required features of the component of the mechanical device being designed. During designing and calculating a particular component of the machine or structure (for example: the shaft support, the clutch or the joint of the two parts of piping) he/she is able to take into account the requirements related to its role in the system transmitting power or mass.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U1
Description:	He/She is able to perceive and define the wider context of the analyzed detail problem including the context related to the required features of the component of the mechanical device being designed. During designing and calculating a particular component of the machine or structure (for example: the shaft support, the clutch or the joint of the two parts of piping) he/she is able to take into account the requirements related to its role in the system transmitting power or mass.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW125_U1
Description:	He/She is able to perceive and define the wider context of the analyzed detail problem including the context related to the required features of the component of the mechanical device being

Table 45. Learning outcomes	
	designed. During designing and calculating a particular component of the machine or structure (for example: the shaft support, the clutch or the joint of the two parts of piping) he/she is able to take into account the requirements related to its role in the system transmitting power or mass.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U2
Description:	He/She is able to perceive the physical limitations (concerning mainly the strength, elasticity, durability and heat resistance of materials) and non physical related to economy, and standardisation as well as that resulting from an incomplete knowledge of engineers and imperfect tools being in their disposal - needed for designing the typical components and subassemblies of mechanical devices.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U2
Description:	He/She is able to perceive the physical limitations (concerning mainly the strength, elasticity, durability and heat resistance of materials) and non physical related to economy, and standardisation as well as that resulting from an incomplete knowledge of engineers and imperfect tools being in their disposal - needed for designing the typical components and subassemblies of mechanical devices.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U3
Description:	On the bases of the perceived limitations and requirements being relevant to a role performed by the designed subassembly/component (for example: joint of the two parts of piping, support of the shaft, clutch) in a machine, device or system, he/she is able to formulate limiting conditions, which are essential for completing calculations in designing. Then he/she is able to utilise them for determining or selecting the appropriate features of the subassembly/component being designed.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U3
Description:	On the bases of the perceived limitations and requirements being relevant to a role performed by the designed subassembly/component (for

Table 45. Learning outcomes	
	example: joint of the two parts of piping, support of the shaft, clutch) in a machine, device or system, he/she is able to formulate limiting conditions, which are essential for completing calculations in designing. Then he/she is able to utilise them for determining or selecting the appropriate features of the subassembly/component being designed.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW125_U3
Description:	On the bases of the perceived limitations and requirements being relevant to a role performed by the designed subassembly/component (for example: joint of the two parts of piping, support of the shaft, clutch) in a machine, device or system, he/she is able to formulate limiting conditions, which are essential for completing calculations in designing. Then he/she is able to utilise them for determining or selecting the appropriate features of the subassembly/component being designed.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U4
Description:	He/She is able to build or to select from the literature (as well as from the standards) adequate models of states and phenomena, which are necessary for utilising the limiting condition in engineering calculations of analysed or designed object/component/subassembly. He/She is able to evaluate the usefulness of the build/selected model in respect of its accuracy and meticulousity.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U4
Description:	He/She is able to build or to select from the literature (as well as from the standards) adequate models of states and phenomena, which are necessary for utilising the limiting condition in engineering calculations of analysed or designed object/component/subassembly. He/She is able to evaluate the usefulness of the build/selected model in respect of its accuracy and meticulousity.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW125_U4
Description:	He/She is able to build or to select from the

Table 45. Learning outcomes	
	literature (as well as from the standards) adequate models of states and phenomena, which are necessary for utilising the limiting condition in engineering calculations of analysed or designed object/component/subassembly. He/She is able to evaluate the usefulness of the build/selected model in respect of its accuracy and meticulousity.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U5
Description:	He/She knows how to perform the essential engineering calculations necessary for determining features of the analysed/designed subassembly/component of mechanical device, (for example: connection of the two parts of piping, shaft support or clutch.)
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U5
Description:	He/She knows how to perform the essential engineering calculations necessary for determining features of the analysed/designed subassembly/component of mechanical device, (for example: connection of the two parts of piping, shaft support or clutch.)
Verification:	Test, exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW125_U5
Description:	He/She knows how to perform the essential engineering calculations necessary for determining features of the analysed/designed subassembly/component of mechanical device, (for example: connection of the two parts of piping, shaft support or clutch.)
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U6
Description:	He/She knows how to apply in practice the general and detail principles of design. He/She is also able to follow the design guidelines resulting from engineering practice.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW125_U6
Description:	He/She knows how to apply in practice the general and detail principles of design. He/She is also able to follow the design guidelines resulting from engineering practice.

Table 45. Learning outcomes	
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U6
Description:	He/She knows how to apply in practice the general and detail principles of design. He/She is also able to follow the design guidelines resulting from engineering practice.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANW125_U6
Description:	He/She knows how to apply in practice the general and detail principles of design. He/She is also able to follow the design guidelines resulting from engineering practice.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U7
Description:	He/She is able to apply in practice the guidelines formulated in the engineering standards, which concern the geometrical features of typical machine elements, as well as their physical properties including the strength properties. He/She knows how to use the catalogues of typical machine elements/subassemblies and engineering materials.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW125_U7
Description:	He/She is able to apply in practice the guidelines formulated in the engineering standards, which concern the geometrical features of typical machine elements, as well as their physical properties including the strength properties. He/She knows how to use the catalogues of typical machine elements/subassemblies and engineering materials.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANW125_U8
Description:	He/She is able to undertake decisions concerning the characteristics/features of analysed/designed elements/subassemblies taking into account both, the results of calculations and the limitations, which cannot be defined mathematically.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW125_U8

Table 45. Learning outcomes	
Description:	He/She is able to undertake decisions concerning the characteristics/features of analysed/designed elements/subassemblies taking into account both, the results of calculations and the limitations, which cannot be defined mathematically.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANW125_U8
Description:	He/She is able to undertake decisions concerning the characteristics/features of analysed/designed elements/subassemblies taking into account both, the results of calculations and the limitations, which cannot be defined mathematically.
Verification:	Test, exam.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	

Description of course

Code of course	ANK351	
Name of course	Measurements and techniques of experiment	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Marcin Żugaj	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Calculus 1, Calculus 2.	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	Preparing students to develop the results of simple measurements and experimental results.	
Effects of education	See Table 46.	
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	Fundamentals of probability - a random variable, multiple random variables, probability distribution and mass functions. Correlation coefficient, technical examples. The characteristics of a random variable, limit theorems. Fundamentals of statistic, parameter estimation, statistical hypotheses. Testing the hypotheses. Errors and confidence intervals. Design of experiments, experiment results analysis and presentation.	
Methods of evaluation	Two tests in semester. The final mark is a wighted mean of Teaching Effect.	
Methods of verification of effects of education	See Table 46.	
Exam	no	
Literature	1. Montgomery D.C.: Applied statistics and probability for engineers. John Wiley and Sons, Inc. 2. Ross S., M.: Introduction to probability and statistics for engineers and scientists. San Diego Academic Press, 2000. 3. Bethea R.,M.: Statistical methods for engineers and scientists. New York, Basel, Marcel Dekker,1985. 4. Montgomery D.,C.: Statistical quality control. Hoboken, Wiley cop. 2009. Additional references: 1. Materials delivered by teacher	

Description of course

Website of the course	http://www.meil.pw.edu.pl/daas/DAAS2/Teaching
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, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: 15 hours preparation for tests. Total: 48 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	0.6 ECTS credit.
E. Additional information	
Notes	The subject Website is available only in the semester in which the course is run.
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Table 46. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK351_W1
Description:	Student has knowledge of the foundations of probability theory.
Verification:	Test no 1.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK351_W1
Description:	Student has knowledge of the foundations of probability theory.
Verification:	Test no 1.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK351_W2
Description:	Student has knowledge of the limit theorem and basic distribution functions of random variables applied in engineering.
Verification:	Test no 1 and 2.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK351_W2
Description:	Student has knowledge of the limit theorem and basic distribution functions of random variables applied in engineering.
Verification:	Test no 1 and 2.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANK351_W3
Description:	Student has knowledge of basic statistics

Table 46. Learning outcomes	
	problems such as confidence interval and hypothesis testing.
Verification:	Test no 2.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANK351_W3
Description:	Student has knowledge of basic statistics problems such as confidence interval and hypothesis testing.
Verification:	Test no 2.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK351_U1
Description:	Student can solve typical probability problem.
Verification:	Test no 1.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK351_U1
Description:	Student can solve typical probability problem.
Verification:	Test no 1.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK351_U2
Description:	Student can perform statistical estimation for typical probability distribution functions of random variable.
Verification:	Tests no 1 and 2.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK351_U2
Description:	Student can perform statistical estimation for typical probability distribution functions of random variable.
Verification:	Tests no 1 and 2.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANK351_U3
Description:	Student can estimate a confidence interval and formulate and test a statistical hypothesis.
Verification:	Test no. 2.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK351_U3
Description:	Student can estimate a confidence interval and formulate and test a statistical hypothesis.
Verification:	Test no. 2.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	

Description of course

Code of course	ANK406	
Name of course	Theory of Flow Machines	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Jarosław Milewski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Thermodynamics, Fluid Mechanics.	
Limit of students	130	
C. Effects of education and manner of teaching		
Purpose of course	Transfer of basic knowledge about energy turbines as part of the energy system.	
Effects of education	See Table 47.	
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	Turbine Energy as part of the gym. Types of turbines, the basic design solutions. Characteristics. Basic analysis of the gas turbine. Issues material. Cooling. Typical design solutions. Gas and steam systems.	
Methods of evaluation	The scoring system includes the work of students in the class and test results are final.	
Methods of verification of effects of education	See Table 47.	
Exam	yes	
Literature	Material provided by the lecturer.	
Website of the course	http://estudia.meil.pw.edu.pl	
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 - 48, including: a) attendance at the lectures-30 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • systematic preparation for classes, tests - 20 hours; • preparation for exam - 8 hours. TOTAL: 76 hours.	
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 48, including: a)	

Description of course

	attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 47. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK406_W1
Description:	Familiar with advanced methods of thermodynamics as applied to turbomachinery.
Verification:	Test.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK406_W1
Description:	Familiar with advanced methods of thermodynamics as applied to turbomachinery.
Verification:	Test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK406_W2
Description:	Familiar with advanced methods of fluid mechanics applied to turbomachinery.
Verification:	Exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK406_W2
Description:	Familiar with advanced methods of fluid mechanics applied to turbomachinery.
Verification:	Exam.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK406_W3
Description:	He knows the one-dimensional theory of the degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK406_W3
Description:	He knows the one-dimensional theory of the degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK406_W4
Description:	He knows the indicators characterizing the structure and work of the degree rotating machine.
Verification:	Exam.

Table 47. Learning outcomes	
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK406_W4
Description:	He knows the indicators characterizing the structure and work of the degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANK406_W4
Description:	He knows the indicators characterizing the structure and work of the degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK406_W4
Description:	He knows the indicators characterizing the structure and work of the degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANK406_W5
Description:	He knows the loss and the mechanisms of their formation to a degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK406_W5
Description:	He knows the loss and the mechanisms of their formation to a degree rotating machine.
Verification:	Exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANK406_W6
Description:	Knows examples of atlases profiles turbine.
Verification:	Exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANK406_W7
Description:	He knows advanced dimensional analysis as applied to the characteristics of rotating machinery.
Verification:	Exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANK406_W7
Description:	He knows advanced dimensional analysis as applied to the characteristics of rotating machinery.
Verification:	Exam.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	

Table 47. Learning outcomes	
Code of effect:	ANK406_W8
Description:	Knows the rules of experimental and using their results in the calculation of rotating machinery.
Verification:	Exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK406_U1
Description:	Has ability to choose the type of rotating machinery and their limits.
Verification:	Exam.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK406_U1
Description:	Has ability to choose the type of rotating machinery and their limits.
Verification:	Exam.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK406_U2
Description:	Can apply advanced methods of thermodynamics to analyze the operation of rotating machinery and their components.
Verification:	Exam.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK406_U2
Description:	Can apply advanced methods of thermodynamics to analyze the operation of rotating machinery and their components.
Verification:	Exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANK406_U2
Description:	Can apply advanced methods of thermodynamics to analyze the operation of rotating machinery and their components.
Verification:	Exam.
Field of study related learning outcomes	E1_U23
Area of study related learning outcomes	
Code of effect:	ANK406_U3
Description:	Can apply advanced methods of fluid mechanics to analyze the action of rotating machinery and their components.
Verification:	Exam.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK406_U3
Description:	Can apply advanced methods of fluid mechanics to analyze the action of rotating machinery and their components.
Verification:	Exam.
Field of study related learning outcomes	E1_U23
Area of study related learning outcomes	

Table 47. Learning outcomes	
Code of effect:	ANK406_U4
Description:	He knows atlases turbine profiles and can use them.
Verification:	Exam.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANK406_U4
Description:	He knows atlases turbine profiles and can use them.
Verification:	Exam.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK406_U4
Description:	He knows atlases turbine profiles and can use them.
Verification:	Exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK406_U5
Description:	Can design degree Turbine selected parameters.
Verification:	Exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANK406_U5
Description:	Can design degree Turbine selected parameters.
Verification:	Exam.
Field of study related learning outcomes	E1_U23
Area of study related learning outcomes	
Code of effect:	ANK406_U5
Description:	Can design degree Turbine selected parameters.
Verification:	Exam.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK406_U5
Description:	Can design degree Turbine selected parameters.
Verification:	Exam.
Field of study related learning outcomes	E1_U13
Area of study related learning outcomes	
Code of effect:	ANK406_U6
Description:	Knows the rules of experimental model turbine stages.
Verification:	Exam.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK406_U6
Description:	Knows the rules of experimental model turbine stages.
Verification:	Exam.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANK406_U6
Description:	Knows the rules of experimental model turbine stages.
Verification:	Exam.

Table 47. Learning outcomes	
Field of study related learning outcomes	E1_U23
Area of study related learning outcomes	
Code of effect:	ANK406_U7
Description:	He can move the results of an experiment on the turbine model for a real object.
Verification:	Exam.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANK406_U7
Description:	He can move the results of an experiment on the turbine model for a real object.
Verification:	Exam.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK406_K1
Description:	Able to develop their knowledge and skills using additional materials.
Verification:	Exam.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANJ4	
Name of course	Foreign Language 4	
Version of course	2014.	
A. Place of the course in system of studies		
Level of education	First 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	The Foreign Language Centre PW	
Coordinator of course	For details, refer to the syllabus of the course	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Languages	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	5 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	For details, refer to the syllabus of the course	
Limit of students	For details, refer to the syllabus of the course	
C. Effects of education and manner of teaching		
Purpose of course	For details, refer to the syllabus of the course	
Effects of education	See Table 48.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	For details, refer to the syllabus of the course	
Methods of evaluation	For details, refer to the syllabus of the course	
Methods of verification of effects of education	See Table 48.	
Exam	no	
Literature	For details, refer to the syllabus of the course	
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	Number of hours that require the presence of a teacher ~30 exercises hours. The number of hours of independent work of student ~30.	
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit.	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes	Detailed information about the effects of teaching presents a course syllabus.	
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Table 48. Learning outcomes

Description of course

Code of course	ANWF5
Name of course	Physical Education and Sport 5
Version of course	2013.

A. Place of the course in system of studies

Level of education	First 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	College of Physical Education and Sport.
Coordinator of course	Teacher at College of Physical Education and Sport.

B. General characteristic of the course

Block of courses	Power Engineering
Group of courses	Physical Education and Sports
Type of course	Compulsory
Language of course	angielski
Nominal semester	5 (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 development of physical activity of students. Detailed data contains syllabus of specific course.	
Effects of education	See Table 49.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The exercise program offer by College of Physical Education and Sport.	
Methods of evaluation	According to the rules of classes developed by College of Physical Education and Sport.	
Methods of verification of effects of education	See Table 49.	
Exam	no	
Literature		
Website of the course		

D. Student's activity

Number of ECTS credits	0
Number of hours of student's work to achieve effects of education	Participation in classes - 30 hours.
Number of ECTS credits on the course with direct participation of academic teacher	0.0 ECTS credit (30 hours of classes, without ECTS).
Number of ECTS credits on practical activities on the course	

E. Additional information

Notes	
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Table 49. Learning outcomes

Description of course

Code of course	ANS510
Name of course	Chemistry of Water
Version of course	

A. Place of the course in system of studies

Level of education	First 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	Zakład Pomp Napędów i Siłowni ITC
Coordinator of course	dr inż. Krzysztof Karaśkiewicz

B. General characteristic of the course

Block of courses	Power Engineering
Group of courses	Specialization
Type of course	Compulsory
Language of course	polski
Nominal semester	5 (r.a. 2019/2020)
Time of completion in the academic year	winter semester
Preliminary requirements	brak
Limit of students	brak

C. Effects of education and manner of teaching

Purpose of course	Celem jest zapoznanie z technologią uzdatniania wody do celów technologicznych jak również doбором parametrów wody do odpowiednich zastosowań technologicznych.	
Effects of education	See Table 50.	
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	Treści merytoryczne przedmiotu: Chemiczne właściwości wody i pary. Składniki wody. Woda jako surowiec energetyczny. Procesy fizykochemiczne w obiegach wodnych i parowych siłowni. Korozja i jej zapobieganie. Metody uzdatniania wody. Kontrola jakości wody w elektrowniach i elektrociepłowniach.	
Methods of evaluation	Wykonanie i przedstawienie prezentacji wybranego tematu	
Methods of verification of effects of education	See Table 50.	
Exam	no	
Literature	1. Edward E, Baruth - WATER TREATMENT PLANT DESIGN - McGRAW-HILL 2. N.F. Gray - Water Technology - Elsevier 3. E.R.Alley - Water Quality Control - McGraw-Hill 4. INDUSTRIAL WATER TREATMENT. OPERATION AND MAINTENANCE 5. Handbook of Water and Wastewater Treatment Plant Operations - Taylor&Francis 6. C.C.Patton - Applied Water Technology - C.P.C	
Website of the course		

D. Student's activity

Description of course

Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	Wykład - 30 godz., przygotowanie prezentacji - 20 godz. Razem 50 godz.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS
Number of ECTS credits on practical activities on the course	1 ECTS
E. Additional information	
Notes	
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Table 50. Learning outcomes

Description of course

Code of course	ANFKT_PE1
Name of course	Elective Course PE1
Version of course	2013.

A. Place of the course in system of studies

Level of education	First 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	Power Engineering
Group of courses	Specialization
Type of course	Elective
Language of course	angielski
Nominal semester	5 (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 51.	
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	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 51.	
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	2
Number of hours of student's work to achieve effects of education	Number of hours that require the presence of a teacher ~30 (lectures / classes / labs / projects). The number of hours of independent work of student ~30.
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 (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 51. Learning outcomes

General academic profile - knowledge

Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W20
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W24
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.

Table 51. Learning outcomes	
Field of study related learning outcomes	course.
Area of study related learning outcomes	E1_W26
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.

Table 51. Learning outcomes	
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

Table 51. Learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	

Description of course

Code of course	ANK442										
Name of course	Electric Machines 2										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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	mgr inż. Paweł Błaszczuk										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	5 (r.a. 2019/2020)										
Time of completion in the academic year	winter semester										
Preliminary requirements	ANW113 Electric Circuits 1, ANK317 Electric Circuits 2, ANW135 Electronics 1, ANW333 Electric Machines 1.										
Limit of students											
C. Effects of education and manner of teaching											
Purpose of course	To get familiar with practical aspects of construction and principles of operation of transformers and rotating electric machines employed in industry. To understand practical aspects of measurement of parameters and characteristics of electric machines. To understand methods of speed control techniques of rotating electrical machines.										
Effects of education	See Table 52.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>15h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	15h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	15h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Experiment 1. Transformer Test. Construction of transformers. Rated data of one-phase and three-phase transformers. Measurement of insulation resistance and winding resistance. Polarity checks. Measurement of voltage ratio for different group of connections. Saturation presence. No-load test. Short-circuit test. Load characteristic. Calculation of per-unit transformer values. Transformers in parallel. Variable autotransformer test. Experiment 2. DC Shunt Machine Test. Construction of dc machines. Rated date of different dc machines . Identification of terminals. Measurement of winding resistances and the contact (brush) resistance of the rotor. No-load characteristic. Load characteristics. Speed										

Description of course

	<p>regulation characteristics. Field speed control. Starting characteristic. Braking. Tachometer and digital speed measurement. Experiment 3. AC 3-phase AC Induction Ring Test. Construction of ac induction machines. Rated date of ac induction machines. Measurements of locked-rotor torque. No-load characteristics. Load characteristic. Speed regulation characteristics. Experiment 4. Synchronous Machine Test. Construction of ac synchronous machines. Rated date of different synchronous machines. Different modes of operation: motor, generator, compensator. Starting methods of synchronous motor. No-load characteristic. V-curves characteristics. Regulation curves. Synchronisation of generator. Experiment 5. Variable Speed Induction Motor Drive Test. Methods of induction motor speed control. Induction motor supplied from voltage inverter. Load characteristic of induction motor with pump load. Valve control vs. variable speed control. Energy efficiency assessment. Experiment 6. Variable Speed Industrial Drives Test. Load characteristic of induction motor with fan load. Load characteristic of induction motor with compressor. Digital measurement equipment. Data loggers. Industrial computer system of data acquisition. Fault findings tips.</p>
Methods of evaluation	<p>Passing test before and after each laboratory, delivering reports from all experiments.</p>
Methods of verification of effects of education	<p>See Table 52.</p>
Exam	<p>no</p>
Literature	<p>Recommended texts (reading): Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006. Further Readings: 1. Bonal J.: Variable speed electric drives. Promethee. Schneider Electric. 1999. tom 1-3. 2. Boldea I., Nasar S.A.: Electric drives, CRC Press, 1999. 3. Chiasson J.: Modeling and high-performance control of electric machines, IEEE Series on Power Engineering, A John Wiley and Sons, Inc., 2005. 4. Hindmarsh J.: Electrical machines and their applications. Pergamon International Library, 1985. 5. Hindmarsh J.: Electrical machines and drives. Worked examples. Pergamon International Library, 1985.</p>
Website of the course	<p>http://estudia.meil.pw.edu.pl/</p>
<p>D. Student's activity</p>	
Number of ECTS credits	<p>1</p>
Number of hours of student's work to achieve effects of education	<p>1) Number of hours that require the presence of a teacher - 17, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours. 2) The number of hours of independent work of student: - preparation of laboratory reports - 4</p>

Description of course

	hours; - preparation for short tests. - 6 hours. TOTAL : 27 hours.
Number of ECTS credits on the course with direct participation of academic teacher	0,5 ECTS credits - number of hours that require the presence of a teacher - 17, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits - 27 hours, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 2 hours; c) preparation of laboratory reports - 4 hours; d) preparation for short tests. - 6 hours.

E. Additional information

Notes	
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Table 52. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK442_W1
Description:	Student knows rules of usage and maintenance, and methods of measurements of transformers and electrical machines.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend).
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	
Code of effect:	ANK442_W1
Description:	Student knows rules of usage and maintenance, and methods of measurements of transformers and electrical machines.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend).
Field of study related learning outcomes	E1_W22
Area of study related learning outcomes	
Code of effect:	ANK442_W2
Description:	Student knows construction of transformers and electrical machines and understands reasons of usage of different materials.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend).
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK442_U1
Description:	Student can select transformer or electrical machine meeting different industrial application.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend).
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	

Table 52. Learning outcomes	
Code of effect:	ANK442_U2
Description:	Student can calculate energy efficiency of transformers and electrical machines.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend) .
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK442_K1
Description:	Student working in a team can prepare an experiment, carry it out, and prepare report from the experiment made.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend) .
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ANK442_K1
Description:	Student working in a team can prepare an experiment, carry it out, and prepare report from the experiment made.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend) .
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	ANK442_K1
Description:	Student working in a team can prepare an experiment, carry it out, and prepare report from the experiment made.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend) .
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	ANK442_K1
Description:	Student working in a team can prepare an experiment, carry it out, and prepare report from the experiment made.
Verification:	Oral test before experiments, preparation of laboratory reports and their successful presentation (defend) .
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANK329										
Name of course	Electric Power Systems 2										
Version of course	2018										
A. Place of the course in system of studies											
Level of education	First 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. Sławomir Bielecki										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	5 (r.a. 2019/2020)										
Time of completion in the academic year	winter semester										
Preliminary requirements	ANW113 Electric Circuits 1, ANK317 Electric Circuits 2, ANK381 Electric Power Systems 1.										
Limit of students											
C. Effects of education and manner of teaching											
Purpose of course	To gain knowledge on construction, operation and maintenance of transmission and distribution networks. To get familiar with power network components and equipment. To understand practical methods of power and energy measurement in power systems. To understand reasons of faults and protection of electric power systems. To obtain basic knowledge on utilization of electric energy and end-user requirements. To gain practical knowledge on power factor correction. To get familiar with electric installations, including smart electrical components in intelligent buildings. To get familiar with numerical modeling of power system.										
Effects of education	See Table 53.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>30h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	30h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	30h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Smart grid and intelligent electric installation in buildings - types, standards, components, equipments, design, programming, control. Practice with model of home automation systems. Transmission and Distribution Network structure. Power network in a normal and an emergency conditions - experiments with laboratory model. Practice with model of distribution transformer, analyse transformer efficiency and operation.										

Description of course

	Power Quality problem - measurements, analysis, causes and effects. Practice with smart energy meters and power quality monitoring. Reactive Power compensation, correction of Power Factor - means, methods, objectives, effects, effects and rationale. Power system simulation with dedicated software (design, study, analysis and interpretation). Project of LV Distribution Power Network in a Technological Park Area
Methods of evaluation	Passing test before and after selected exercises, delivering reports from all experiments, making a simply design of power system (project in groups), observation of student's work.
Methods of verification of effects of education	See Table 53.
Exam	no
Literature	Recommended texts (reading): Glover J., Sarma M., Overbye T.: Power Systems Analysis and Design, Cengage Learning, 2012. Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006. Further Readings: Schavemaker P., Sluis L. Electrical power system essentials, Wiley, 2008.
Website of the course	http://estudia.meil.pw.edu.pl/
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 - 33, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: a) preparation of laboratory reports - 20 hours; b) preparation for short tests. - 20 hours. TOTAL - 73 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits - 73 hours, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 3 hours; c) preparation of laboratory reports - 20 hours; d) preparation for short tests - 20 hours.
E. Additional information	
Notes	The classes were prepared with the use of information and communication technologies Moodle e-learning platform.
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Table 53. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK329_W1
Description:	Students knows and understands fundamental practical aspects of operation of power systems.

Table 53. Learning outcomes

Verification:	Preparation of laboratory reports and their successful presentation.
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK329_U1
Description:	Student can design simple industrial electrical installation or basic power system.
Verification:	Project
Field of study related learning outcomes	E1_U20
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK329_K1
Description:	Students understands the importance of power systems in the modern society and can value societal costs of their functioning.
Verification:	Preparation of laboratory reports and their successful presentation.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Description of course

Code of course	ANS603	
Name of course	Energy Sources and Conversion	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. nzw. dr hab. inż. Tomasz Wiśniewski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	5 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Physics (ANW135), Thermodynamics 1 (ANW116).	
Limit of students	The lecture - 90 students, exercises - 30 students.	
C. Effects of education and manner of teaching		
Purpose of course	After passing the subject student will be able to: <ul style="list-style-type: none"> • identify and analyze energy resources and conversion systems, • identify threats attributable to energy conversion systems, • assess availability of different forms of energy and their potential, • assess efficiency of different energy conversion systems. 	
Effects of education	See Table 54.	
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	Lectures: <ul style="list-style-type: none"> • Basic terms related to energy conversion processes. • World's energy resources (organic fossil fuels, nuclear fuels, renewable sources): documented and possible. • Selected scenarios for world's energy development (IEA, WEC, DOE...). Threats related to energy conversion processes. Scenarios for Poland. • Energy conversion matrix. Energy conversion efficiency for selected processes and devices. • Issues of energy accumulation in various forms. • Energy conversion from fossil fuels. CO2 capture and storage. • Supercritical power plant. • Possibility of energy storage. • Environmental footprint of energy conversion processes: local and global. Greenhouse effect. Legal framework and standards for environmental protection. • Renewable sources; sun as an energy source, conversion of solar radiation energy (collectors 	

Description of course

	and photovoltaic systems). • Biomass and biofuels. • Wind power, energy of waters and oceans, OTEC. • Geothermy – geothermal systems, prospective hot dry rock technologies. Geothermy in Poland. • Nuclear reactions, nuclear fission and fusion, nuclear threats. BWR, PWR, HTGR nuclear reactors. • Heat pumps, examples of application. • Hydrogen as an energy carrier, hydrogen production and storage. • Fuel cells in power industry and transportation. Energy conversion in lasers. • Energy conversion in space. • Prospective power generation technologies. • Rationalization of energy consumption, increase of energy conversion efficiencies. Exercises: • Calculations of efficiency for different kinds of energy conversion systems and devices. • Calculation of actual cost of electricity form different sources of energy.
Methods of evaluation	The final mark will be given as a weighted average of two components: • 60% of a multiple-choice final test, • 40% of a homework project. The project will be made in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.
Methods of verification of effects of education	See Table 54.
Exam	no
Literature	1. Materials for students placed on website. 2. Dincer I., Rosen M.A.: Thermal Energy Storage, John Wiley& Sons Ltd, England 2002. 3. Kruger P.: Alternative Energy Resources, The Quest for Sustainable Energy, John Wiley & Sons, Inc.,2006. 4. IEA: World Energy Outlook, OECD/IEA.
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, including: a) attendance at the lectures -15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: 15 hours for completion of homework project.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the lectures- 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
Notes	
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Table 54. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS603_W1
Description:	Knowledge of different sources of energy, their features and possibilities of use.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANS603_W2
Description:	Knowledge of different energy conversion systems and devices, and their efficiencies.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS603_W2
Description:	Knowledge of different energy conversion systems and devices, and their efficiencies.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS603_W2
Description:	Knowledge of different energy conversion systems and devices, and their efficiencies.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
Code of effect:	ANS603_W2
Description:	Knowledge of different energy conversion systems and devices, and their efficiencies.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS603_W3
Description:	Knowledge of environmental footprint of energy conversion processes.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS603_W3
Description:	Knowledge of environmental footprint of energy conversion processes.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
Code of effect:	ANS603_W3
Description:	Knowledge of environmental footprint of energy conversion processes.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS603_W3
Description:	Knowledge of environmental footprint of energy conversion processes.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W12

Table 54. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANS603_W4
Description:	Knowledge of energy storage technologies and possibilities.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS603_W4
Description:	Knowledge of energy storage technologies and possibilities.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS603_W4
Description:	Knowledge of energy storage technologies and possibilities.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
Code of effect:	ANS603_W4
Description:	Knowledge of energy storage technologies and possibilities.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS603_U1
Description:	Ability to identify and analyze energy resources and conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS603_U1
Description:	Ability to identify and analyze energy resources and conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS603_U1
Description:	Ability to identify and analyze energy resources and conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS603_U2
Description:	Ability to identify threats attributable to energy conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS603_U2
Description:	Ability to identify threats attributable to energy conversion systems.
Verification:	Multiple-choice final test.

Table 54. Learning outcomes	
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS603_U2
Description:	Ability to identify threats attributable to energy conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS603_U3
Description:	Ability to assess availability of different forms of energy and their potential.
Verification:	Multiple-choice final test
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS603_U3
Description:	Ability to assess availability of different forms of energy and their potential.
Verification:	Multiple-choice final test
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS603_U3
Description:	Ability to assess availability of different forms of energy and their potential.
Verification:	Multiple-choice final test
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS603_U4
Description:	Ability to assess efficiency of different energy conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS603_U4
Description:	Ability to assess efficiency of different energy conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS603_U4
Description:	Ability to assess efficiency of different energy conversion systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS603_K1
Description:	Ability to work within a team on a specific engineering / analytical task.
Verification:	Home work defined as above carried out in teams.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ANK390										
Name of course	Energy systems										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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. Paweł Skowroński										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	5 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Theory of Heat Machines.										
Limit of students	130										
C. Effects of education and manner of teaching											
Purpose of course	Familiarize students with the nature of the energy system - in terms of its shape and function. Characteristics of selected subsystems energy. Methods and objectives of energy-systems modeling technology.										
Effects of education	See Table 55.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>15h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	15h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	15h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Selected topics of general systems theory. The basic processes of energy and technology. Features and structure of large energy systems. Principles of power systems. Objectives and methods (selected) modeling energy systems. Examples of methods for solving simulation and optimization. The national electricity system, the national gas systems, heating systems, some examples of power and heat sources - construction, the role of individual components, internal relations, systemic (internal) limit the operation, load variation, forecasting growth.										
Methods of evaluation	Exam.										
Methods of verification of effects of education	See Table 55.										
Exam	yes										
Literature	Materials provided by the lecturer.										
Website of the course	http://estudia.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: 30 hours, including: a)										

Description of course

effects of education	participation in lectures - 15 hours; b) participation in exercises - 15 hours. 2) Own work student: a) the preparation for the exam - 10 hours. 2) current preparation for exercises, lectures - studying literature - 20 hours. TOTAL - 60 hours. - 3 ECTS credits.
Number of ECTS credits on the course with direct participation of academic teacher	1.8 ECTS credits - contact hours: 45 hours, including: a) participation in lectures - 30 hours; b) participation in exercises - 15 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 55. Learning outcomes

General academic profile - knowledge	
Code of effect:	ANK390_W1
Description:	Student knows the problem of energy as a sector of the economy.
Verification:	Test.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANK390_W1
Description:	Student knows the problem of energy as a sector of the economy.
Verification:	Test.
Field of study related learning outcomes	E1_W17
Area of study related learning outcomes	
Code of effect:	ANK390_W1
Description:	Student knows the problem of energy as a sector of the economy.
Verification:	Test.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANK390_W2
Description:	Student knows the typical energy systems.
Verification:	Test.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANK390_W2
Description:	Student knows the typical energy systems.
Verification:	Test.
Field of study related learning outcomes	E1_W17
Area of study related learning outcomes	
Code of effect:	ANK390_W3
Description:	Student knows the characteristics of the selected sub-energy.
Verification:	Test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK390_W3

Table 55. Learning outcomes	
Description:	Student knows the characteristics of the selected sub-energy.
Verification:	Test.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANK390_W4
Description:	Student knows the possibility of modeling energy systems and subsystems.
Verification:	Test.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANK390_W4
Description:	Student knows the possibility of modeling energy systems and subsystems.
Verification:	Test.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANK390_W4
Description:	Student knows the possibility of modeling energy systems and subsystems.
Verification:	Test.
Field of study related learning outcomes	E1_W17
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK390_U1
Description:	Student is able to assess the basic technical and economic parameters of the system.
Verification:	Test.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANK390_U1
Description:	Student is able to assess the basic technical and economic parameters of the system.
Verification:	Test.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANK390_U1
Description:	Student is able to assess the basic technical and economic parameters of the system.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK390_U1
Description:	Student is able to assess the basic technical and economic parameters of the system.
Verification:	Test.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK390_U1
Description:	Student is able to assess the basic technical and economic parameters of the system.
Verification:	Test.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	

Table 55. Learning outcomes	
Code of effect:	ANK390_U2
Description:	Student can describe (characterize) the selected system and subsystem energy.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK390_U2
Description:	Student can describe (characterize) the selected system and subsystem energy.
Verification:	Test.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK390_U2
Description:	Student can describe (characterize) the selected system and subsystem energy.
Verification:	Test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK390_U2
Description:	Student can describe (characterize) the selected system and subsystem energy.
Verification:	Test.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.

Table 55. Learning outcomes	
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANK390_U3
Description:	Student can choose the parameters of the system and its main devices and evaluate the impact of the most important factors on Main contacts technical and economic parameters.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK390_K1
Description:	Student is able to describe energy systems for those not professionally connected with energy.
Verification:	Test.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANK390_K1
Description:	Student is able to describe energy systems for those not professionally connected with energy.
Verification:	Test.
Field of study related learning outcomes	E1_K05

Table 55. Learning outcomes

Area of study related learning outcomes	
Code of effect:	ANK390_K1
Description:	Student is able to describe energy systems for those not professionally connected with energy.
Verification:	Test.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	

Description of course

Code of course	ANK364										
Name of course	Fundamentals of Operation and Maintenance										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Konrad Świrski, prof. PW.										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	5 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	-										
Limit of students	60										
C. Effects of education and manner of teaching											
Purpose of course	Messages concerning the operation of equipment, modernization policy, performance standards. Diagnostic systems and control operation. Basics of operation in the energy sector - the equipment industry standards.										
Effects of education	See Table 56.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Messages for the basic operation of equipment - from principles of ownership by the standards and regulations, problems of modernization, repairs and replacement of equipment. Systems supporting the operation and conduct repairs. The operation of power equipment (including control systems of exploitation). Lectures supplemented by a number of practical tasks (actual data) and simulation.										
Methods of evaluation	The scoring system includes the work of students in the class (project evaluation) and the results of the final test (online) according to the principles of the subject.										
Methods of verification of effects of education	See Table 56.										
Exam	no										
Literature	http://energetyka.itc.pw.edu.pl/pe .										
Website of the course	http://energetyka.itc.pw.edu.pl/pe										
D. Student's activity											
Number of ECTS credits	5										
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 - 55, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours. c) consultancy meetings - 10 hours. 2) The number of hours of independent work of student - 60 hours, including: a) systematic preparation for classes, analyzing literature - 20 hours; b) preparation for test - 15 hours; c) work on the project - 25 hours. Total: 115 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits - number of hours that require the presence of a teacher - 55, including: a) attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours. c) consultancy meetings - 10 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
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Table 56. Learning outcomes

General academic profile - knowledge

Code of effect:	ANK364_W1
Description:	The student has knowledge of the energy system and the basic devices.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANK364_W1
Description:	The student has knowledge of the energy system and the basic devices.
Verification:	Test.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANK364_W2
Description:	The student has knowledge of the principles of operation of equipment.
Verification:	Test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK364_W2
Description:	The student has knowledge of the principles of operation of equipment.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANK364_W3
Description:	The student knows the industry standards and operating procedures.
Verification:	Project evaluation.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANK364_W3

Table 56. Learning outcomes	
Description:	The student knows the industry standards and operating procedures.
Verification:	Project evaluation.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK364_W3
Description:	The student knows the industry standards and operating procedures.
Verification:	Project evaluation.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANK364_W4
Description:	The student knows the methods of analysis of technical and economic investment.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANK364_W4
Description:	The student knows the methods of analysis of technical and economic investment.
Verification:	Test.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANK364_W5
Description:	Student knows the issues of life and the cost of the basic types of power units and knows the systems supporting the operation and repair procedures.
Verification:	Test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANK364_W5
Description:	Student knows the issues of life and the cost of the basic types of power units and knows the systems supporting the operation and repair procedures.
Verification:	Test.
Field of study related learning outcomes	E1_W26
Area of study related learning outcomes	
Code of effect:	ANK364_W5
Description:	Student knows the issues of life and the cost of the basic types of power units and knows the systems supporting the operation and repair procedures.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U05

Table 56. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANK364_U1
Description:	Student can evaluate the basic operating parameters of power and is able to calculate the efficiency upgrade the equipment.

Table 56. Learning outcomes	
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common

Table 56. Learning outcomes	
	engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK364_U2
Description:	Student knows how to solve common engineering problems associated with the operation of equipment.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK364_U3
Description:	The student knows how to apply the methodology of TKE in the control operation of the power unit.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANK364_U3
Description:	The student knows how to apply the methodology of TKE in the control operation of the power unit.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	

Table 56. Learning outcomes	
Code of effect:	ANK364_U3
Description:	The student knows how to apply the methodology of TKE in the control operation of the power unit.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANK364_U3
Description:	The student knows how to apply the methodology of TKE in the control operation of the power unit.
Verification:	Test, project evaluation.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANK364_U4
Description:	The student knows and is able to calculate the indicators availability of equipment failure.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK364_U4
Description:	The student knows and is able to calculate the indicators availability of equipment failure.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.

Table 56. Learning outcomes	
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANK364_U5
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANK364_K1
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ANK364_K1
Description:	Student knows how to work in a group and present their results.
Verification:	Work in groups, project evaluation.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

Description of course

Code of course	ANS549										
Name of course	Internal Combustion Engines										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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. Andrzej Teodorczyk										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	5 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Thermodynamics.										
Limit of students	160										
C. Effects of education and manner of teaching											
Purpose of course	Learning about fundamentals of internal combustion engines operation, understanding dependencies between engine power, emissions and thermal and flow processes.										
Effects of education	See Table 57.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Operating principles. Thermodynamic principles. Combustion and fuels. Spark ignition engines. Compression ignition engines. Induction and exhaust processes. Two stroke engines. In-cylinder motion. Turbocharging. Future trends.										
Methods of evaluation	Final test:(50%), 3 projects (50%).										
Methods of verification of effects of education	See Table 57.										
Exam	no										
Literature	1. R.Stone: Introduction to Internal Combustion Engines, McMillan Press 1999. 2. C.F.Fergusson, A.T.Kirkpatrick: Internal Combustion Engines, Wiley 2001. 3. J. B. Heywood, „Internal Combustion Engine Fundamentals”, McGrawHill Book Co., New York, 1988.										
Website of the course	http://estudia.meil.pw.edu.pl/										
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) attendance at the lectures - 30 hours. 2) The number of hours of independent work of student - 30, including: a)										

Description of course

	work on the project 1 - 8 hours; b) work on the project 2 - 8 hours; c) work on the project 3 - 8 hours. d) preparation for final test - 6 hours. Total - 60 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - attendance at the lectures - 30 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits - 24 hours, including: a) work on the project 1 - 8 hours; b) work on the project 2 - 8 hours; c) work on the project 3 - 8 hours.

E. Additional information

Notes	
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Table 57. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS549_W1
Description:	Student knows types of engines, principles of their operation and applications.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANS549_W1
Description:	Student knows types of engines, principles of their operation and applications.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANS549_W1
Description:	Student knows types of engines, principles of their operation and applications.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS549_W2
Description:	Student knows performance parameters and maps of internal combustion engines.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANS549_W2
Description:	Student knows performance parameters and maps of internal combustion engines.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANS549_W2
Description:	Student knows performance parameters and maps of internal combustion engines.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS549_W3

Table 57. Learning outcomes	
Description:	Student knows: engine cycles, fuel supply and combustion systems, engine supercharging, toxic properties of exhaust gases.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANS549_W3
Description:	Student knows: engine cycles, fuel supply and combustion systems, engine supercharging, toxic properties of exhaust gases.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANS549_W3
Description:	Student knows: engine cycles, fuel supply and combustion systems, engine supercharging, toxic properties of exhaust gases.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS549_U1
Description:	Student is capable to show the dependense between engine performance + toxic emissions and engine thermal and flow processes
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANS549_U2
Description:	Student understands terminology and processes regarding internal combustion engines.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS549_U3
Description:	Student is able to calculate fundamental parameters of engine cycles and performance.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANS549_U4
Description:	Student knows the future trends in engine development.
Verification:	Written test, project evaluation.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	

Description of course

Code of course	ML ANK332	
Name of course	Marketing	
Version of course	2013-11-26	
A. Place of the course in system of studies		
Level of education	First 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 Administration & Social Sciences	
Coordinator of course	prof. dr hab. Janusz Gudowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	5 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Knowing of basic economics.	
Limit of students	30	
C. Effects of education and manner of teaching		
Purpose of course	Learning marketing tools & techniques.	
Effects of education	See Table 58.	
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	<p>1. Marketing Orientations: Production - until 1950s - Production methods. Quality Product - until the 1960s Selling methods. Marketing as such - 1970s to the present day - Needs and wants of customers. Holistic Marketing - 21st century - Everything matters in marketing. 2. Marketing mix - 4 p family. 3. Other contemporary approaches: Relationship marketing - Building and keeping good customer relations. Business marketing - Building and keeping relationships between organizations. Society marketing - Benefit to society (CSR - corporate social responsibility). Branding - Brand value. Internet marketing - Internet techniques of marketing. 4. Marketing techniques. 5. Pricing strategies. 6. Micro-environment of company. 7. Analysis of competition.</p>	
Methods of evaluation	Presentation of selected topics; colloque.	
Methods of verification of effects of education	See Table 58.	
Exam	no	
Literature	<p>1. Jay W. Tolman, Marketing for the new Millennium, PSI Successful Business Library, new edition. 2. L. Garbarski et al., Marketing, PWE Warszawa, latest edition.</p>	

Description of course

Website of the course	www.meil.pl
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) attendance at the lectures - 30 hours. 2) The number of hours of independent work of student: a) literature studies - 10 hours; b) preparing presentation of selected topic - 5 hours; c) preparing to colloque - 10 hours. Total: 55 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - attendance at the lectures - 30 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
Notes	
Date of last edition	2019-09-10 08:04:48

Table 58. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANK332_01
Description:	Ma podstawową wiedzę dotyczącą zarządzania, w tym zarządzania jakością, i prowadzenia działalności gospodarczej
Verification:	sprawdzian
Field of study related learning outcomes	E1_W32
Area of study related learning outcomes	

Code of effect:	ML.ANK332_02
Description:	Zna ogólne zasady tworzenia i rozwoju form indywidualnej przedsiębiorczości, wykorzystującej wiedzę z zakresu nauk ekonomicznych
Verification:	sprawdzian
Field of study related learning outcomes	E1_W34
Area of study related learning outcomes	

Code of effect:	ML.ANK332_03
Description:	Ma podstawową wiedzę niezbędną do rozumienia ekonomicznych uwarunkowań działalności inżynierskiej
Verification:	sprawdzian
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	

General academic profile - skills

Code of effect:	ML.ANK332_U01
Description:	Ma świadomość samokształcenia się i rozwijania tej świadomości korzystając z dostępnych baz wiedzy, informacji technicznej i Internetu
Verification:	przygotowanie prezentacji wybranego zagadnienia
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

General academic profile - social competences

Table 58. Learning outcomes

Code of effect:	ML.ANK332_K01
Description:	Ma świadomość ważności i rozumie ekonomiczne aspekty i skutki działalności inżynierskiej
Verification:	dyskusja podsumowująca
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Description of course

Code of course	ANS539										
Name of course	Rotodynamic Pumps and Pumping Systems										
Version of course	2018										
A. Place of the course in system of studies											
Level of education	First 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 Krzysztof Karaśkiewicz										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	5 (r.a. 2019/2020)										
Time of completion in the academic year	winter semester										
Preliminary requirements	Fluid Mechanics 1, Fluid Mechanics 2, Fluid Mechanics 3.										
Limit of students											
C. Effects of education and manner of teaching											
Purpose of course	Get acquainted with different types of pumps and principle of their operation. Learn parameters of pumps and pumping systems. Learn one dimensional flow theory of pumps; Euler equation, impact of impeller geometry on pump operation parameters. Learn affinity laws for rotodynamic pumps. Ecquire basic design knowledge of pump impeller and other flow-through pump parts. Learn about hydraulic forces acting on impeller and how to balance them. Learn about cavitation in pumps and cavitation characteristics of pump and pumping system. Get familiar with methods for regulating parameters of rotodynamic pumps. Learn pump selection and operation. Review pumps standards and certificates.										
Effects of education	See Table 59.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Classification of pumps and applications, pump types, special pump types. Basic principles of pump and hydraulic elevator operation. Characteristic parameters of pump and pumping systems, specific work and head of pump and pumping system, general characteristics of pumping systems. One dimensional flow theory of pumps, velocity triangles, Euler Equation for infinite blade number, specific work and head,										

Description of course

	<p>flow deflection caused by the blades, slip factor. Dimensionless coefficients, similarity laws and specific speed. Power balance and efficiencies, disk friction losses, leakage losses through annular seals, power loss caused by the inter-stage seal, leakage loss of radial or diagonal seals, leakage losses in open impellers, mechanical losses . Impact of impeller geometry on the pump performance. Impeller and volute design. Hydraulic thrust. Flow phenomena in the impeller sidewall gaps. Axial thrust, General procedure for calculating axial thrust, Unsteady axial thrust, Axial thrust balancing. Radial thrust, Radial thrust balancing, Radial thrust prediction Noise and Vibrations. Pressure pulsations, Generation of pressure pulsations, Noise generation in a fluid. Radiation of noise. Overview of mechanical vibrations of centrifugal pumps. Forces in annular seals. Hydraulic impeller interaction. Bearing reaction forces. Eigen values and critical speeds. Rotor instabilities. Interactions between impeller and diffuser blades. Rotating stall. Cavitation. Growth and implosion of vapor bubbles in a flowing liquid. Cavitation in impeller or diffuser. Required NPSH, extent of cavitation, cavitation criteria. Scaling laws for cavitating flows. The suction specific speed. Experimental determination of the required NPSHR. Pump drivers and regulation. Installation, Operation, and Maintenance. Life Cycle Costs for pumps and pumping systems. Pumps standards and certificates. Pump Testing. Classes have been prepared and will be conducted using innovative and creative forms of education.</p>
Methods of evaluation	Homework and final test
Methods of verification of effects of education	See Table 59.
Exam	no
Literature	1.) Pump Handbook - Igor J. Karassik, Joseph P. Messina, Paul Cooper, Charles C. Heald - McGraw-Hill 2.) Impeller Pumps - S. Lazarkiewicz, A.T. Trokolanski - Elsevier 3.) Centrifugal Pumps - J.F.Gulich, - - Springer
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, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student - 30 hours (homework, preparation for test). Total - 63 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a)

Description of course

	attendance at the lectures - 30 hours; b) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	0,5 ECTS credit.
E. Additional information	
Notes	The classes are carried out on the Problem Based Learning
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Table 59. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS539_W1
Description:	Has knowledge on classification of different types of pumps and their applications, limitations, special pump types. Understands basic principles of operation of pumps and hydraulic elevators. Has knowledge on characteristics of pumps, specific work and head pump and pumping system, general characteristics of pumping systems. Has knowledge on one dimensional flow theory of pumps including velocity triangles, Euler Equation for infinite blade number, specific work and head, flow deflection caused by the blades, slip factor. Has knowledge on of dimensionless coefficients, similarity laws and specific speed. Has knowledge on power balance and efficiencies, disk friction losses, leakage losses through annular seals, power loss caused by the inter-stage seal, leakage loss of radial or diagonal seals, leakage losses in open impellers, mechanical losses . Has knowledge on impact of impeller geometry on the pump performance. Has knowledge on impeller and volute design procedures.
Verification:	Homework and test.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANS539_W1
Description:	Has knowledge on classification of different types of pumps and their applications, limitations, special pump types. Understands basic principles of operation of pumps and hydraulic elevators. Has knowledge on characteristics of pumps, specific work and head pump and pumping system, general characteristics of pumping systems. Has knowledge on one dimensional flow theory of pumps including velocity triangles, Euler Equation for infinite blade number, specific work and head, flow deflection caused by the blades, slip factor. Has knowledge on of dimensionless coefficients, similarity laws and specific speed. Has knowledge on power balance

Table 59. Learning outcomes	
	and efficiencies, disk friction losses, leakage losses through annular seals, power loss caused by the inter-stage seal, leakage loss of radial or diagonal seals, leakage losses in open impellers, mechanical losses . Has knowledge on impact of impeller geometry on the pump performance. Has knowledge on impeller and volute design procedures.
Verification:	Homework and test.
Field of study related learning outcomes	E1_W07
Area of study related learning outcomes	
Code of effect:	ANS539_W1
Description:	Has knowledge on classification of different types of pumps and their applications, limitations, special pump types. Understands basic principles of operation of pumps and hydraulic elevators. Has knowledge on characteristics of pumps, specific work and head pump and pumping system, general characteristics of pumping systems. Has knowledge on one dimensional flow theory of pumps including velocity triangles, Euler Equation for infinite blade number, specific work and head, flow deflection caused by the blades, slip factor. Has knowledge on of dimensionless coefficients, similarity laws and specific speed. Has knowledge on power balance and efficiencies, disk friction losses, leakage losses through annular seals, power loss caused by the inter-stage seal, leakage loss of radial or diagonal seals, leakage losses in open impellers, mechanical losses . Has knowledge on impact of impeller geometry on the pump performance. Has knowledge on impeller and volute design procedures.
Verification:	Homework and test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS539_W2
Description:	Has knowledge on hydraulic thrust in rotodynamic pumps and flow phenomena in the impeller sidewall gaps. Has knowledge on axial thrust, general procedures for calculating axial thrust, of unsteady axial thrust and of axial thrust balancing. Has knowledge on radial thrust, radial thrust balancing and radial thrust prediction Has knowledge on noise and vibrations in rotodynamic pumps including pressure pulsations, generation of pressure pulsations, noise generation in a fluid and radiation of noise. Has knowledge on forces acting in annular seals including issues involving hydraulic impeller interaction, bearing reaction forces, eigen values and critical speeds, rotor instabilities, interactions between impeller and

Table 59. Learning outcomes

	diffuser blades, rotating stall. Has knowledge on cavitation, growth and implosion of vapor bubbles in a flowing liquid, cavitation in impeller or diffuser, required NPSH, extent of cavitation, cavitation criteria, scaling laws for cavitating flows, the suction specific speed, experimental determination of the required NPSHR. Has knowledge on pump drivers and regulation. Has knowledge on Installation, Operation, and Maintenance of rotodynamic pumps. Has knowledge on Life Cycle Costs for pumps and pumping systems. Has knowledge on Pumps standards and certificates. has knowledge on Pump Testing.
Verification:	Homework and test.
Field of study related learning outcomes	E1_W06
Area of study related learning outcomes	
Code of effect:	ANS539_W2
Description:	Has knowledge on hydraulic thrust in rotodynamic pumps and flow phenomena in the impeller sidewall gaps. Has knowledge on axial thrust, general procedures for calculating axial thrust, of unsteady axial thrust and of axial thrust balancing. Has knowledge on radial thrust, radial thrust balancing and radial thrust prediction Has knowledge on noise and vibrations in rotodynamic pumps including pressure pulsations, generation of pressure pulsations, noise generation in a fluid and radiation of noise. Has knowledge on forces acting in annular seals including issues involving hydraulic impeller interaction, bearing reaction forces, eigen values and critical speeds, rotor instabilities, interactions between impeller and diffuser blades, rotating stall. Has knowledge on cavitation, growth and implosion of vapor bubbles in a flowing liquid, cavitation in impeller or diffuser, required NPSH, extent of cavitation, cavitation criteria, scaling laws for cavitating flows, the suction specific speed, experimental determination of the required NPSHR. Has knowledge on pump drivers and regulation. Has knowledge on Installation, Operation, and Maintenance of rotodynamic pumps. Has knowledge on Life Cycle Costs for pumps and pumping systems. Has knowledge on Pumps standards and certificates. has knowledge on Pump Testing.
Verification:	Homework and test.
Field of study related learning outcomes	E1_W07
Area of study related learning outcomes	
Code of effect:	ANS539_W2
Description:	Has knowledge on hydraulic thrust in rotodynamic pumps and flow phenomena in the

Table 59. Learning outcomes	
	<p>impeller sidewall gaps. Has knowledge on axial thrust, general procedures for calculating axial thrust, of unsteady axial thrust and of axial thrust balancing. Has knowledge on radial thrust, radial thrust balancing and radial thrust prediction Has knowledge on noise and vibrations in rotodynamic pumps including pressure pulsations, generation of pressure pulsations, noise generation in a fluid and radiation of noise. Has knowledge on forces acting in annular seals including issues involving hydraulic impeller interaction, bearing reaction forces, eigen values and critical speeds, rotor instabilities, interactions between impeller and diffuser blades, rotating stall. Has knowledge on cavitation, growth and implosion of vapor bubbles in a flowing liquid, cavitation in impeller or diffuser, required NPSH, extent of cavitation, cavitation criteria, scaling laws for cavitating flows, the suction specific speed, experimental determination of the required NPSHR. Has knowledge on pump drivers and regulation. Has knowledge on Installation, Operation, and Maintenance of rotodynamic pumps. Has knowledge on Life Cycle Costs for pumps and pumping systems. Has knowledge on Pumps standards and certificates. has knowledge on Pump Testing.</p>
Verification:	Homework and test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	

Table 59. Learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U16

Table 59. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS539_U1
Description:	Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering.
Verification:	Homework.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of

Table 59. Learning outcomes	
	cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U12
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of

Table 59. Learning outcomes	
	cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of

Table 59. Learning outcomes	
	cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANS539_U3
Description:	Can prepare Life Cycle Costs analysis for a pump. Can use norms and standards relevant to pumps and procedures connected with work-related safety norms. Understands pump characteristics, work and head of pump and pumping system. Is able to predict parameters of pump according to similarity laws. Understands the methods of designing impeller and volute. Understands the flow phenomena in the impeller sidewall gaps and is able to calculate hydraulic axial and radial thrust. Understands hydraulic forces in annular seals. Understands the phenomenon of cavitation in pumps. Is able to perform Pump Test.
Verification:	Homework and test
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS539_K1
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Correctly identifies and solves dilemmas connected with his/her job. Can think and act in an entrepreneurial way.
Verification:	Homework
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	ANS539_K1
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Correctly identifies and solves dilemmas connected with his/her job. Can think and act in an entrepreneurial way.
Verification:	Homework
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	ANS539_K1
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Correctly identifies and solves dilemmas connected with his/her job. Can think and act in an entrepreneurial way.
Verification:	Homework
Field of study related learning outcomes	E1_K06
Area of study related learning outcomes	

Description of course

Code of course	ANS521	
Name of course	Steam Boilers	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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 Krawczyk	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	5 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Thermodynamics I, Heat Transfer I, Theory of Heat Machines.	
Limit of students	130	
C. Effects of education and manner of teaching		
Purpose of course	Learning the basic principles of construction and operation of steam boilers and how to assess the impact of structural and thermodynamic parameters on the efficiency of thermal processes occurring in the water-steam cycles and air-flue boiler.	
Effects of education	See Table 60.	
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	Basic concepts and parameters of the boiler and the requirements of the UDT. Operating factors: water and steam, requirements and quality control. Fuel boiler, types and characteristics. Typical construction of boilers and their basic elements. Types and characteristics of the water-steam circuit. Classification of combustion processes, the demand and the excess air coefficient. Low-emission combustion technologies. Basic issues Supplies. Calculate the heat-flow water-steam circuit and air flue. Term losses, heat balance and efficiency of the boiler. The balance of salt and determination of the degree of desalination in the boiler with natural circulation.	
Methods of evaluation	Two colloquia.	
Methods of verification of effects of education	See Table 60.	
Exam	no	

Description of course

Literature	materials provided by the lecturer.
Website of the course	http://estudia.meil.pw.edu.pl
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) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours. 2) The number of hours of independent work of student: a) systematic preparation for classes, problem solving, analyzing literature - 20 hours; b) preparation for tests - 6 hours. Total - 56 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - number of hours that require the presence of a teacher - 30, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises - 15 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
Notes	
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Table 60. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS521_W1
Description:	Student has knowledge of the structure of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W07
Area of study related learning outcomes	
Code of effect:	ANS521_W1
Description:	Student has knowledge of the structure of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS521_W1
Description:	Student has knowledge of the structure of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS521_W2
Description:	Student has knowledge of the principles of operation of steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS521_W2
Description:	Student has knowledge of the principles of operation of steam boiler.
Verification:	Test.

Table 60. Learning outcomes	
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS521_W3
Description:	Student knows the basic heat-flow processes taking place in a steam boiler.
Verification:	Test
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS521_W3
Description:	Student knows the basic heat-flow processes taking place in a steam boiler.
Verification:	Test
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS521_W4
Description:	Student knows the basic low-emission combustion technologies.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS521_W4
Description:	Student knows the basic low-emission combustion technologies.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS521_W4
Description:	Student knows the basic low-emission combustion technologies.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS521_W5
Description:	Student knows the basic steam boiler control systems.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS521_W5
Description:	Student knows the basic steam boiler control systems.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS521_W5
Description:	Student knows the basic steam boiler control systems.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS521_W6
Description:	Student knows the basic material properties of boiler.
Verification:	Test.

Table 60. Learning outcomes	
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS521_W6
Description:	Student knows the basic material properties of boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS521_U1
Description:	Student is able to determine the basic thermal losses of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS521_U1
Description:	Student is able to determine the basic thermal losses of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS521_U1
Description:	Student is able to determine the basic thermal losses of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS521_U1
Description:	Student is able to determine the basic thermal losses of the steam boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS521_U2
Description:	Student is able to perform the calculation of the balance sheet and determine the efficiency of the boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS521_U2
Description:	Student is able to perform the calculation of the balance sheet and determine the efficiency of the boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS521_U2
Description:	Student is able to perform the calculation of the balance sheet and determine the efficiency of the boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	

Table 60. Learning outcomes	
Code of effect:	ANS521_U2
Description:	Student is able to perform the calculation of the balance sheet and determine the efficiency of the boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS521_U2
Description:	Student is able to perform the calculation of the balance sheet and determine the efficiency of the boiler.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS521_U3
Description:	Student is able to perform the calculation of heat-flow heating surfaces.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS521_U3
Description:	Student is able to perform the calculation of heat-flow heating surfaces.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS521_U3
Description:	Student is able to perform the calculation of heat-flow heating surfaces.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS521_U3
Description:	Student is able to perform the calculation of heat-flow heating surfaces.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS521_U4
Description:	Student is able to perform the calculation of the strength of the pressurized parts.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS521_U4
Description:	Student is able to perform the calculation of the strength of the pressurized parts.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS521_U4
Description:	Student is able to perform the calculation of the strength of the pressurized parts.
Verification:	Test.

Table 60. Learning outcomes	
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS521_U4
Description:	Student is able to perform the calculation of the strength of the pressurized parts.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS521_U5
Description:	Student is able to assess the impact of the technical parameters of the boiler on the basic processes of heat-flow.
Verification:	Test
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS521_U5
Description:	Student is able to assess the impact of the technical parameters of the boiler on the basic processes of heat-flow.
Verification:	Test
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS521_U5
Description:	Student is able to assess the impact of the technical parameters of the boiler on the basic processes of heat-flow.
Verification:	Test
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS521_U5
Description:	Student is able to assess the impact of the technical parameters of the boiler on the basic processes of heat-flow.
Verification:	Test
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS521_U6
Description:	Student is able to analyze the thermal and flow processes in the boiler, and the results used in simple engineering issues.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS521_U6
Description:	Student is able to analyze the thermal and flow processes in the boiler, and the results used in simple engineering issues.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS521_U6
Description:	Student is able to analyze the thermal and flow processes in the boiler, and the results used in simple engineering issues.

Table 60. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS521_U6
Description:	Student is able to analyze the thermal and flow processes in the boiler, and the results used in simple engineering issues.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS521_K1
Description:	Knows how to work individually and in groups solving engineering tasks.
Verification:	Test, active participation in classes.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ANS521_K1
Description:	Knows how to work individually and in groups solving engineering tasks.
Verification:	Test, active participation in classes.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

Description of course

Code of course	ANS577	
Name of course	Turbines	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Jarosław Milewski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	5 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Theory of Heat Machines, Theory of Flow Machines	
Limit of students	60	
C. Effects of education and manner of teaching		
Purpose of course		
Effects of education	See Table 61.	
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	- Classes have been prepared and will be conducted using the design thinking method.	
Methods of evaluation	-	
Methods of verification of effects of education	See Table 61.	
Exam	yes	
Literature	-	
Website of the course	http://estudia.meil.pw.edu.pl	
D. Student's activity		
Number of ECTS credits	2	
Number of hours of student's work to achieve effects of education	30h	
Number of ECTS credits on the course with direct participation of academic teacher		
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes		
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Table 61. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS577_W1
Description:	He knows the place and task of the steam turbine as part of the powerplant.

Table 61. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W1
Description:	He knows the place and task of the steam turbine as part of the powerplant.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W10
Description:	Has knowledge of modern steam turbines as components of the energy system.
Verification:	Test.
Field of study related learning outcomes	E1_W27
Area of study related learning outcomes	
Code of effect:	ANS577_W2
Description:	Knows the types of steam turbines and the scope of their applications.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W2
Description:	Knows the types of steam turbines and the scope of their applications.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W3
Description:	Familiar with contemporary design solutions steam turbines.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W3
Description:	Familiar with contemporary design solutions steam turbines.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W4
Description:	He knows the basic design of turbine components.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W4
Description:	He knows the basic design of turbine components.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W5
Description:	He knows the working conditions, load and principles of strength calculations main parts of a

Table 61. Learning outcomes	
	steam turbine.
Verification:	Test
Field of study related learning outcomes	E1_W07
Area of study related learning outcomes	
Code of effect:	ANS577_W5
Description:	He knows the working conditions, load and principles of strength calculations main parts of a steam turbine.
Verification:	Test
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W5
Description:	He knows the working conditions, load and principles of strength calculations main parts of a steam turbine.
Verification:	Test
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W6
Description:	He knows the materials used in the construction of steam turbines.
Verification:	Test
Field of study related learning outcomes	E1_W07
Area of study related learning outcomes	
Code of effect:	ANS577_W6
Description:	He knows the materials used in the construction of steam turbines.
Verification:	Test
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W6
Description:	He knows the materials used in the construction of steam turbines.
Verification:	Test
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W7
Description:	He knows the ways of turbine control.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W7
Description:	He knows the ways of turbine control.
Verification:	Test.
Field of study related learning outcomes	E1_W19
Area of study related learning outcomes	
Code of effect:	ANS577_W7
Description:	He knows the ways of turbine control.
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W8
Description:	He knows the characteristics of the main types of turbines.

Table 61. Learning outcomes	
Verification:	Test
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W8
Description:	He knows the characteristics of the main types of turbines.
Verification:	Test
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANS577_W9
Description:	He knows the peculiarities of working conditions and turbine construction of nuclear power plants
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS577_W9
Description:	He knows the peculiarities of working conditions and turbine construction of nuclear power plants
Verification:	Test.
Field of study related learning outcomes	E1_W27
Area of study related learning outcomes	
Code of effect:	ANS577_W9
Description:	He knows the peculiarities of working conditions and turbine construction of nuclear power plants
Verification:	Test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS577_U1
Description:	He can choose a steam turbine according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS577_U1
Description:	He can choose a steam turbine according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS577_U1
Description:	He can choose a steam turbine according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS577_U1
Description:	He can choose a steam turbine according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS577_U2
Description:	He knows the basics of steam turbine operation.

Table 61. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS577_U2
Description:	He knows the basics of steam turbine operation.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS577_U2
Description:	He knows the basics of steam turbine operation.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS577_U2
Description:	He knows the basics of steam turbine operation.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS577_U4
Description:	Can determine overall performance and the characteristics of different types of steam turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS577_U4
Description:	Can determine overall performance and the characteristics of different types of steam turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS577_U4
Description:	Can determine overall performance and the characteristics of different types of steam turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS577_U4
Description:	Can determine overall performance and the characteristics of different types of steam turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS577_U5
Description:	Able to determine the solution of the condensation unit according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS577_U5

Table 61. Learning outcomes	
Description:	Able to determine the solution of the condensation unit according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS577_U5
Description:	Able to determine the solution of the condensation unit according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS577_U5
Description:	Able to determine the solution of the condensation unit according to the specific needs.
Verification:	Test
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	

Description of course

Code of course	ANWF6	
Name of course	Physical Education and Sport 6	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	College of Physical Education and Sport.	
Coordinator of course	Teacher at College of Physical Education and Sport.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Physical Education and Sports	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	6 (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 development of physical activity of students. Detailed data contains syllabus of specific course.	
Effects of education	See Table 62.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	30h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The exercise program offer by College of Physical Education and Sport.	
Methods of evaluation	According to the rules of classes developed by College of Physical Education and Sport.	
Methods of verification of effects of education	See Table 62.	
Exam	no	
Literature		
Website of the course		
D. Student's activity		
Number of ECTS credits	0	
Number of hours of student's work to achieve effects of education	Participation in classes - 30 hours.	
Number of ECTS credits on the course with direct participation of academic teacher	0.0 ECTS credit (30 hours of classes, without ECTS).	
Number of ECTS credits on practical activities on the course		
E. Additional information		
Notes		
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Table 62. Learning outcomes

Description of course

Code of course	ANS534										
Name of course	Advanced Renewable Energy Sources										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Roman Domański										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	6 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Knowledge of different energy sources and conversion methods. Knowledge of basic thermodynamics (Thermodynamics I or equivalent). Understanding of operating principles of essential types of energy conversion equipment: boilers, turbines, nuclear reactors, wind turbines, water turbines, photovoltaic cells.										
Limit of students											
C. Effects of education and manner of teaching											
Purpose of course	Upon completion of the course students will have: <ul style="list-style-type: none"> • understanding of capabilities and limitations of individual renewable energy types and renewable energy sector as a whole, • ability to evaluate potential of renewable energy sources at a specific region, • ability to identify challenges related to integration of renewable energy sources in a larger energy system and propose potential solutions to these challenges, • basic understanding of direct and indirect costs related to renewable energy utilisation. 										
Effects of education	See Table 63.										
Form of didactic studies and number of hours per semester	<table border="1"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>15h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	15h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	15h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Lecture: <ul style="list-style-type: none"> • Basic terminology related to energy conversion processes. World's energy resources (fossil fuel and nuclear) versus renewable energy sources. • The basic parameters for energy storage. • Energy conversion efficiency for selected processes and devices. Possibility of energy storage. • Renewable sources; sun as an energy source, conversion of solar radiation 										

Description of course

	<p>energy (collectors and photovoltaic systems). • Solarsystems for heating and hot water production. Biomass and biofuels – in energy and transportationsector. Solar power plants. Solar energy for heating and hot water generation. • Wind energy and windpower generation. • Energy of waters and oceans (tidal and wave energy conversion), OTEC. • Geothermy –geothermal systems, prospective hot dry rock technologies. Heat pump. Geothermy in Poland. • Hydrogen as an energy carrier, hydrogen production by renewables. • Examples of renewable energy conversionsystems for heat and power generation. Place for renewable in world energy scenario. • Prospectivewpower generation technologies using the renewables. Typical solutions of waste utilisation used inpower engineering. • Rationalization of energy consumption, increase of energy conversion efficiencies. • Environmental footprint of renewable technologies. • Integration of renewable power generation systems with the grid. Exercises: • Calculations of actual cost of renewable electricity generation. • Calculations of required system reserves for compensating imbalance caused by renewable systems. • Comparisons of capacity factors for different technologies and different areas of the world. • Calculations of maximum share of renewables for different conditions.</p>
Methods of evaluation	<p>The final mark will be given as a weighted average of two components: • 60% of a multiple-choice final test, • 40% of a homework project. The project will be made in teams of several students with individually assigned subjects.</p>
Methods of verification of effects of education	See Table 63.
Exam	no
Literature	<p>1. IEA World Energy Outlook (currentedition). 2. Duffie J.A., Beckman W.A.: Solar Engineering of ThermalProcesses, John Willey&Sons, 2006. 3. Klimstra J., Power SupplyChallenges, Vaasa 2014.</p>
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	<p>1) Number of hours thatrequire the presence of a teacher - 47, including: a) attendanceat the lectures - 30 hours; b) attendanceat the exercises - 15 hours; c) consultancymeetings - 2 hours. 2) The number of hours of independent work of student - 10 hours for completion of homeworkproject.</p>
Number of ECTS credits on the course with direct participation of academic teacher	2 ECTS credits- number of hours that require the presence of a teacher – 47, including: a)

Description of course

	attendance at the lectures - 30 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 2 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
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Table 63. Learning outcomes

General academic profile - knowledge	
Code of effect:	ANS 534_W2
Description:	Knowledge of technologies for renewable energy conversion and their limiting parameters (efficiencies, capacity factors).
Verification:	Multiple choice test at the end of the course
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS 534_W2
Description:	Knowledge of technologies for renewable energy conversion and their limiting parameters (efficiencies, capacity factors).
Verification:	Multiple choice test at the end of the course
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS534_W1
Description:	Knowledge of renewable energy sources.
Verification:	Multiple choice test at the end of the course
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS534_W1
Description:	Knowledge of renewable energy sources.
Verification:	Multiple choice test at the end of the course
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS534_U1
Description:	Understanding of physical and technical limitations of renewable technologies.
Verification:	Multiple choice test at the end of the course. Home work project involving a detailed analysis of a specific problem related to practical application of a renewable technology.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANS534_U1
Description:	Understanding of physical and technical limitations of renewable technologies.
Verification:	Multiple choice test at the end of the course. Home work project involving a detailed analysis of a specific problem related to practical application of a renewable technology.

Table 63. Learning outcomes	
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS534_U2
Description:	Ability to analyse a certain power system in the context of maximum and feasible share of renewable sources.
Verification:	Multiple choice test at the end of the course. Home work project involving a detailed analysis of a specific problem related to practical application of a renewable technology.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS534_K1
Description:	Ability to work within a team on a specific engineering / analytical task.
Verification:	Home work defined as above carried out in teams.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANS534_K1
Description:	Ability to work within a team on a specific engineering / analytical task.
Verification:	Home work defined as above carried out in teams.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

Description of course

Code of course	ANS555										
Name of course	Control of Heat Processes										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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	ITC MUE										
Coordinator of course	dr inż. Konrad Wojdan										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	6 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Basic knowledge of the theory of heat machines, turbomachinery theory, basic automation and control, construction of power equipment (boilers, pumps, turbines).										
Limit of students	130										
C. Effects of education and manner of teaching											
Purpose of course	Familiarize students with the basic regulation systems of devices within the power and control methods of the energy block. Presentation of the rules for determining the properties of devices for the purpose of designing control systems.										
Effects of education	See Table 64.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Mathematical modeling elements of fitness for the purpose of designing control systems. Nonlinear and linear models, Laplace transform. Static and dynamic characteristics. Basic elements of control systems. Adjustment of boilers, turbines and pumps. Control of the turbine set. Use of emc control processes.										
Methods of evaluation	2 colloquia during the semester. Final examination in the case of negative or unsatisfactory ratings of colloquia.										
Methods of verification of effects of education	See Table 64.										
Exam	yes										
Literature	„The Control of Boilers”, 2nd edition, S. G. Dukelow, publisher ISA, USA, 1991.										
Website of the course	http://estudia.meil.pw.edu.pl										
D. Student's activity											
Number of ECTS credits	2										

Description of course

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) attendance at the lectures - 30 hours. 2). The number of hours of independent work of student: a) systematic preparation for the lecture, analyzing literature - 10 hours; b) preparation for test - 10 hours. Total - 50 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - attendance at the lectures - 30 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 64. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS555_W1
Description:	Student an understanding of thermal process automation.
Verification:	Test.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANS555_W1
Description:	Student an understanding of thermal process automation.
Verification:	Test.
Field of study related learning outcomes	E1_W19
Area of study related learning outcomes	
Code of effect:	ANS555_W2
Description:	Student knows the basic control systems of power unit.
Verification:	Test.
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	ANS555_W2
Description:	Student knows the basic control systems of power unit.
Verification:	Test.
Field of study related learning outcomes	E1_W19
Area of study related learning outcomes	
Code of effect:	ANS555_U1
Description:	Student knows how to analyze the work of the control system of thermal processes.
Verification:	Test.
Field of study related learning outcomes	E1_U26
Area of study related learning outcomes	
Code of effect:	ANS555_U2
Description:	Student is able to verify the experimental data for the purposes of job evaluation system.
Verification:	Test.

Table 64. Learning outcomes	
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANS555_U2
Description:	Student is able to verify the experimental data for the purposes of job evaluation system.
Verification:	Test.
Field of study related learning outcomes	E1_U26
Area of study related learning outcomes	
Code of effect:	ANS555_U2
Description:	Student is able to verify the experimental data for the purposes of job evaluation system.
Verification:	Test.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANS555_U3
Description:	Student knows how to evaluate technical solutions.
Verification:	Test
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS555_U3
Description:	Student knows how to evaluate technical solutions.
Verification:	Test
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANS555_U3
Description:	Student knows how to evaluate technical solutions.
Verification:	Test
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS555_K1
Description:	Student is able to use the databases and additional materials.
Verification:	Test.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANFKT_PE2	
Name of course	Elective Course PE2	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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	Power Engineering	
Group of courses	Specialization	
Type of course	Elective	
Language of course	angielski	
Nominal semester	6 (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 65.	
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	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 65.	
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	2	
Number of hours of student's work to achieve effects of education	Number of hours that require the presence of a teacher ~30 (lectures / classes / labs / projects). The number of hours of independent work of student ~30.	
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 (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 65. Learning outcomes

General academic profile - knowledge

Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W20
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W24
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.

Table 65. Learning outcomes	
Field of study related learning outcomes	course.
Area of study related learning outcomes	E1_W26
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.

Table 65. Learning outcomes	
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

Table 65. Learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	

Description of course

Code of course	ANS540	
Name of course	Heat Pumps	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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 Wiśniewski, prof. PW.	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	6 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Thermodynamics I.	
Limit of students	The lecture - 90 students, exercises - 30 students.	
C. Effects of education and manner of teaching		
Purpose of course	After passing the subject student will be able to analyze energy systems with heat pumps, understand needs for heat pump application, energy storage for all energy conversion processes, realize shortcomings of prospective heat pump technologies and limitations in their implementation today. Student will be able to pre-design and choose elements of system with heat pump. Student will be able to apply heat pumps in renewable energy systems.	
Effects of education	See Table 66.	
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 terms related to energy conversion processes in thermodynamic cycles. • Efficiency of reverse thermodynamics cycle. • Operation principle of a heat pump. • General information about heat pumping technology. • Types of heat pumps. • Working fluids for heat pumps. • Heat sources of heat pumps: air, ground, solid state. • Earth as an energy source. Ground heat exchangers. • Thermal energy storage (long and short term – ground storage, PCM storage). • Heat pump application systems. Reduction of CO2 emissions through the use of heat pump systems. • Increase of energy conversion efficiencies by introducing heat pumps and energy storage. Exercises: • Calculations of	

Description of course

	COP for different kinds of heat pumps. • Calculation of actual cost of heat produced by heat pumps. • Calculations of required heat source capacities. • Calculations of heat exchangers necessary for heat pumps.
Methods of evaluation	The final mark will be given as a weighted average of two components: • 60% of a multiple-choice final test, • 40% of a homework project. The project will be made in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.
Methods of verification of effects of education	See Table 66.
Exam	no
Literature	1. Materials for students placed on website. 2. Cengel Y.A., Boles M. A.: Thermodynamics: An Engineering Approach, New York, 1994.
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, including: a) attendance at the lectures- 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours. 2) The number of hours of independent work of student - 15 hours for completion of homework project.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits - number of hours that require the presence of a teacher - 33, including: a) attendance at the lectures- 15 hours; b) attendance at the exercises - 15 hours; c) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
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Table 66. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS540_W1
Description:	Knowledge on operation principle of a heat pump and general information about heat pumping technology.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS540_W1
Description:	Knowledge on operation principle of a heat pump and general information about heat pumping technology.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W28

Table 66. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANS540_W2
Description:	Knowledge on heat sources of heat pumps and heat pump application systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS540_W2
Description:	Knowledge on heat sources of heat pumps and heat pump application systems.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS540_U1
Description:	Ability to analyze a certain power system in the context of application of heat pumps.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS540_U1
Description:	Ability to analyze a certain power system in the context of application of heat pumps.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS540_U1
Description:	Ability to analyze a certain power system in the context of application of heat pumps.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS540_U2
Description:	Ability to pre-design and choose elements of system with heat pump.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U25
Area of study related learning outcomes	
Code of effect:	ANS540_U2
Description:	Ability to pre-design and choose elements of system with heat pump.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS540_U2
Description:	Ability to pre-design and choose elements of system with heat pump.
Verification:	Multiple-choice final test.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS540_K1
Description:	Ability to work within a team on a specific engineering / analytical task.

Table 66. Learning outcomes

Verification:	Home work defined as above carried out in teams.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ML.ANW127										
Name of course	Intermediate Engineering Project.										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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	The teacher authorized by the Faculty Council.										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	6 (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 67.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>60h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	0h	Project type of course	60h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	60h										
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 67.										
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 - 60, including a) consultancy meetings - 54 hours; b) final completion of the course - 6 hours; 2) The number of hours of independent										

Description of course

	work of student: a) work on the project - 110 hours. Total: 170 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,6 ECTS credits - 40 hours, including: a) consultancy meetings - 54 hours; b) final completion of the course - 6 hours.
Number of ECTS credits on practical activities on the course	6 ECTS credits - 170 hours, including: a) consultancy meetings - 54 hours; b) final completion of the course - 6 hours; c) work on the project - 110 hours.

E. Additional information

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Table 67. Learning outcomes

General academic profile - skills

Code of effect:	ML.ANW127_U1
Description:	Student can identify the solved problem in a wide range of science, based on the literature.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U1
Description:	Student can identify the solved problem in a wide range of science, based on the literature.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U1
Description:	Student can identify the solved problem in a wide range of science, based on the literature.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U2
Description:	Student can use the literature to search for tips to solve research or engineering problems.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U2
Description:	Student can use the literature to search for tips to solve research or engineering problems.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U3
Description:	Can solve simple engineering task with the help of the tutor.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U3

Table 67. Learning outcomes	
Description:	Can solve simple engineering task with the help of the tutor.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U4
Description:	Student can critically assess the results of the solved problem.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U4
Description:	Student can critically assess the results of the solved problem.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U4
Description:	Student can critically assess the results of the solved problem.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation of the tutor.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation of the tutor.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation of the tutor.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ML.ANW127_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation of the tutor.
Verification:	The final report assessed by the teacher.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ML.ANW127_K1
Description:	Development of self-learning needs in order to

Table 67. Learning outcomes	
	achieve the desired effect.
Verification:	The current assessment of the progress of work.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ML.ANW127_K1
Description:	Development of self-learning needs in order to achieve the desired effect.
Verification:	The current assessment of the progress of work.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	

Description of course

Code of course	ML.ANW126										
Name of course	Physics I										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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. Cezariusz Jastrzębski										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	6 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Basic knowledge of mathematics and elementary course of physics.										
Limit of students	150										
C. Effects of education and manner of teaching											
Purpose of course	The objective of the subject is to acquaint students with elements of modern physics especially quantum mechanics and to present its recent history, importance in general word perception and particularly its importance in physics, chemistry, modern electronics and materials science. Another objective is to teach students the skills of defining correctly area of physics and nanoscience where classical approach fails and quantum mechanical approach is needed to understand the physical phenomena. The scope covered by the subject is basis of quantum mechanics and its applications in atomics physics , chemistry and materials science . Basic level skills of quantum mechanical problems solving complete the task.										
Effects of education	See Table 68.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Lecture 1. Fundamental assumptions of classical and quantum mechanics, where classical physics fails, blackbody radiation, Plancks formula, de Broglie waves, optical spectra of light atoms, photoelectric effect. Lecture 2. Electron and photons waves and particles. Thomson cathode ray experiment, e/m calculation. Compton effect. Light and photon diffraction. Wave particle duality										

Description of course

solution, one and two slits electron diffraction. X-ray production and diffraction. Lecture 3. Uncertainty principle, energy uncertainty, momentum uncertainty, Quantum states. Expectation values. Superposition of states. Probability, wave function and Copenhagen interpretation. Examples. Lecture 4. Wave motion. Light and matter - Schrödinger equation. General solution of Schrödinger equation. Classical examples. Schrödinger equation of a free particle. Particle in a finite and infinite potential well. Lecture 5. Schrödinger equation continued.. Properties of valid wave function. Time independent Schrödinger equation. Stationary states.. Particle in a box. Potential barrier. Schrödinger equation solutions, classical and quantum approach. Reflection and transmission of electron wave. Wave particle duality solution, one and two slits electron diffraction. Lecture 6. Harmonic oscillator-recall. Classical and quantum solution of harmonic oscillator. equation. Analogy with optics. Application in nuclear physics. Alpha particle decay. Structure of the atom. Thomson model of atom. Rutherford scattering experiment. Rutherford model of atom Successes and failures. Bohr model of atom. The correspondence principle. Limitations of the Bohr model. Lecture 7. Schrödinger equation in three dimensions. Spherical coordinates. Separable solution. Solution of Schrödinger equation for hydrogen atom. Lecture 8. Quantum numbers in spherical coordinates, principal quantum number, magnetic (azimuthal) quantum number, spin quantum number. Magnetic effects on atomic spectra the Zeeman effect. Energy levels on electrons in atom. Optical spectra and selection rules. The role of spin. Lecture 9. Atomic structure many electron atoms. Electronic structure of many electron atoms. Building principle. The periodic table. Lecture 10. Molecules. Molecular bonding and spectra. Molecular bonds; ionic bonds, covalent bonds, Van der Waals bonds, hydrogen bonds, metallic bonds. Molecular orbitals, orbitals overlap, bonding and antibonding orbital. Classification of molecular states. Vibrations of molecules. Rotational and vibrational states. Lecture 11. Quantum mechanics applications in solid state physics. Fourier analysis of solid state physics of crystals. Bloch theory of electron in a periodic crystal lattice. Energy bands. Velocity of electron in Bloch formalism. Effective mass. "Free" Bloch electrons vs. tight binding. Lecture 12. Crystal and amorphous solids. Dielectrics,

Description of course

	semiconductors, metals. Fermi level. X-ray and neutron analysis of solids. Bragg formula. Electron diffraction in solid state physics. Surface analysis. RHEED. Lecture 13. Quantum mechanics applications in modern optics. Blackbody and laser. Stimulated and spontaneous emission. Inversion of electron population. Three and four step laser model.. Examples of lasers; gas laser semiconductor laser, cascade laser. Lecture 14. Analogy between optics and solid state physics. Optical constants-recall, wave equation and Schrödinger equation. Light in periodic structures. Photonic crystals. Energy gap in a crystal and in a photonic crystal. Lecture 15. Entangled quantum states. Principles of quantum computing. Build a quantum computer, what it means. How to build it? Introduction to quantum cryptography.
Methods of evaluation	100% exam.
Methods of verification of effects of education	See Table 68.
Exam	yes
Literature	To be decided later on the basis of availability of books, Internet sources etc.
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 - 30, including: a) attendance at the lectures - 30 hours. 2) The number of hours of independent work of student - 45: a) preparing for an exam - 22 hours; b) systematic preparing for lectures, analyzing literature - 23 hours. Total: 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - attendance at the lectures - 30 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	-
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Table 68. Learning outcomes

General academic profile - knowledge

Code of effect:	ML.ANW126_W1
Description:	Student knows and understands basic concepts and laws of quantum mechanics.
Verification:	Exam.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ML.ANW126_W2
Description:	Student knows technological applications of quantum mechanics and quantum chemistry.
Verification:	Exam.

Table 68. Learning outcomes	
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ML.ANW126_W2
Description:	Student knows technological applications of quantum mechanics and quantum chemistry.
Verification:	Exam.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ML.ANW126_W3
Description:	Student understands principles of operation of modern devices using quantum mechanics and nanotechnology.
Verification:	Exam.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ML.ANW126_U1
Description:	Student can solve basic problems in quantum mechanics.
Verification:	Exam.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW126_U1
Description:	Student can solve basic problems in quantum mechanics.
Verification:	Exam.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ML.ANW126_U2
Description:	Student is able to carry out critical assessment of experiments in quantum physics and chemistry.
Verification:	Exam.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ML.ANW126_U2
Description:	Student is able to carry out critical assessment of experiments in quantum physics and chemistry.
Verification:	Exam.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ML.ANW126_U3
Description:	Student is able expand his/her knowledge on modern physics and technology by literature-based self-study.
Verification:	Exam.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ML.ANW126_U3
Description:	Student is able expand his/her knowledge on modern physics and technology by literature-based self-study.
Verification:	Exam.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

Table 68. Learning outcomes	
General academic profile - social competences	
Code of effect:	ML.ANW126_K1
Description:	Student understands the progress in quantum physics and technology, and notes its relationship to social development.
Verification:	Exam, discussion.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	ML.ANW126_K1
Description:	Student understands the progress in quantum physics and technology, and notes its relationship to social development.
Verification:	Exam, discussion.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	
Code of effect:	ML.ANW126_K2
Description:	Student has awareness of significance of physical science in technological development and recognizes the need of permanent self-study in this area.
Verification:	Exam.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	

Description of course

Code of course	ANS524										
Name of course	Power Engineering Machines and Systems 1										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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. Jerzy Kuta										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	6 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Heat transfer 1.										
Limit of students											
C. Effects of education and manner of teaching											
Purpose of course	After completion of course knowledge about the influence of the parameters of pumps, fans, compressors and how they control for energy efficiency. Knowledge about formation place of various kinds of energy losses.										
Effects of education	See Table 69.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>30h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	30h	Project type of course	0h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	30h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Improving the energy efficiency, different ways of power equipment regulating, Knowledge about locations of various types energy losses. Learning how to research and development characteristics of the equipment used in power generation.										
Methods of evaluation	Evaluation reports of laboratory exercises.										
Methods of verification of effects of education	See Table 69.										
Exam	no										
Literature	Materials provided by a lecturer.										
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 • systematic preparation for classes - 10 hours; • prepare laboratory reports - 10 hours. Total: 52 hours.										
Number of ECTS credits on the course with direct	1,5 ECTS credits - number of hours that require										

Description of course

participation of academic teacher	the presence of a teacher - 32, 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 - 52 hours, including: a) attendance at the labs - 30 hours; b) consultancy meetings - 2 hours. c) systematic preparation for classes - 10 hours; d) prepare laboratory reports - 10 hours.

E. Additional information

Notes	
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Table 69. Learning outcomes

General academic profile - knowledge

Code of effect:	EW1
Description:	student zna zagadnienia obiegów cieplnych
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	EW1
Description:	student zna zagadnienia obiegów cieplnych
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	EW2
Description:	student zna zagadnienia pracy urządzeń energetycznych
Verification:	wyniki ćwiczen laboratoryjnych, sprawozdanie
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	EW2
Description:	student zna zagadnienia pracy urządzeń energetycznych
Verification:	wyniki ćwiczen laboratoryjnych, sprawozdanie
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	EW3
Description:	student zna zagadnienia regulacji i sterowania urządzeń energetycznych
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_W19
Area of study related learning outcomes	
Code of effect:	EW3
Description:	student zna zagadnienia regulacji i sterowania urządzeń energetycznych
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_W09
Area of study related learning outcomes	
Code of effect:	EW3
Description:	student zna zagadnienia regulacji i sterowania urządzeń energetycznych
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	

Table 69. Learning outcomes	
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	EU1
Description:	student potrafi zaplanowac i przeprowadzić eksperyment i poprawnie opracowac wyniki
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	EU1
Description:	student potrafi zaplanowac i przeprowadzić eksperyment i poprawnie opracowac wyniki
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	EU1
Description:	student potrafi zaplanowac i przeprowadzić eksperyment i poprawnie opracowac wyniki
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student potrafi przeprowadzić badania osiągow technicznych urządzenia energetycznego
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student potrafi przeprowadzić badania osiągow technicznych urządzenia energetycznego
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student potrafi przeprowadzić badania osiągow technicznych urządzenia energetycznego
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	EU2
Description:	student potrafi przeprowadzić badania osiągow technicznych urządzenia energetycznego
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student potrafi na podstawie wyników badań ocenic parametry eksploatacyjne urządzeń
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student potrafi na podstawie wyników badań ocenic parametry eksploatacyjne urządzeń
Verification:	ćwiczenia laboratoryjne, sprawozdanie

Table 69. Learning outcomes	
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student potrafi na podstawie wyników badań ocenić parametry eksploatacyjne urządzeń
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	EU3
Description:	student potrafi na podstawie wyników badań ocenić parametry eksploatacyjne urządzeń
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	EK1
Description:	student potrafi pracować w grupie
Verification:	ćwiczenia laboratoryjne, sprawozdanie
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ANS516	
Name of course	RES-Solar Engineering 1	
Version of course	2008	
A. Place of the course in system of studies		
Level of education	First 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. Dorota Chwieduk, prof. PW	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	6 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Fizyka (ML.DW001); Termodynamika (ML.ZNK414); Wymiana ciepła 1 (ML.NK423); Wymiana ciepła 2 (ML.NK424).	
Limit of students	Minimum 15 students, for seminar mode minimum 1 student.	
C. Effects of education and manner of teaching		
Purpose of course	<p>Students get fundamental knowledge on solar energy (radiation) and practical information on applied devices and systems, what includes theory on systems operation, performance and characteristics, and technical data on the system elements, modes of operation and integration into domestic and commercial heating/cooling and power (electric) systems. After completing his course the students will be able to specify all elements of different types of solar systems, to select the type of the solar conversion method and the installation according to the user needs. They will be prepared to design and evaluate solar systems depending on the expected working conditions. Students could propose and plan solar heating/cooling system and its dimensioning and evaluate its performance. Students would be able to evaluate energy and economic efficiency of solar collectors and whole systems and their environmental impact. They would be able to implement modern idea of solar passive systems into building architectural and energy concept. They could develop practical solution for low energy buildings.</p>	
Effects of education	See Table 70.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h

Description of course

	Project type of course	0h
	Computer lessons	0h
Contents of education	<p>Fundamentals of solar radiation and solar energy conversion methods: solar thermal and photovoltaics. Availability and structure of solar radiation. Determination of solar irradiation on surfaces under consideration. Shading problems. Theoretical background for practical implementation of solar energy conversion, including fundamentals in optics and thermodynamics. Internal photovoltaic effect. Physics of materials used for PV cells. Creation of PV modules and panels. Different types of PV systems. BIPV modern options. Solar thermal conversion. Basic elements of solar thermal systems. Active and passive solution. Modes of solar system operation (domestic hot water, process heat, space heating and cooling and etc.) Working fluids. Short and long term storage. Energy performance of solar heating and cooling systems. Schematic operation modes. Methods of improvement of solar systems operation. Modelling of solar system operation. Domestic and commercial application. Primary energy reduction. Solar buildings; natural heating and cooling. Evaluation and planning of natural and construction shading elements. Passive systems. Operational issues. Daylighting, modern systems. Improvement of energy efficiency of installations under operation. Standards for solar systems.</p>	
Methods of evaluation	100% continuous assessment based on tests and final closing test	
Methods of verification of effects of education	See Table 70.	
Exam	no	
Literature	<p>1. Anderson B.: Solar Energy: Fundamentals in Building Design, Total Environmental Action, Inc., Harrisville, New Hampshire, 1975 2. Anderson E. E: Fundamentals of solar energy conversion, Addison-Vesley Publ. Co., Reading, MA, 1982 3. Balcomb J.D. (ed.): Passive Solar Buildings, The MIT Press, Cambridge, Massachusetts, 1992 4. Chwieduk D., Bogdańska B.: Some recommendations for inclinations and orientations of building elements under solar radiation in Polish conditions, Renewable Energy Journal 29, 2004, 1569 - 1581 5. Duffie J.A., Beckman W.A, Klein S.A.: Solar Heating Design by the F-Chart Method, J. Wiley, Interscience Publication, 1978 6. Duffie J. A., Beckman W. A.: Solar Engineering of Thermal Processes, John Wiley & Sons, Inc., New York, 1991 7. Gordon J.: Solar energy the state of the art., ISES position papers, UK 2001 8. Sayigh A.A.M. (ed.): Solar Energy Engineering, Academic</p>	

Description of course

	<p>Press, London, 1997 9. Schulz H., Chwieduk D. Wärme aus Sonne und Erde Energiesparende Heizungssysteme mit Erdwärmespeicher, Solarabsorber und Wärmepumpe. Okobuch Verlage, Staufen bei Freiburg, 1995 10. Twidell J., Weir T.: Renewable Energy Resources, E&FN SPON, London, University Press Cambridge, 1996 11. Veziroglu T. N. (ed.): Solar energy and conservation, Pergamon Press, Oxford 1978 12. Weiss W., Bergmann I., Faninger G.: Solar heat Worldwide Markets and Contribution to the Energy Supply 2004, IEA Solar Heating & Cooling Programme, Austria 2006</p>
Website of the course	it is to be put on the website
D. Student's activity	
Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	Depending on the regularity of participation in the course students can work from 5 to 15 hours at home.
Number of ECTS credits on the course with direct participation of academic teacher	The course is based on lectures and therefore the direct involvement of an academic teacher is very strong. The ECTS number is equal to 1,5.
Number of ECTS credits on practical activities on the course	Even if, the course is based on lectures, students are made to be active through answering questions and solving problems given by the academic teacher. They can prepare and give a presentation on a solar energy topic selected by them. The ECTS number is equal to 0,5.
E. Additional information	
Notes	This is very new course, it started in 2011. The course is on very innovative technology and includes the wide spectrum on solar technologies and application. However, a lot of fundamental knowledge is included to understand highly advanced problem.
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Table 70. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS517_W1
Description:	Student knows fundamentals of the solar radiation and its conversion methods.
Verification:	Homework, test 1.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANS517_W1
Description:	Student knows fundamentals of the solar radiation and its conversion methods.
Verification:	Homework, test 1.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS517_W1

Table 70. Learning outcomes	
Description:	Student knows fundamentals of the solar radiation and its conversion methods.
Verification:	Homework, test 1.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W01
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W24
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student knows the principles of operation of solar heating and photovoltaic systems.
Verification:	Homework, test 1 and 2.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS517_W3

Table 70. Learning outcomes	
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Students knows foundations, ideas and practical applications of the solar energy in buildings.
Verification:	Homework, test 2.
Field of study related learning outcomes	E1_W24
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their

Table 70. Learning outcomes	
	operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the

Table 70. Learning outcomes	
	magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to evaluate properly the magnitude of a solar system, choose its main components and set up parameters for their operation.
Verification:	Homework 2, test 1.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.

Table 70. Learning outcomes	
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U21
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze foundations of operation of devices and systems of solar energy.
Verification:	Homework 1, test 1.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	

Table 70. Learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar instalations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar instalations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar instalations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar instalations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student can come up with the technical concept of heating and photovoltaic solar instalations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	

Table 70. Learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student can conduct an assessment of power efficiency and costs of solar installations.
Verification:	Homework 3, test 2.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	EU_5
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stsowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	EU_5
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stsowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	EU_5
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stsowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	EU_5
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stsowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	EU_5
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stsowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U21
Area of study related learning outcomes	
Code of effect:	EU_5

Table 70. Learning outcomes	
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stosowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	EU_5
Description:	Umie realizować koncepcję budownictwa niskoenergochłonnego poprzez stosowanie słonecznych systemów pasywnych
Verification:	Praca domowa 2, test 1
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	EK_1
Description:	ma świadomość konieczności wdrażania energooszczędnych technologii OZE
Verification:	Praca domowa 1,2,3
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	EK_1
Description:	ma świadomość konieczności wdrażania energooszczędnych technologii OZE
Verification:	Praca domowa 1,2,3
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	EK_1
Description:	ma świadomość konieczności wdrażania energooszczędnych technologii OZE
Verification:	Praca domowa 1,2,3
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	EK_1
Description:	ma świadomość konieczności wdrażania energooszczędnych technologii OZE
Verification:	Praca domowa 1,2,3
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	
Code of effect:	EK_2
Description:	Ma wiarę w konieczność realizacji prac interdyscyplinarnych (współpraca różnych branż technicznych) przy wdrażaniu energetyki słonecznej w budownictwie
Verification:	Praca domowa 2, 3, test 1,2
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	EK_2
Description:	Ma wiarę w konieczność realizacji prac interdyscyplinarnych (współpraca różnych branż technicznych) przy wdrażaniu energetyki słonecznej w budownictwie
Verification:	Praca domowa 2, 3, test 1,2
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Table 70. Learning outcomes	
Code of effect:	EK_2
Description:	Ma wiarę w konieczność realizacji prac interdyscyplinarnych (współpraca różnych branż technicznych) przy wdrażaniu energetyki słonecznej w budownictwie
Verification:	Praca domowa 2, 3, test 1,2
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	EK_2
Description:	Ma wiarę w konieczność realizacji prac interdyscyplinarnych (współpraca różnych branż technicznych) przy wdrażaniu energetyki słonecznej w budownictwie
Verification:	Praca domowa 2, 3, test 1,2
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	EK_3
Description:	Rozumie konieczność ochrony środowiska poprzez wdrażanie zintegrowanych technologii energetycznych
Verification:	Praca domowa 3, test 2
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	EK_3
Description:	Rozumie konieczność ochrony środowiska poprzez wdrażanie zintegrowanych technologii energetycznych
Verification:	Praca domowa 3, test 2
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	EK_3
Description:	Rozumie konieczność ochrony środowiska poprzez wdrażanie zintegrowanych technologii energetycznych
Verification:	Praca domowa 3, test 2
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	EK_3
Description:	Rozumie konieczność ochrony środowiska poprzez wdrażanie zintegrowanych technologii energetycznych
Verification:	Praca domowa 3, test 2
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	EK_3
Description:	Rozumie konieczność ochrony środowiska poprzez wdrażanie zintegrowanych technologii energetycznych
Verification:	Praca domowa 3, test 2
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	

Description of course

Code of course	ANS566										
Name of course	Technologies of Environmental Protection										
Version of course	2013										
A. Place of the course in system of studies											
Level of education	First 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. Krzysztof Badyda										
B. General characteristic of the course											
Block of courses	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	6 (r.a. 2019/2020)										
Time of completion in the academic year	summer semester										
Preliminary requirements	Knowledge regarding power technologies, machinery design and technological process in the basic power plant machinery and equipment. Prerequisites: Steam Boilers, Turbines, Thermal Power Stations (Course carried out parallel).										
Limit of students	60										
C. Effects of education and manner of teaching											
Purpose of course	Knowledge about evaluation of main factors causing harmfully emissions from power generating installations, especially in the area of air protection. Knowledge of main technologies of environmental protection used in power generation industry.										
Effects of education	See Table 71.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	0h										
Computer lessons	0h										
Contents of education	Environment protection legal system and technical possibility of the requirements realization in power generation industry. Best Available Technologies (BAT). Overview of today's and future technologies to reduce emissions of dust, SO _x , NO _x and CO ₂ . Primary (pre-combustion) and secondary (post-combustion) clean-up technologies in power engineering. Typical solutions of waste utilization employed in power plants. Exercises: calculation of the harmfully emissions for different plants, reduction technologies. Evaluation of the results.										
Methods of evaluation	Successful completion of this course depends on final grade from test and (oral) colloquium.										
Methods of verification of effects of education	See Table 71.										

Description of course

Exam	no
Literature	Materials provided by the lecturer. Handouts available on-line.
Website of the course	http://estudia.meil.pw.edu.pl
D. Student's activity	
Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	1) The number of contact hours - 30 hours. part in a lecture; 2) Own work student 20 hours., including: a) current preparation for lectures, literature studies - 15 hours. b) preparing for the test / test - 5 hours. TOTAL: 50 hours. - 2 credits.
Number of ECTS credits on the course with direct participation of academic teacher	1.2 ECTS credits - contact hours - 30 hours. participated in the lecture.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
Date of last edition	2019-09-10 08:04:49

Table 71. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS566_W1
Description:	He knows the mechanisms and sources of environmental threats from power plants operating according to standard energy technologies.
Verification:	Test
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W1
Description:	He knows the mechanisms and sources of environmental threats from power plants operating according to standard energy technologies.
Verification:	Test
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS566_W2
Description:	He knows the best available environmental technologies associated with the primary energy technologies.
Verification:	Test
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W2
Description:	He knows the best available environmental technologies associated with the primary energy technologies.
Verification:	Test
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS566_W3

Table 71. Learning outcomes	
Description:	He knows the rules for creating and indicative emission standards by associating it with the possibilities of abatement technology.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W3
Description:	He knows the rules for creating and indicative emission standards by associating it with the possibilities of abatement technology.
Verification:	Test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS566_W4
Description:	He knows the typical solutions of environmental protection systems used in modern power.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W4
Description:	He knows the typical solutions of environmental protection systems used in modern power.
Verification:	Test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS566_W5
Description:	Distinguishes between the concept of primary and secondary methods, rules for the selection of appropriate technologies and the threat of secondary.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W5
Description:	Distinguishes between the concept of primary and secondary methods, rules for the selection of appropriate technologies and the threat of secondary.
Verification:	Test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS566_W6
Description:	Understands the principles of environmental protection, including power plants.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W6
Description:	Understands the principles of environmental protection, including power plants.
Verification:	Test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS566_W7

Table 71. Learning outcomes	
Description:	He knows the classical energy technologies (fossil fuel-based n) expected as a low or zero carbon in relation to greenhouse gas emissions.
Verification:	Test.
Field of study related learning outcomes	E1_W14
Area of study related learning outcomes	
Code of effect:	ANS566_W7
Description:	He knows the classical energy technologies (fossil fuel-based n) expected as a low or zero carbon in relation to greenhouse gas emissions.
Verification:	Test.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS566_U1
Description:	Able to calculate the emissions of harmful substances into the environment produced in an industrial process, including conventional processes characteristic of power plants.
Verification:	Test.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS566_U1
Description:	Able to calculate the emissions of harmful substances into the environment produced in an industrial process, including conventional processes characteristic of power plants.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANS566_U2
Description:	He knows how to assess the indicators characterizing the impact of power plants on the environment.
Verification:	Test
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS566_U2
Description:	He knows how to assess the indicators characterizing the impact of power plants on the environment.
Verification:	Test
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANS566_U3
Description:	He knows how to assess the possibility of limiting the basic energy technologies to reduce emissions.
Verification:	Test.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS566_U3
Description:	He knows how to assess the possibility of limiting the basic energy technologies to reduce

Table 71. Learning outcomes	
	emissions.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANS566_U4
Description:	Can indicate the side effects resulting from application of environmental technologies, including adverse effects.
Verification:	Test.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS566_U4
Description:	Can indicate the side effects resulting from application of environmental technologies, including adverse effects.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	
Code of effect:	ANS566_U5
Description:	He can indicate environmental technologies appropriate to the industrial process.
Verification:	Test.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS566_U5
Description:	He can indicate environmental technologies appropriate to the industrial process.
Verification:	Test.
Field of study related learning outcomes	E1_U19
Area of study related learning outcomes	

Description of course

Code of course	ANS550	
Name of course	Thermal Power Stations	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Henryk Kaproń	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	6 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Knowledge of basic physics.	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	Gaining knowledge of the operation of thermal power plants and knowledge of technical vocabulary related to the topic of the lecture in English.	
Effects of education	See Table 72.	
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	<p>I. General information (2 hours). Energy conversion forms, energy units, classification of thermal power stations, power plant economics. II. Analysis of conventional steam power plants (6 hours). Component of power unit: boiler types, steam turbine set, condenser, cooling towers (structure, types -wet, dry and hybrid), coal mill, electrofilter combustion fun, smokestack, coal belt convertor, unit transformer and auxiliary transformer, container of supply water with degasser control room, auxiliaries switching station. III. Thermodynamic theory of Rankine cycle of steam power plant (6 hours). Thermodynamic cycle realized in steam power plant. Reheating and superheating steam, turbines (steam turbine, high pressure, medium pressure, low pressure parts), thermodynamic theory, stack gas (clean up, heat losses, environmental impact), ventilation system (natural draft, forced ventilation, induced ventilation), water treatment, environmental</p>	

Description of course

	<p>impacts. IV. Combined cycle power generation (4 hours). Thermodynamic process and efficiency of CHP, cogeneration of power and process heat laws of steam as working fluid in power cycle. V. Power plants with gas turbine (2 hours). Used thermal cycles and their efficiency. Gas steam cycles and their usage in power plant. CHP plant efficiency taking into account Polish and EU law. VI. Diesel-engine based power generating set (2 hours). Thermodynamic cycle and efficiency of reciprocating engine. Applying combustion generating set. VII. Nuclear power plants (2 hours). Theory (fission, heat generation, cooling), reactor types, safety feature, environmental impact, long time storage. Evolution of nuclear power plant. VIII. Electric scheme of steam power plant (2 hours). Electric generators historical developments. Synchronous generators and their substitute scheme. Connecting the generator model with the model of the system. Input and output quantities of synchronous generator. IX. Some issue of conventional power plant work in power system (2 hours). Quantitative and general characteristics of conventional power plant. Functional structure of electric power system. Location and work of power plants in power system. Power plants and environmental protection. Electrical energy generation costs. Energy market. X. New tendency of electrical energy generation technology (2 hours). Power generating units with fluidized-bed boilers. Gas-steam arrangements integrated with coal gasification. Conventional high-efficient power units and units with overcritical parameters of steam. Renewable energy.</p>
Methods of evaluation	Exam, 2 tests.
Methods of verification of effects of education	See Table 72.
Exam	yes
Literature	1) Aschner F.S.: Planning Fundamentals of Thermal Power Plant. A Halsted Press Book. New York, 1978. 2) Bryan J.C.: Introduction to nuclear science. Taylor & Francis Group LLC, 2009.
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 - attendance at the lectures - 30 hours. 2) The number of hours of independent work of student - preparing for lectures, tests and exam.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credit - attendance at the lectures - 30 hours.
Number of ECTS credits on practical activities on the course	

Description of course

E. Additional information

Notes	-
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Table 72. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS550_W1
Description:	Student has knowledge of construction, the structure and operation of thermal power plants.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS550_W1
Description:	Student has knowledge of construction, the structure and operation of thermal power plants.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS550_W1
Description:	Student has knowledge of construction, the structure and operation of thermal power plants.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS550_W1
Description:	Student has knowledge of construction, the structure and operation of thermal power plants.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W17
Area of study related learning outcomes	
Code of effect:	ANS550_W1
Description:	Student has knowledge of construction, the structure and operation of thermal power plants.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W19
Area of study related learning outcomes	
Code of effect:	ANS550_W2
Description:	Familiarization with thermal power stations, their structure and components. Improving the energy efficiency, different ways of power equipment regulating. Knowledge about locations of various types energy losses.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS550_W2
Description:	Familiarization with thermal power stations, their structure and components. Improving the energy efficiency, different ways of power equipment regulating. Knowledge about locations of various types energy losses.
Verification:	Written test, exam.

Table 72. Learning outcomes	
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS550_W2
Description:	Familiarization with thermal power stations, their structure and components. Improving the energy efficiency, different ways of power equipment regulating. Knowledge about locations of various types energy losses.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS550_W2
Description:	Familiarization with thermal power stations, their structure and components. Improving the energy efficiency, different ways of power equipment regulating. Knowledge about locations of various types energy losses.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W15
Area of study related learning outcomes	
Code of effect:	ANS550_W2
Description:	Familiarization with thermal power stations, their structure and components. Improving the energy efficiency, different ways of power equipment regulating. Knowledge about locations of various types energy losses.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_W10
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS550_U1
Description:	Student is able to characterize the research process relies on identifying the characteristics of components and pieces of equipment used in the production of energy.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS550_U1
Description:	Student is able to characterize the research process relies on identifying the characteristics of components and pieces of equipment used in the production of energy.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	ANS550_U1
Description:	Student is able to characterize the research process relies on identifying the characteristics of components and pieces of equipment used in the production of energy.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	

Table 72. Learning outcomes

Code of effect:	ANS550_U2
Description:	Student can characterize the building, the structure and functioning of thermal power plants.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS550_K1
Description:	The student is aware of the role played by the conventional energy sector in modern civilization.
Verification:	Written test, exam.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	

Description of course

Code of course	ANFKT_PE3										
Name of course	Elective Course PE3										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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	Power Engineering										
Group of courses	Specialization										
Type of course	Elective										
Language of course	angielski										
Nominal semester	7 (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 73.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>30h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>0h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	30h	Exercise type of course	0h	Laboratory	0h	Project type of course	0h	Computer lessons	0h
Lecture	30h										
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 73.										
Exam	no										
Literature	Detailed data contains syllabus of specific course.										
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	Number of hours that require the presence of a teacher ~30 (lectures / classes / labs / projects). The number of hours of independent work of student ~30.										
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 (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 73. Learning outcomes

General academic profile - skills

Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	Detailed data contains syllabus of specific course.
Description:	Detailed data contains syllabus of specific course.
Verification:	Detailed data contains syllabus of specific course.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	

Description of course

Code of course	ANS625	
Name of course	Energy Market	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. nzw. dr hab. inż. Konrad Świrski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	7 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	130	
C. Effects of education and manner of teaching		
Purpose of course	To familiarize students with the history, theory and practice of energy market operations in Poland and in the world. C1. To familiarize students with the principles of modern trade. C2. Presentation of the current state of the power system and problems. C3. Knowledge of modern energy market in Poland, market regulations. C4. Indication of the possible use of IT systems supporting trade. C5. Broad issues of trade linking energy with other processes in the energy, industry and economy. C6. Getting Acquainted with industrial practice and possibilities to optimize energy consumption through the use of market mechanisms.	
Effects of education	See Table 74.	
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	The lecture presents comprehensively the issues concerning the functioning of the energy market in Poland and around the world. Is supplemented by practical knowledge of legal regulations, commercial offers and other documents relating to the energy market and related issues, and through simulations, group tasks and work using dedicated systems for the development of skills of assessing the cost of production, energy consumption, optimization capabilities.	
Methods of evaluation	Final test and evaluation of performance of the	

Description of course

	tasks of group and individual project.
Methods of verification of effects of education	See Table 74.
Exam	no
Literature	Materials on the subject website.
Website of the course	http://energetyka.itc.pw.edu.pl/re
D. Student's activity	
Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) The number of contact hours - 30 hours., including: a) participation in the lecture - 30 hours. 2) Own work student 20 hours, including: a) performing the tasks of group and individual project execution - 15 hours; b) preparing for the final test - 5 hours. TOTAL: 50 hours. - 2 credits.
Number of ECTS credits on the course with direct participation of academic teacher	1.2 ECTS credits - contact hours - 30 hours, including: a) participation in the lecture - 30 hours.
Number of ECTS credits on practical activities on the course	-
E. Additional information	
Notes	
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Table 74. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS625_W1
Description:	The student has knowledge of the power system in Poland.
Verification:	Final test.
Field of study related learning outcomes	E1_W21
Area of study related learning outcomes	
Code of effect:	ANS625_W2
Description:	The student understands the trade energy on the wholesale market.
Verification:	Final test and evaluation of group work and project implementation.
Field of study related learning outcomes	E1_W21
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	
Description:	
Verification:	
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	
Description:	
Verification:	
Field of study related learning outcomes	E1_U06
Area of study related learning outcomes	
Code of effect:	
Description:	
Verification:	
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	

Table 74. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	
Description:	
Verification:	
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS625_U1
Description:	Student is able to search for needed information in the literature.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	

Description of course

Code of course	ANS527
Name of course	Energy Storage
Version of course	2013.
A. Place of the course in system of studies	
Level of education	First 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. Roman Domański
B. General characteristic of the course	
Block of courses	Power Engineering
Group of courses	Specialization
Type of course	Compulsory
Language of course	angielski
Nominal semester	7 (r.a. 2019/2020)
Time of completion in the academic year	summer semester
Preliminary requirements	<ul style="list-style-type: none"> • Mathematics – level of first degree technical studies. • Physics – the scope of secondary school. • Thermodynamics – level of first degree technical studies. • Heat and mass transfer – level of first degree technical studies.
Limit of students	
C. Effects of education and manner of teaching	
Purpose of course	<p>Teaching evaluation of energy storage and resources. Evaluation of implementation possibilities for new energy storage technologies, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of energy storage. Presenting new and future energy storage technologies for different energy sources. Has basic knowledge on theory of energy storage systems and knowledge on applied storage units in different energy systems. Has knowledge on materials used in energy storage system. Is familiar with basic technologies of energy conversion and with determining process efficiency. Knows the needs for storage for basics energy conversion and operation of renewable power devices. Can derive information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in the field of study; can integrate the information obtained, interpret it and draw conclusions, and formulate and justify opinions in power engineering. Can communicate using various techniques in the professional environment and other environments, knows the technical terminology used in energy storage systems. Can</p>

Description of course

	cooperate and work in a team, assuming various roles.
Effects of education	See Table 75.
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 terms related to energy conversion processes. World's energy resources (organic fossil fuels, nuclear fuels, renewable sources). The basic parameters for energy storage. Energy conversion efficiency for selected processes and devices. Issues of energy accumulation in various forms. Possibility of energy storage. Thermal energy storage, (long and short term - heat storage tanks, ground storage, PCM storage), mechanical energy storage (flywheels). CAES energy storage systems for power plants, industry and air weapons. Hydrogen as an energy carrier, hydrogen production and storage. Fuel cells as energy storage and conversion system. Hydro storage power plant. Electrical energy storage (batteries, capacitors, super capacitors, electromagnetic systems, superconducting magnetic energy storage (SMES)). Examples of energy storage systems. Efficiency of energy storage in different forms. Increase of energy conversion efficiencies by introducing the energy storage.
Methods of evaluation	60% multiple-choice test carried out at the end of the lectures, 40% homework grade. Own work: Homework done in teams of 2-3. Subject and form of work (paper, calculations, presentation) determined at the beginning of a semester.
Methods of verification of effects of education	See Table 75.
Exam	no
Literature	1. Culp A.W.: Energy Conversion, John Wiley& Sons, 1992. 2. Cengel Y.A., Boles M. A.: Thermodynamics: An Engineering Approach, New York 1994. 3. Dincer I., Rosen M.A.: Thermal Energy Storage, John Wiley& Sons Ltd, England 2002. 4. Domanski R.:Power Point presentations - Energy Storage.
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, including: a) attendance at the lectures- 30 hours; b) consultancy meetings - 3hours. 2) The number of hours of independent work of student - 20, including: • preparation for multiple-choice test- 6 hours; • homework - 14

Description of course

	hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 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 75. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS527_W1
Description:	After passing the subject student will be able to understand all typical methods of energy storage system, will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.
Verification:	Multiple-choice test - Total about 30 Questions. Ten of them connected with basic knowledge about energy storage systems.
Field of study related learning outcomes	E1_W17
Area of study related learning outcomes	
Code of effect:	ANS527_W1
Description:	After passing the subject student will be able to understand all typical methods of energy storage system, will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.
Verification:	Multiple-choice test - Total about 30 Questions. Ten of them connected with basic knowledge about energy storage systems.
Field of study related learning outcomes	E1_W18

Table 75. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANS527_W1
Description:	After passing the subject student will be able to understand all typical methods of energy storage system, will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.
Verification:	Multiple-choice test - Total about 30 Questions. Ten of them connected with basic knowledge about energy storage systems.
Field of study related learning outcomes	E1_W23
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS527_U1
Description:	After passing the subject student will be able to analyze energy resources and needs for energy storage systems, identify threats attributable to energy conversion and storage processes, carry out an energy balance for renewable energy sources and energy storage, evaluate energy security of a system, understand relation between the feasibility of power generation technologies and geographical conditions, realize shortcomings of prospective technologies and limitations in their industrial implementation today.
Verification:	Homework done in teams of 2-3. Subject and form of work (paper, calculations, presentation) determined at the beginning of a semester.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS527_U1
Description:	After passing the subject student will be able to analyze energy resources and needs for energy storage systems, identify threats attributable to energy conversion and storage processes, carry out an energy balance for renewable energy sources and energy storage, evaluate energy security of a system, understand relation between the feasibility of power generation technologies and geographical conditions, realize shortcomings of prospective technologies and limitations in their industrial implementation today.
Verification:	Homework done in teams of 2-3. Subject and

Table 75. Learning outcomes	
	form of work (paper, calculations, presentation) determined at the beginning of a semester.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS527_U1
Description:	After passing the subject student will be able to analyze energy resources and needs for energy storage systems, identify threats attributable to energy conversion and storage processes, carry out an energy balance for renewable energy sources and energy storage, evaluate energy security of a system, understand relation between the feasibility of power generation technologies and geographical conditions, realize shortcomings of prospective technologies and limitations in their industrial implementation today.
Verification:	Homework done in teams of 2-3. Subject and form of work (paper, calculations, presentation) determined at the beginning of a semester.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS527_U1
Description:	After passing the subject student will be able to analyze energy resources and needs for energy storage systems, identify threats attributable to energy conversion and storage processes, carry out an energy balance for renewable energy sources and energy storage, evaluate energy security of a system, understand relation between the feasibility of power generation technologies and geographical conditions, realize shortcomings of prospective technologies and limitations in their industrial implementation today.
Verification:	Homework done in teams of 2-3. Subject and form of work (paper, calculations, presentation) determined at the beginning of a semester.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS527_U1
Description:	After passing the subject student will be able to analyze energy resources and needs for energy storage systems, identify threats attributable to energy conversion and storage processes, carry out an energy balance for renewable energy sources and energy storage, evaluate energy security of a system, understand relation between the feasibility of power generation technologies and geographical conditions, realize shortcomings of prospective technologies and limitations in their industrial implementation today.
Verification:	Homework done in teams of 2-3. Subject and

Table 75. Learning outcomes	
	form of work (paper, calculations, presentation) determined at the beginning of a semester.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANS527_U1
Description:	After passing the subject student will be able to analyze energy resources and needs for energy storage systems, identify threats attributable to energy conversion and storage processes, carry out an energy balance for renewable energy sources and energy storage, evaluate energy security of a system, understand relation between the feasibility of power generation technologies and geographical conditions, realize shortcomings of prospective technologies and limitations in their industrial implementation today.
Verification:	Homework done in teams of 2-3. Subject and form of work (paper, calculations, presentation) determined at the beginning of a semester.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	

Description of course

Code of course	ANW128	
Name of course	Engineering Diploma Seminar	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	7 (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 76.	
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 76.	
Exam	yes	

Description of course

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 - 20, including: a) consultancy meetings - 18 hours; b) final completion - 2 hours. 2) The number of hours of independent work of student - 30 hours. Total - 50 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1 ECTS credits - number of hours that require the presence of a teacher - 20, including: a) consultancy meetings - 18 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 76. Learning outcomes

General academic profile - skills

Code of effect:	ANW128_U1
Description:	He can search the available sources of knowledge in the field of power energy.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW128_U1
Description:	He can search the available sources of knowledge in the field of power energy.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW128_U1
Description:	He can search the available sources of knowledge in the field of power energy.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANW128_U2
Description:	Able to carry out a detailed analysis of the literature. Is critical to the analyzed materials, including non-technical aspect.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANW128_U2
Description:	Able to carry out a detailed analysis of the

Table 76. Learning outcomes	
	literature. Is critical to the analyzed materials, including non-technical aspect.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANW128_U2
Description:	Able to carry out a detailed analysis of the literature. Is critical to the analyzed materials, including non-technical aspect.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANW128_U3
Description:	Able to provide written results of their work in the form of a short report.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANW128_U4
Description:	Student can a short and clearly present the results of their work in the form of oral presentation at the seminar.
Verification:	Oral presentation of the work.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANW128_U4
Description:	Student can a short and clearly present the results of their work in the form of oral presentation at the seminar.
Verification:	Oral presentation of the work.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW128_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	E1_K01
Area of study related learning outcomes	
Code of effect:	ANW128_K2
Description:	Understands the need for discussion in order to present their results, as well as work together on the the subject.
Verification:	The oral presentation of the work.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANW128_K2
Description:	Understands the need for discussion in order to present their results, as well as work together on

Table 76. Learning outcomes

	the the subject.
Verification:	The oral presentation of the work.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ANW136										
Name of course	Engineering Diploma Thesis										
Version of course	2013.										
A. Place of the course in system of studies											
Level of education	First 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	Power Engineering										
Group of courses	Specialization										
Type of course	Compulsory										
Language of course	angielski										
Nominal semester	7 (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	Selection of a proper literature; the choice of methods; solution of the simple engineering problem; presentation and critical analysis of the results. The exact specification depends on the subject of work.										
Effects of education	See Table 77.										
Form of didactic studies and number of hours per semester	<table border="0"> <tr> <td>Lecture</td> <td>0h</td> </tr> <tr> <td>Exercise type of course</td> <td>0h</td> </tr> <tr> <td>Laboratory</td> <td>0h</td> </tr> <tr> <td>Project type of course</td> <td>180h</td> </tr> <tr> <td>Computer lessons</td> <td>0h</td> </tr> </table>	Lecture	0h	Exercise type of course	0h	Laboratory	0h	Project type of course	180h	Computer lessons	0h
Lecture	0h										
Exercise type of course	0h										
Laboratory	0h										
Project type of course	180h										
Computer lessons	0h										
Contents of education	Detailed course content depends on the subject.										
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 77.										
Exam	yes										
Literature	Books and academic textbooks, journals, Internet.										
Website of the course											
D. Student's activity											
Number of ECTS credits	15										
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 150, including: a) consultancy meetings - 149 hours, b) final exam - 1 hours. 2) The number of hours of independent work of student - 225. TOTAL: 375 hours.										
Number of ECTS credits on the course with direct participation of academic teacher	6 ECTS credits - number of hours that require the presence of a teacher - 150, including: a) consultancy meetings - 149 hours. b) final exam - 1 hours.										

Description of course

Number of ECTS credits on practical activities on the course 15 ECTS credits.

E. Additional information

Notes

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Table 77. Learning outcomes

General academic profile - knowledge

Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W26
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on

Table 77. Learning outcomes	
Verification:	the chosen topic within his field of study. Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W20
Area of study related learning outcomes	
Code of effect:	ANW136_W1
Description:	Student has acquired extensive knowledge on the chosen topic within his field of study.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_W24
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANW136_U1
Description:	Student can identify the solved problem in a wide range of science, based on the literature
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U02
Area of study related learning outcomes	
Code of effect:	ANW136_U1
Description:	Student can identify the solved problem in a wide range of science, based on the literature
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANW136_U2
Description:	Student can use the literature to search for tips to solve research or engineering problems.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANW136_U3
Description:	Student can solve simple engineering tasks.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANW136_U3
Description:	Student can solve simple engineering tasks.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANW136_U4
Description:	Student can critically assess the results of the solved problem.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANW136_U5

Table 77. Learning outcomes	
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANW136_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U04
Area of study related learning outcomes	
Code of effect:	ANW136_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANW136_U5
Description:	Student can personally prepare a report on the work and defend the thesis in conversation.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANW136_K1
Description:	Development of self-learning needs in order to achieve the desired effect.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ANW136_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 engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANW136_K3
Description:	Student correctly identifies and resolves dilemmas associated with his profession.
Verification:	Assessment of engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	ANW136_K4
Description:	Student understands the need to inform the

Table 77. Learning outcomes	
	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 engineering thesis and the diploma examination.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	

Description of course

Code of course	ANS576	
Name of course	Gas turbines and gas-steam systems	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	First 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. Jarosław Milewski, prof. PW	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	7 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	130	
C. Effects of education and manner of teaching		
Purpose of course	The course is the opportunity to obtain knowledge of the theory and practice of power systems operation of the gas turbine and gas-steam systems.	
Effects of education	See Table 78.	
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	The lecture presents comprehensive information on gas and steam systems both in terms of design and operation. The substantive scope of the course includes: steam-gas systems in power, status and prospects. Systems with fluidized bed boilers. Systems with coal gasification. Gasification of coal for energy purposes. Systems with stirring and hybrid factors.	
Methods of evaluation	The scoring system includes the work of students in the class and test results are final.	
Methods of verification of effects of education	See Table 78.	
Exam	no	
Literature	Materials provided by a lecturer.	
Website of the course	http://estudia.meil.pw.edu.pl	
D. Student's activity		
Number of ECTS credits	2	
Number of hours of student's work to achieve effects of education	1) The number of contact hours - 30, including: a) participation in lectures - 15 hours, b) participation in exercises - 15 hours. 2) Own work student - 20 hours, including: a) current preparation for classes, literature studies - 15	

Description of course

	hours, b) preparing for the test / test - 5 hours. TOTAL - 50 hours. - 2 credits.
Number of ECTS credits on the course with direct participation of academic teacher	1.2 ECTS credits - contact hours - 30, including: a) participation in lectures - 15 hours; b) participation in exercises - 15 hours.
Number of ECTS credits on practical activities on the course	
E. Additional information	
Notes	
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Table 78. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS576_W1
Description:	He knows the methods of analysis of the gas turbine simple-cycle, complex and combined cycles.
Verification:	Test.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS576_W1
Description:	He knows the methods of analysis of the gas turbine simple-cycle, complex and combined cycles.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W2
Description:	Aware of the results of such analyzes of the impact of key parameters on the performance of the gas turbine and its system.
Verification:	Test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS576_W2
Description:	Aware of the results of such analyzes of the impact of key parameters on the performance of the gas turbine and its system.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W3
Description:	He knows the characteristics of the gas turbine units.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W4
Description:	He knows the method for determining the characteristics of the gas turbine.
Verification:	Test
Field of study related learning outcomes	E1_W16

Table 78. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANS576_W5
Description:	He knows the heat-resistant materials used in gas turbines.
Verification:	Test.
Field of study related learning outcomes	E1_W07
Area of study related learning outcomes	
Code of effect:	ANS576_W5
Description:	He knows the heat-resistant materials used in gas turbines.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W6
Description:	He knows the ways of the cooling gas turbine blades.
Verification:	Test.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS576_W6
Description:	He knows the ways of the cooling gas turbine blades.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W7
Description:	Knows the types of gas-steam systems.
Verification:	Test.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS576_W7
Description:	Knows the types of gas-steam systems.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W8
Description:	He knows the characteristics and performance of systems with waste heat boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
Code of effect:	ANS576_W8
Description:	He knows the characteristics and performance of systems with waste heat boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS576_W8
Description:	He knows the characteristics and performance of systems with waste heat boiler.
Verification:	Test.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS576_W9

Table 78. Learning outcomes	
Description:	Knows the principles of construction and performance of systems with pressurized fluidized bed combustion boiler (8FBC) and coal gasification (IGCC).
Verification:	Test.
Field of study related learning outcomes	E1_W16
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS576_U1
Description:	Has knowledge of modern gas turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS576_U1
Description:	Has knowledge of modern gas turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS576_U1
Description:	Has knowledge of modern gas turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS576_U1
Description:	Has knowledge of modern gas turbines.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS576_U2
Description:	Has knowledge of modern gas-steam systems of various types.
Verification:	Test.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS576_U2
Description:	Has knowledge of modern gas-steam systems of various types.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS576_U2
Description:	Has knowledge of modern gas-steam systems of various types.
Verification:	Test.
Field of study related learning outcomes	E1_U29
Area of study related learning outcomes	
Code of effect:	ANS576_U3
Description:	Able to select a gas turbine and / or gas-steam system according to the specific needs.
Verification:	Test.
Field of study related learning outcomes	E1_U08
Area of study related learning outcomes	
Code of effect:	ANS576_U3
Description:	Able to select a gas turbine and / or gas-steam

Table 78. Learning outcomes	
	system according to the specific needs.
Verification:	Test.
Field of study related learning outcomes	E1_U27
Area of study related learning outcomes	
Code of effect:	ANS576_U4
Description:	He knows the issues of operation of gas turbines and steam and gas systems.
Verification:	Test.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS576_U4
Description:	He knows the issues of operation of gas turbines and steam and gas systems.
Verification:	Test.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	

Description of course

Code of course	ANS525	
Name of course	Power Engineering Machines and Systems 2	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	First 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. Jerzy Kuta	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialization	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	7 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	130	
C. Effects of education and manner of teaching		
Purpose of course	Practical knowledge of the operational issues of power equipment.	
Effects of education	See Table 79.	
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	Presentations and study large energy facilities, specialized laboratory classes.	
Methods of evaluation	Evaluation reports of laboratory exercises.	
Methods of verification of effects of education	See Table 79.	
Exam	no	
Literature	materials provided by a lecturer	
Website of the course	http://estudia.meil.pw.edu.pl	
D. Student's activity		
Number of ECTS credits	2	
Number of hours of student's work to achieve effects of education	1) The number of contact hours - 32, including: a) participation in laboratory exercises - 30 hours; b) consultation - 2 hours. 2) Own work student - 18 hours - preparation of laboratory reports.	
Number of ECTS credits on the course with direct participation of academic teacher	1.3 ECTS credits - contact hours - 32, including: a) participation in laboratory exercises - 30 hours. b) consultation - 2 hours.	
Number of ECTS credits on practical activities on the course	1.8 ECTS credits - 48 hours. , Including: a) participation in laboratory exercises - 30 hours. b) Self student - 18 hours. - Preparation of laboratory reports.	
E. Additional information		
Notes		
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Table 79. Learning outcomes	
General academic profile - knowledge	
Code of effect:	ANS525_W1
Description:	Knows the basic issues of thermal circuits and power devices.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS525_W1
Description:	Knows the basic issues of thermal circuits and power devices.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_W13
Area of study related learning outcomes	
Code of effect:	ANS525_W2
Description:	An understanding of energy systems operation.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_W28
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS525_U1
Description:	Able to determine the technical parameters of devices based on research.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANS525_U1
Description:	Able to determine the technical parameters of devices based on research.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS525_U1
Description:	Able to determine the technical parameters of devices based on research.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS525_U2
Description:	Able to carry out maintenance of machines and devices in accordance with the standards and operating instructions.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANS525_U2
Description:	Able to carry out maintenance of machines and devices in accordance with the standards and operating instructions.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS525_K1

Table 79. Learning outcomes

Description:	Able to work in a group.
Verification:	Laboratory exercises, report.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	

Description of course

Code of course	ANS517
Name of course	RES-Solar Engineering 2
Version of course	2013
A. Place of the course in system of studies	
Level of education	First 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. Dorota Chwieduk, prof. PW
B. General characteristic of the course	
Block of courses	Power Engineering
Group of courses	Specialization
Type of course	Compulsory
Language of course	angielski
Nominal semester	7 (r.a. 2019/2020)
Time of completion in the academic year	summer semester
Preliminary requirements	Heat Transfer 1 (ML.ANK423), Heat Transfer 2 (MLA.NK424).
Limit of students	12 st./group
C. Effects of education and manner of teaching	
Purpose of course	Students get practical knowledge on solar energy (radiation) measurements and testing of solar collectors and systems. They can evaluate effectiveness of operation of solar systems, energy performance and characteristics. They can select devices and equipment for solar active systems and integrate solar system into domestic and commercial heating/cooling systems. After completing this course the students will be able to select the solar system to be the most suitable to planned application, to energy heating/ cooling needs and their distribution in time and climatic conditions. They will be able to calculate the solar energy fraction and auxiliary energy use for short time and throughout the year. They could specify all elements of solar systems, their type and size to assure their effective use. They could calculate the reduction in primary energy, greenhouses gas emission, and running costs. They can plan, design, and construct, test and control different types of solar systems. They can advise on improvement of energy efficiency and environment, and economic gains of heating/cooling systems. Students would be able to evaluate thermal energy use in buildings and to propose the upgrading of energy systems by applying solar energy. They would be able to develop solar passive solutions in buildings and implement modern energy effective methods into building concept during the design process and

Description of course

	building/energy use.
Effects of education	See Table 80.
Form of didactic studies and number of hours per semester	Lecture 0h
	Exercise type of course 0h
	Laboratory 15h
	Project type of course 0h
	Computer lessons 0h
Contents of education	<p>The Sun, solar radiation spectrum and solar energy components and irradiation on tilted surfaces. Measurements of solar radiation and solar radiation data, estimation methods for different receiving surfaces. Radiation characteristics of opaque and transparent materials. Absorptance and emittance, mechanism of selectivity. Reflectance and transmittance. Solar collector structure and materials used. Flat plate and vacuum solar collectors. Collector characterization. Measurement of solar collector performance. Collector tests: Efficiency, Incident Angle Modifier and Time Constant. Practical consideration. Solar collectors output. Energy storage in solar systems active and passive, short term and seasonal storage. Solar process loads: hot water, space heating and cooling, modeling and calculation. Solar active heating systems: modes of operation and control in practice. Concept of passive heating/ cooling. Comfort criteria and heating/cooling loads. Costs and economic of passive systems.</p>
Methods of evaluation	100% continuous assessment based on theoretical, experimental and calculation tests (tasks). Reports. Practical work: Measurements and tests of solar radiation, solar collectors and solar systems under solar simulator and outdoor conditions. Monitoring and control of solar system operation in real conditions, measurements of thermal and flow parameters. Simulation exercises of solar systems operations. Visit to other solar laboratories, solar active and passive systems in operation.
Methods of verification of effects of education	See Table 80.
Exam	no
Literature	<p>1. Duffie J. A., Beckman W. A.: Solar Engineering of Thermal Processes, John Wiley & Sons, Inc., New York, 1991. 2. Schulz H., Chwieduk D. Wärme aus Sonne und Erde Energiesparende Heizungssysteme mit Erdwärmespeicher, Solarabsorber und Wärmepumpe. Okobuch Verlage, Staufen bei Freiburg, 1995. 3. Twidell J., Weir T.: Renewable Energy Resources, E&FN SPON, London, University Press Cambridge, 1996. 4. Quaschnig V.: Understanding Renewable</p>

Description of course

	Energy Systems. EarthScan, London, 2006.
Website of the course	
D. Student's activity	
Number of ECTS credits	1
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 labs - 15 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student: • preparation for classes 3 hours; • preparation of the reports from labs 12 hours; TOTAL: 33 hours.
Number of ECTS credits on the course with direct participation of academic teacher	0,5 ECTS credits - number of hours that require the presence of a teacher - 18, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits - 33 hours, including: a) attendance at the labs - 15 hours; b) consultancy meetings - 3 hours; c) preparation for classes - 3 hours; d) preparation of the reports from labs - 12 hours.
E. Additional information	
Notes	The course gives practical experience and ability to develop solar systems.
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Table 80. Learning outcomes

General academic profile - knowledge

Code of effect:	ANS517_W1
Description:	Student gets known fundamentals of technical measurement methods and methods of testing solar energy devices.
Verification:	Reports no. 1, 2,3
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANS517_W1
Description:	Student gets known fundamentals of technical measurement methods and methods of testing solar energy devices.
Verification:	Reports no. 1, 2,3
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANS517_W1
Description:	Student gets known fundamentals of technical measurement methods and methods of testing solar energy devices.
Verification:	Reports no. 1, 2,3
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS517_W1
Description:	Student gets known fundamentals of technical measurement methods and methods of testing solar energy devices.
Verification:	Reports no. 1, 2,3

Table 80. Learning outcomes	
Field of study related learning outcomes	E1_W31
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student gets experience in operation of solar system in real conditions.
Verification:	Reports no. 4, 5.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student gets experience in operation of solar system in real conditions.
Verification:	Reports no. 4, 5.
Field of study related learning outcomes	E1_W12
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student gets experience in operation of solar system in real conditions.
Verification:	Reports no. 4, 5.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student gets experience in operation of solar system in real conditions.
Verification:	Reports no. 4, 5.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student gets experience in operation of solar system in real conditions.
Verification:	Reports no. 4, 5.
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANS517_W2
Description:	Student gets experience in operation of solar system in real conditions.
Verification:	Reports no. 4, 5.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Student gets known methods of standardization of devices and solar energy systems.
Verification:	Reports no. 4,5.
Field of study related learning outcomes	E1_W18
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Student gets known methods of standardization of devices and solar energy systems.
Verification:	Reports no. 4,5.
Field of study related learning outcomes	E1_W25
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Student gets known methods of standardization of devices and solar energy systems.
Verification:	Reports no. 4,5.

Table 80. Learning outcomes	
Field of study related learning outcomes	E1_W02
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Student gets known methods of standardization of devices and solar energy systems.
Verification:	Reports no. 4,5.
Field of study related learning outcomes	E1_W03
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Student gets known methods of standardization of devices and solar energy systems.
Verification:	Reports no. 4,5.
Field of study related learning outcomes	E1_W05
Area of study related learning outcomes	
Code of effect:	ANS517_W3
Description:	Student gets known methods of standardization of devices and solar energy systems.
Verification:	Reports no. 4,5.
Field of study related learning outcomes	E1_W11
Area of study related learning outcomes	
General academic profile - skills	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U01
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U21
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.

Table 80. Learning outcomes	
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS517_U1
Description:	Student is able to measure parameters and test operation of solar energy devices.
Verification:	Reports no. 1 ,2, 3.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANS517_U2
Description:	Student is able to analyze energy efficiency of operation of solar system in real conditions.

Table 80. Learning outcomes	
Verification:	Reports no. 3,4,5.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U11
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U16
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS517_U3
Description:	Student is able to modify the structure of solar system depending on its function and conditions of operation.
Verification:	Reports no. 2,3,4,5.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student is able to test solar devices and systems

Table 80. Learning outcomes	
	with reference to standards.
Verification:	Reports no. 6,7.
Field of study related learning outcomes	E1_U22
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student is able to test solar devices and systems with reference to standards.
Verification:	Reports no. 6,7.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student is able to test solar devices and systems with reference to standards.
Verification:	Reports no. 6,7.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student is able to test solar devices and systems with reference to standards.
Verification:	Reports no. 6,7.
Field of study related learning outcomes	E1_U09
Area of study related learning outcomes	
Code of effect:	ANS517_U4
Description:	Student is able to test solar devices and systems with reference to standards.
Verification:	Reports no. 6,7.
Field of study related learning outcomes	E1_U21
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U03
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U05
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U07
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U10
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of

Table 80. Learning outcomes	
	operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U14
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U15
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U17
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U18
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U24
Area of study related learning outcomes	
Code of effect:	ANS517_U5
Description:	Student is able to evaluate conditions of operation of solar system devices.
Verification:	Reports no. 5,6,7.
Field of study related learning outcomes	E1_U28
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	ANS517_K1
Description:	Student is aware of idea and importance of experimental tests in new branches of energy sector.
Verification:	Reports. no. 1 - 7.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ANS517_K1
Description:	Student is aware of idea and importance of experimental tests in new branches of energy sector.
Verification:	Reports. no. 1 - 7.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANS517_K1
Description:	Student is aware of idea and importance of experimental tests in new branches of energy sector.
Verification:	Reports. no. 1 - 7.

Table 80. Learning outcomes	
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ANS517_K1
Description:	Student is aware of idea and importance of experimental tests in new branches of energy sector.
Verification:	Reports. no. 1 - 7.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	
Code of effect:	ANS517_K2
Description:	Student understands the necessity of assuring high quality of tests and tested new generation energy products.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ANS517_K2
Description:	Student understands the necessity of assuring high quality of tests and tested new generation energy products.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K02
Area of study related learning outcomes	
Code of effect:	ANS517_K2
Description:	Student understands the necessity of assuring high quality of tests and tested new generation energy products.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	
Code of effect:	ANS517_K2
Description:	Student understands the necessity of assuring high quality of tests and tested new generation energy products.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K07
Area of study related learning outcomes	
Code of effect:	ANS517_K3
Description:	Student understands necessity of standardization of results of research studies.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K05
Area of study related learning outcomes	
Code of effect:	ANS517_K3
Description:	Student understands necessity of standardization of results of research studies.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K01
Area of study related learning outcomes	
Code of effect:	ANS517_K3
Description:	Student understands necessity of standardization of results of research studies.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K02

Table 80. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	ANS517_K3
Description:	Student understands necessity of standardization of results of research studies.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K03
Area of study related learning outcomes	
Code of effect:	ANS517_K3
Description:	Student understands necessity of standardization of results of research studies.
Verification:	Reports no. 1-7.
Field of study related learning outcomes	E1_K04
Area of study related learning outcomes	

