Programme		
Power Engineering		
Degree	Type	Academic year
Msc	full-time	2019/2020

Purposes

The objectives of the study is to gain the skills allowing for the independent and creative analysis of advanced engineering problems. The graduates are prepared not only for the work in industry but also for solving the research problems. Each diploma thesis is reviewed by 2 reviewers and is defended in the presence of commission consisting of professors and assistant professors.

Effects of education

Code of effect:	**E2_W01**
Description:	has extensive knowledge on applied mathematics; knows general and detailed mathematical description of the course of physical and chemical processes, knows advanced mathematical methods needed in mathematical modelling (differential equations, elements of algebra and analytical geometry, statistical methods, methods of experiment planning, optimisation theory).
Area of study related learning outcomes	
Code of effect:	**E2_W02**
Description:	knows basic and advanced methods of organic and inorganic chemistry, such as atomic structure, spectroscopy, magnetic resonance, kinetics of chemical processes, catalysis and surface chemistry; knows the basics of modern physics.
Area of study related learning outcomes	
Code of effect:	**E2_W03**
Description:	knows advanced numerical methods of solving problems described with mathematical methods, knows the possibilities of commercial computer software.
Area of study related learning outcomes	
Code of effect:	**E2_W04**
Description:	has knowledge on materials engineering, in particular on properties of materials used in high-temperature power engineering (gas turbines, supercritical steam turbines, conventional and fluid steam boilers).
Area of study related learning outcomes	
Code of effect:	**E2_W05**
Description:	has advanced knowledge in the area of phenomenological and mathematical description of processes of momentum, heat and mass exchange, in particular basic laws of fluid mechanics, description of processes of heat flow via conduction, convection and radiation, mass flow; knows basic mathematical methods of solving such problems.
Area of study related learning outcomes	
Code of effect:	**E2_W06**
Description:	has advanced knowledge in the area of technical and chemical thermodynamics, such as

Effects of education	
	equilibrium thermodynamics and thermodynamics of irreversible processes, knows analytical methods of determining properties of solutions and creating phase diagrams, determining parameters of chemical equilibrium, reaction kinetics (also combustion processes), elements of statistical thermodynamics and stability theory.
Area of study related learning outcomes	
Code of effect:	**E2_W07**
Description:	knows technologies of energy conversion and transport in detail.
Area of study related learning outcomes	
Code of effect:	**E2_W08**
Description:	knows methods of design of devices (steam boilers, gas and steam turbines, compressors) and systems of district heating networks, cooling, air-conditioning and ventilation devices, and of CHP economy.
Area of study related learning outcomes	
Code of effect:	**E2_W09**
Description:	knows advanced methods of using renewable (water, solar, geothermal, wind, biomass) energy sources.
Area of study related learning outcomes	
Code of effect:	**E2_W10**
Description:	knows the rules of work and use of fuel cells and hydrogen power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_W11**
Description:	knows the methods of energy evaluation of processes – materials, energy and exergy balancing, determination of indicators of accumulated consumption of energy and exergy, thermo-ecological analysis, use of waste energy, district heating, CHP economy, methods of energy audits.
Area of study related learning outcomes	
Code of effect:	**E2_W12**
Description:	has knowledge on resources of natural fuels, their physical and chemical properties, processes of coal gasification, clean coal technologies, gas storage, basic petrochemical processes.
Area of study related learning outcomes	
Code of effect:	**E2_W13**
Description:	has advanced knowledge in the field of nuclear power engineering, such as construction of nuclear reactors, mechanisms of nuclear reaction, nuclear power plant failures, calculation methods of reactor physics.
Area of study related learning outcomes	
Code of effect:	**E2_W14**
Description:	has knowledge on development trends and most important new achievements in power

Effects of education	
	engineering.
Area of study related learning outcomes	
Code of effect:	**E2_W15**
Description:	has basic and advanced knowledge on life cycle of technical devices, objects and systems in power engineering, thoroughly knows the rules of operation and maintenance of machines, as well as the rules of choice of construction and maintenance materials for power machines and devices, and for cooling and air-conditioning devices.
Area of study related learning outcomes	
Code of effect:	**E2_W16**
Description:	knows the rules of creating and testing numerical algorithms, knows the possibilities and limitations of typical calculation and design commercial software, can use it on his/her own when solving power engineering problems.
Area of study related learning outcomes	
Code of effect:	**E2_W17**
Description:	knows optimisation methods, such as linear and non-linear programming, multidimensional optimisation, dynamic and stochastic programming, practical applications of optimisation in thermodynamics, energy exchange, industrial power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_W18**
Description:	knows the rules of technical and economic analysis when designing and modernising power devices.
Area of study related learning outcomes	
Code of effect:	**E2_W19**
Description:	has knowledge necessary to understand social, economic, legal and other non-technical conditions of power engineering activity and to take them into account in engineering practice.
Area of study related learning outcomes	
Code of effect:	**E2_W20**
Description:	has basic knowledge on management, such as quality management and management of business activity.
Area of study related learning outcomes	
Code of effect:	**E2_W21**
Description:	knows and understands basic terms and rules connected with industrial property protection and copyright, as well as the need for intellectual property management; can use the resources of patent information.
Area of study related learning outcomes	
Code of effect:	**E2_W22**
Description:	knows general rules of founding and development of forms of individual entrepreneurship, using the knowledge in

Effects of education	
	scientific fields and disciplines relevant to power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U01**
Description:	can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Area of study related learning outcomes	
Code of effect:	**E2_U02**
Description:	can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U03**
Description:	can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results.
Area of study related learning outcomes	
Code of effect:	**E2_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:	**E2_U05**
Description:	can set the goals of further education and organise his/her learning process.
Area of study related learning outcomes	
Code of effect:	**E2_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, knows the terminology and symbols specific for power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U07**
Description:	can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Area of study related learning outcomes	
Code of effect:	**E2_U08**
Description:	can plan and conduct experiments, such as measurements and computer simulations, interpret the results obtained and draw

Effects of education	
	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:	**E2_U09**
Description:	can use mathematical methods in numerical and analytical solving of mathematical models of physical and chemical processes in heat power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U10**
Description:	can apply the methods of modern physics to analysis and experimental research of processes in heat power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U11**
Description:	can apply the rules and methods of equilibrium and irreversible thermodynamics.
Area of study related learning outcomes	
Code of effect:	**E2_U12**
Description:	can implement the methods of chemical research (kinetics and catalysis) in research on processes in heat power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U13**
Description:	can use IT knowledge in analysis of physical and chemical processes.
Area of study related learning outcomes	
Code of effect:	**E2_U14**
Description:	can formulate equations of mathematical models describing the properties of heating or cooling installations and their parts in steady and transient states.
Area of study related learning outcomes	
Code of effect:	**E2_U15**
Description:	can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U16**
Description:	is prepared to work in the industry and knows work-related safety standards.
Area of study related learning outcomes	
Code of effect:	**E2_U17**
Description:	can conduct a technical and economic analysis of designed and modernised technological systems using the methods of accumulated energy and exergy consumption indicators and economic analysis.
Area of study related learning outcomes	
Code of effect:	**E2_U17**
Description:	can conduct a technical and economic analysis of designed and modernised technological systems

Effects of education	
	using the methods of accumulated energy and exergy consumption indicators and economic analysis.
Area of study related learning outcomes	
Code of effect:	**E2_U18**
Description:	can use mathematical models of processes of momentum, heat and mass exchange and solve balance tasks, also using commercial software.
Area of study related learning outcomes	
Code of effect:	**E2_U19**
Description:	can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services.
Area of study related learning outcomes	
Code of effect:	**E2_U20**
Description:	can suggest improvements of existing technical solutions.
Area of study related learning outcomes	
Code of effect:	**E2_U21**
Description:	can use algorithms of identification of mathematical models.
Area of study related learning outcomes	
Code of effect:	**E2_U22**
Description:	can use optimisation methods and solve practical problems in technical and economic description in power engineering.
Area of study related learning outcomes	
Code of effect:	**E2_U23**
Description:	can solve design tasks and work analyses for power devices and installations taking into consideration legal restrictions and environmental impact.
Area of study related learning outcomes	
Code of effect:	**E2_U24**
Description:	can use commercial calculation software and create his/her own small applications for mathematical modelling and research.
Area of study related learning outcomes	
Code of effect:	**E2_U25**
Description:	can design and select basic power machines depending on the type of process.
Area of study related learning outcomes	
Code of effect:	**E2_U26**
Description:	can select the types of fuels for designed power processes.
Area of study related learning outcomes	
Code of effect:	**E2_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:	**E2_K02**
Description:	is aware of the importance of engineering

Effects of education	
	activity and understands its non-technical aspects and consequences, such as its impact on the environment and the responsibility for ensuing decisions.
Area of study related learning outcomes	
Code of effect:	**E2_K03**
Description:	can cooperate and work in a team, assuming various roles.
Area of study related learning outcomes	
Code of effect:	**E2_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:	**E2_K05**
Description:	correctly identifies and solves dilemmas connected with his/her job.
Area of study related learning outcomes	
Code of effect:	**E2_K06**
Description:	can think and act in a creative and entrepreneurial way.
Area of study related learning outcomes	
Code of effect:	**E2_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, presenting various points of view.
Area of study related learning outcomes	

Courses by semester

Semester 1

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Directional	Obligatory	Computational Fluid Dynamics	3	30	0	15	0
Directional	Obligatory	Energy Policy and Law	2	30	0	0	0
Directional	Obligatory	Energy Transport	2	15	15	0	0
Directional	Obligatory	Finite Element Method I	4	30	0	15	0
Directional	Obligatory	Mathematical Modeling and Process Identification	4	30	15	0	0
Directional	Obligatory	Numerical Methods in Heat Transfer	3	30	0	15	0
Directional	Obligatory	Partial Differential Equations	4	15	30	0	0
HES	HES	HES 21	2	30	0	0	0
Nuclear Power Engineering	Elective	Elective course(s) NPE1	2	30	0	0	0
Nuclear Power Engineering	Specialistic	Elements of Nuclear Physics	4	30	15	30	0
Power Engineering	Elective	Elective course(s) PE1	2	30	0	0	0
Power Engineering	Specialistic	Algorithms and Program for Heat Balances	2	15	15	0	0
Power Engineering	Specialistic	Energy Efficiency	2	15	0	15	0

Semester 2

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Directional	Obligatory	Business Law	2	15	15	0	0
Directional	Obligatory	Neural Networks	3	30	0	0	0

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Directional	Obligatory	Physics 2	3	30	0	0	0
Directional	Obligatory	Statistical and Nonequilibrium Thermodynamics	3	15	15	0	0
Nuclear Power Engineering	Elective	Elective course(s) NPE2	2	30	0	0	0
Nuclear Power Engineering	Specialistic	Contemporary Nuclear Reactor Systems (LWR, HWR)	3	45	0	0	0
Nuclear Power Engineering	Specialistic	Nuclear Fuels and Fuel Cycles	2	30	0	0	0
Nuclear Power Engineering	Specialistic	Nuclear Reactor Modeling and Simulation	6	30	15	30	0
Nuclear Power Engineering	Specialistic	Nuclear Reactor Physics	6	30	15	30	0
Power Engineering	Elective	Elective course(s) PE2	2	30	0	0	0
Power Engineering	Specialistic	Advanced Heat Transfer	3	15	15	0	0
Power Engineering	Specialistic	Advanced Renewable Energy Sources	3	30	15	0	0
Power Engineering	Specialistic	Engineering Project	3	0	0	0	60
Power Engineering	Specialistic	Future Power Technologies	2	30	0	0	0
Power Engineering	Specialistic	Intermediate Master Project	6	0	0	0	90

Semester 3

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Directional	Obligatory	Information Systems in Management	2	30	0	0	0
Directional	Obligatory	Project Management	2	30	0	0	0
Nuclear Power Engineering	Specialistic	Engineering Project	3	0	0	0	60
Nuclear Power Engineering	Specialistic	GenIV Nuclear Reactor Systems (HTR,FBR)	2	30	0	0	0
Nuclear Power Engineering	Specialistic	Intermediate Master Project	6	0	0	0	90
Nuclear Power Engineering	Specialistic	Nuclear Energy and International Security	2	15	0	15	0
Nuclear Power Engineering	Specialistic	Nuclear Instrumentation and Control	4	30	0	30	0
Nuclear Power Engineering	Specialistic	Nuclear Power Plant Operation and Maintenance	2	30	0	0	0
Nuclear Power Engineering	Specialistic	Nuclear Power Plant Safety	3	30	15	0	0
Nuclear Power Engineering	Specialistic	Thermonuclear Synthesis	2	30	0	0	0
Power Engineering	Specialistic	Elective Course PE3	2	30	0	0	0
Power Engineering	Specialistic	Master Diploma Seminar	2	0	0	0	30
Power Engineering	Specialistic	Master Diploma Thesis	20	0	0	0	225

Semester 4

Block	Group	Course	ECTS	Lect.	Exrc.	Lab.	Proj.
Nuclear Power Engineering	Specialistic	Internship at a Nuclear Installation	8	0	0	0	0
Nuclear Power Engineering	Specialistic	Master Diploma Seminar	2	0	0	0	0
Nuclear Power Engineering	Specialistic	Master Diploma Thesis	20	0	0	0	225

Description of course

Code of course	ANK348	
Name of course	Computational Fluid Dynamics	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Prof. J. Rokicki	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	Fluid Mechanics, Computer Science II	
Limit of students	90 - lecture, 12 - lab. groups	
C. Effects of education and manner of teaching		
Purpose of course	To familiarize the students with the computational methods of flow simulations After completing this course the students will be able to understand basic algorithms of CFD as well as perform simulations using comertial CFD code (mesh generation, setting up boundary and initial conditions, monitoring simulations, assessment nad visualization of results).	
Effects of education	See Table 1.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Basic models in fluid mechanics. Conservative versus non-conservative formulation. Basic discretisation methods for model equations (boundary and initial conditions, stability, CFL condition, Godunov barier). General algorithms for nonlinear problems (pseudo-time iterations, frozen coefficients, quasi-linearisation). Simulation of incompressible flows (stream-function vorticity formulation, projection method and artificial compressibility). Finite volume method for compressible flows. Flux-vector splitting technique. Modelling of shock-waves. Basic information on spectral methods.	
Methods of evaluation	Assesment method: 2 lecture tests (60 points), lab. continuous assignement (20 points), lab. test (20 points), resulting mark: (30-49 N, 50-59 3.0,	

Description of course

	60-69 3.5, 70-79 4.0, 80-89 4.5, 90-100 5.0), if necessary the optional final exam may override the score received during both lecture tests. Practical work: lab work.
Methods of verification of effects of education	See Table 1.
Exam	no
Literature	Hirsch, Charles, Numerical computation of internal and external flows, 2007 Versteeg. Henk Kaarle, An introduction to computational fluid dynamics, 2007.
Website of the course	http://c-cfd.meil.pw.edu.pl/ccfd/index.php?item=6

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 55, including: a) presence of the lectures – 30 hours; b) presence in the labs – 15 hours; c) presence on consultation – 10 hours. 2) The number of hours of independent work of student - 20 hours, including: a) 10 hours – preparation for labs and lectures, b) 10 hours – preparation for the exam. 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 - 55, including: a) presence of the lectures – 30 hours; b) presence in the labs – 15 hours; c) presence on consultation – 10 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits - 23 hours including: a) labs - 15 hours; b) preparation for the labs - 8 hours.

E. Additional information

Notes	-
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Table 1. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK348_W1**
Description:	Student knows basic modesl and equations of fluid mechanics.
Verification:	Exam
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK348_W1**
Description:	Student knows basic modesl and equations of fluid mechanics.
Verification:	Exam
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANK348_W2**
Description:	Student knows basic techniques of discretization of differential equations.
Verification:	Exam
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	

Table 1. Learning outcomes	
Code of effect:	**ANK348_W2**
Description:	Student knows basic techniques of discretization of differential equations.
Verification:	Exam
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANK348_W3**
Description:	Student knows stability limiatations of various discretization methods.
Verification:	Exam
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK348_W3**
Description:	Student knows stability limiatations of various discretization methods.
Verification:	Exam
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANK348_U1**
Description:	Student can discretize and solve numerically a simple boundary value problem.
Verification:	Exam, lab meetings
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK348_U1**
Description:	Student can discretize and solve numerically a simple boundary value problem.
Verification:	Exam, lab meetings
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANK348_U1**
Description:	Student can discretize and solve numerically a simple boundary value problem.
Verification:	Exam, lab meetings
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ANK348_U2**
Description:	Using an appropriate engineering computer package, a student is able to solve simple engineering flow problem and critically assess obtained solution.
Verification:	Assessment of progress/activity in lab tutorials
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ANK348_U2**
Description:	Using an appropriate engineering computer package, a student is able to solve simple engineering flow problem and critically assess obtained solution.
Verification:	Assessment of progress/activity in lab tutorials
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK348_U2**

Table 1. Learning outcomes	
Description:	Using an appropriate engineering computer package, a student is able to solve simple engineering flow problem and critically assess obtained solution.
Verification:	Assessment of progress/activity in lab tutorials
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK348_K1**
Description:	Student is able to identify and eliminate threats implied by erroneously performed computer simulations.
Verification:	Assessment of progress/activity in lab tutorials
Field of study related learning outcomes	E2_K06
Area of study related learning outcomes	
Code of effect:	**ANK348_K1**
Description:	Student is able to identify and eliminate threats implied by erroneously performed computer simulations.
Verification:	Assessment of progress/activity in lab tutorials
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ANK348_K1**
Description:	Student is able to identify and eliminate threats implied by erroneously performed computer simulations.
Verification:	Assessment of progress/activity in lab tutorials
Field of study related learning outcomes	E2_K05
Area of study related learning outcomes	

Description of course

Code of course	ANK487	
Name of course	Energy Policy and Law	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering	
Coordinator of course	prof. Tadeusz Skoczkowski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	50	
C. Effects of education and manner of teaching		
Purpose of course	To understand world’s and EU energy resources, supply and demands. To understand the ongoing changes in global energy markets, including EU internal energy market. To gain general knowledge on energy policy of the EU and Poland. To understand the transformation to sustainable energy systems. To learn the modern concept of energy security. To understand fundamentals of electricity reform and competition in electricity markets. To get familiar with main trends in energy research and promotion. To gain in-depth knowledge on energy law in Poland. To understand legal regulations concerning environmental impact of energy sector. To understand legal status of distributed generation.	
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	ENERGY GENERAL. Role of Energy in our Life. World’s Energy Resources. Population Growth and Global Energy Demand. Globalisation in Energy Markets. World’s Energy Forecasts. Energy Trends in the EU. EU Energy Priorities. EU Targets for 2020 and Beyond. EU Internal Energy Market. EU External Energy Relations. Energy Policy in Chosen Countries (USA, China, India, Russia, Brazil). Global Energy Investments. Nuclear Option. Development of RES Energy. Role of	

Description of course

	Energy Efficiency. Climate Change Impact. International Energy Agency. Global strategic petroleum reserves. Energy Charter Treaty. International Atomic Energy Agency. SUSTAINABLE ENERGY POLICY. Sustainable Development Concept. Definition of Sustainable Energy Policy. Clean Energy. Sustainable Energy Systems Attributes: Energy Efficiency. RES Penetration. Climate Impact. Low Carbon Technology Drive. Costs of Energy Technologies. Fossil Fuels in Sustainable Systems. SECURITY OF SUPPLY. Definition of Security of Supply. Energy Dependence of EU. Security of Supply in Electricity and Gas Markets. Investment Decisions. Policy Tools: Capacity Mechanism and Price Cap. Green Paper on Security Of Supply. Trends in IES Countries. Collective Energy Security. Generation: Investments. Reserves and Fuel Mix in Liberalized Markets. Role of Prices and Market Structure. Role of Governments. Transmission: Current Investments Needs. Transmission Congestion. Cross-Border Interconnections. Planning. Development and Ownership. End-Use Efficiency. Case Studies. ELECTRICITY REFORM AND COMPETITION IN ELECTRICITY MARKETS. Background To Electricity Reform. Electricity Directive2003/54/EC. Stranded Costs. Unbundling. Electricity Markets: Spot Markets. Power Exchange. Pool. Capacity Mechanism. Financial Markets. Networks: Network Regulations. Managing Congestion. Setting Price Levels. Regulation. Institutional Frameworks. Operators in Investments. Institutions and Policy Framework. Impact of Electricity Market Liberalization on Generation Costs: Market Liberalization. Transparency of Public Policy Objectives and Costs. Allocation of Risk. Investment Costs. Operation and Maintenance Costs. Investments In Power Generating Capacity. Investments in the Past. Investments Under Competition. Energy Investments Needs and Benefits. Conditions for Investment in the Energy Sector. Latest Proposals for legislation relating to EC internal energy markets. ENERGY RESEARCH AND PROMOTION. Energy in Frame Prjects. SET-Plan. Intelligent Energy Europe Program. ENERGY LAW IN POLAND. Energy Sector in Poland and its Development. Energy Policy of Poland. Energy Law. Objectives. Scope. Built-In Mechanisms. Main Provisions. Duties of the Energy Sector. End-User Position. Penalties. Role of the President of the Regulatory Office. Green Certificates. Red Certificates. Weaknesses. Main Decrees to Energy Law. Tariff

Description of course

	Decree. Connection Decree. Energy Efficiency Law. Objectives. Main Provisions. White Certificates. Energy Efficiency Financing. NEEAP. Development of Nuclear Law. Competition Law. ENVIRONMENTAL IMPACT OF ENERGY SECTOR. Energy Related Environmental Directives: IPPC, LCP. Environmental Accounting GHG Emission Reduction. EMAS. ISO1400. Best Available Techniques. Environmental Protection Law. Climate Change. Importance of Climate Change. Kyoto Protocol And Post-Kyoto. Kyoto Experience. UNFCCC. Climate Change EU Action Plan. Climate Change and Carbon Trading Mechanism. Carbon Trading Mechanisms and Complementary Measures. Flexible Mechanisms. Joint Implementation. Clean Development Mechanism. Emission Trading Mechanism. EU Emission Trading System. EU Demand Side and Energy Efficiency Measures. Carbon Market Activity. Nuclear Safety. LEGAL STATUS OF DISTRIBUTED GENERATION. Definitions of Distributed Generations (DG). DG Technologies. Res. Small CHP. CHP Directive. Economics of DG. DG Level Playing Field. Policy Issues. Barriers. Regulation Electricity Markets Covering DG. Energy Companies in Dg Markets. Development of DG. Renewables. RES State. RES Development. Directives2001/77/EC. Directive2009/28/EC. Feed-in Tariff. National Renewable Energy Action Plans (NREAPS). RES Financing. RES Policy and Legislation in Chosen Countries.
Methods of evaluation	1. Weekly active participation in discussions – ability to present, argue and defend own opinions supported by concrete evidences, e.g. policy documents, statistics, research papers. 2. Preparation and making public presentation (group work). 3. Writing an essay on a given subject (3…5 pages, individual work), and/or 4. Active participation in a semester-long project.
Methods of verification of effects of education	See Table 2.
Exam	no
Literature	1) Jaccard M.: Sustainable Fossil Fuels, Cambridge University Press, 2005. 2) Toward sustainable energy future, OECD/IEA, 2001, http://www.oecd.org/bookshop
Website of the course	http://itc.pw.edu.pl/IT/Moodle

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 - 35, including: a) presence of the lectures 30 hours; b) presence on consultation – 5 hours. 2) The number of hours of independent work of student – 30 hours, including: a) preparation for

Description of course

	lecture, analyse of the literature - 10 hours; b) prepare at least one subject and its presentation during classes (group work) – 10 hours; c) to prepare an elaborate on a given subject 3-5 pages (individual work) – 10 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,4 ECTS credits – number of hours that require the presence of a teacher - 35, including: a) presence of the lectures 30 hours; b) presence on consultation – 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 2. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK487_W1**
Description:	Student understands political and economic processes ongoing in the world’s and EU energy markets, including EU internal energy market.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANK487_W2**
Description:	Student understands fundamentals of electricity reform and competition in electricity markets.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANK487_W2**
Description:	Student understands fundamentals of electricity reform and competition in electricity markets.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANK487_W3**
Description:	Student has in-depth knowledge on energy law in Poland and understands legal regulations concerning environmental impact of energy sector.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	

Table 2. Learning outcomes	
General academic profile - skils	
Code of effect:	**ANK487_U1**
Description:	Student has ability to understand the EU and Poland's energy law and environmental law influencing energy processes.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U23
Area of study related learning outcomes	
Code of effect:	**ANK487_U1**
Description:	Student has ability to understand the EU and Poland's energy law and environmental law influencing energy processes.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANK487_U1**
Description:	Student has ability to understand the EU and Poland's energy law and environmental law influencing energy processes.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANK487_U1**
Description:	Student has ability to understand the EU and Poland's energy law and environmental law influencing energy processes.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANK487_U2**
Description:	Student has ability to understand business processes in energy market and market law regulations.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANK487_U2**
Description:	Student has ability to understand business processes in energy market and market law regulations.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U02

Table 2. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ANK487_U2**
Description:	Student has ability to understand business processes in energy market and market law regulations.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANK487_U2**
Description:	Student has ability to understand business processes in energy market and market law regulations.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U07
Area of study related learning outcomes	
Code of effect:	**ANK487_U2**
Description:	Student has ability to understand business processes in energy market and market law regulations.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U23
Area of study related learning outcomes	
Code of effect:	**ANK487_U3**
Description:	Student can practically use the Polish energy law in his job.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANK487_U3**
Description:	Student can practically use the Polish energy law in his job.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANK487_U3**
Description:	Student can practically use the Polish energy law in his job.
Verification:	Writing an essay; final assessment; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK487_K1**

Table 2. Learning outcomes	
Description:	Student understands the role of energy sector and is able to communicate the role to the society.
Verification:	Writing an essay; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_K05
Area of study related learning outcomes	
Code of effect:	**ANK487_K1**
Description:	Student understands the role of energy sector and is able to communicate the role to the society.
Verification:	Writing an essay; making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**ANK487_K2**
Description:	Students can work in a group and accomplish specific tasks given.
Verification:	Making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_K03
Area of study related learning outcomes	
Code of effect:	**ANK487_K2**
Description:	Students can work in a group and accomplish specific tasks given.
Verification:	Making a slide presentation (in a group); activity in discussions
Field of study related learning outcomes	E2_K05
Area of study related learning outcomes	

Description of course

Code of course	ANK415	
Name of course	Energy Transport	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering	
Coordinator of course	prof. Jerzy Banaszek	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	Fondamentals of thermodynamics, heat transfer and fluid flow. ANW416 - Thermodynamics 1, ANK413 - Thermodynamics 3, ANK423 - Heat Transfer 1, ANW122 - Fluid Mechanics 1.	
Limit of students	30	
C. Effects of education and manner of teaching		
Purpose of course	Analysis of energy losses, based on the combination of the First and Second Laws of Thermodynamics, when applied to various thermodynamic processes occurring in heat machines. Fundamental concepts and theory of mass transfer phenomena and concurrent heat and mass transfer processes, their occurrence in nature and applications in technology.	
Effects of education	See Table 3.	
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: Fundamental mechanisms of energy transfer. Application of the First and Second Laws of Thermodynamics in the quality assessment of energy transfer phenomena – a review of irreversible processes. Examples of mass transfer in nature and technology. Fundamental concepts and transfer mechanisms of a mixture component. Molecular diffusion and its one –dimensional practical models (plane wall and cylindrical geometry, transient mass diffusion, equimolar counter-diffusion, Stefan flow). Convective mass transfer - forced and natural convection, the boundary layer theory, mass convection empirical	

Description of course

	relations. Analogy of heat, mass and momentum transfer, Chilton-Colburn analogy and its practical applications. Simultaneous heat and mass transfer - examples. Tutorials: Calculations of power losses in selected irreversible processes - such as fluid flow with friction, heat transfer, gas mixing, Joule's effect and combustion occurring in pipes, valves, combustion chambers, heat pumps, internal combustion and turbojet engines. Computation of diffusive and convective mass transfer, using one-dimensional analytical models, empirical relationships and Chilton-Colburn analogy in various processes, such as the waste utilisation, steel carbonizing, humidification and drying of air and other media, NOx propagation in the atmosphere and thermal convection around a body of a complex geometry (calculation of convective heat transfer coefficient).
Methods of evaluation	Two problem solution tests during the course (mid-term tests) and a theoretical test at a final exam. All tests must be passed and a final grade is an arithmetic mean of all tests evaluations.
Methods of verification of effects of education	See Table 3.
Exam	yes
Literature	1. Y.A. Cengel and M.A. Boles,"Thermodynamics, An Engineering Approach", Sixth Edition, Mc Graw Hill, Boston, 2008. 2. Y.A. Cengel, "Heat and Mass Transfer: A Practical Approach", Third Edition, Mc Graw Hill, Singapore, 2006. 3. F.P. Incropera, and D.P. DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, Inc., 1998. 4. A. Bejan, "Convection Heat Transfer", John Wiley & Sons, Inc., 1984.
Website of the course	www.itc.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 - 40, including: a) presence of the lectures - 15 hours; b) presence in the exercises - 15 hours; c) presence on consultation - 10 hours. 2) The number of hours of independent work of student 20 hours, including: prepare themselves to two tests (problem solving) during the semester and final exam preparation. TOTAL: 60 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,6 ECTS credits – Number of hours that require the presence of a teacher - 40, including: a) presence of the lectures- 15 hours; b) presence in the exercises - 15 hours; c) presence on consultation - 10 hours.
Number of ECTS credits on practical activities on the course	-

Description of course

E. Additional information

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Table 3. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK415_W1**
Description:	A student is familiar with methods of quantitative estimation of energy losses in heat maachines.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_W06
Area of study related learning outcomes	
Code of effect:	**ANK415_W1**
Description:	A student is familiar with methods of quantitative estimation of energy losses in heat maachines.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANK415_W2**
Description:	A student is familiar with basic physics of diffusive and convection mass transfer and their mathematical modelling.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANK415_W3**
Description:	A student has a knowledge of process of simultaneous heat and mass transfer and their applications in technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK415_W3**
Description:	A student has a knowledge of process of simultaneous heat and mass transfer and their applications in technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANK415_W3**
Description:	A student has a knowledge of process of simultaneous heat and mass transfer and their applications in technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	

Table 3. Learning outcomes	
General academic profile - skils	
Code of effect:	**ANK415_U1**
Description:	A student kwnows how to use thermodynamics laws in energy and exergy balances.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U11
Area of study related learning outcomes	
Code of effect:	**ANK415_U1**
Description:	A student kwnows how to use thermodynamics laws in energy and exergy balances.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK415_U2**
Description:	A student knows how to estimate a quantity of useful energy resources and an amount of energy losses.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK415_U2**
Description:	A student knows how to estimate a quantity of useful energy resources and an amount of energy losses.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U11
Area of study related learning outcomes	
Code of effect:	**ANK415_U2**
Description:	A student knows how to estimate a quantity of useful energy resources and an amount of energy losses.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANK415_U3**
Description:	A student can identify processes of heat and mass transfer in nature and technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANK415_U3**
Description:	A student can identify processes of heat and mass transfer in nature and technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANK415_U3**

Table 3. Learning outcomes	
Description:	A student can identify processes of heat and mass transfer in nature and technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U11
Area of study related learning outcomes	
Code of effect:	**ANK415_U3**
Description:	A student can identify processes of heat and mass transfer in nature and technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANK415_U4**
Description:	A student knows how to use mathematical models and their solutions in the analysis of heat and mass transfer processes encountered in instruments and machines of energy power technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK415_U4**
Description:	A student knows how to use mathematical models and their solutions in the analysis of heat and mass transfer processes encountered in instruments and machines of energy power technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U11
Area of study related learning outcomes	
Code of effect:	**ANK415_U4**
Description:	A student knows how to use mathematical models and their solutions in the analysis of heat and mass transfer processes encountered in instruments and machines of energy power technology.
Verification:	Two tests during the course (mid-term tests) and a theoretical test at a final exam.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	

Description of course

Code of course	ANK342	
Name of course	Finite Element Method I	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering	
Coordinator of course	dr hab. inż. Grzegorz Krzesiński, prof. PW.	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	L.ANW117 Mechanics of Structures 1 (MOS1), ML.ANK427 Mechanics of Structures 2 (MOS2).	
Limit of students	min. 15	
C. Effects of education and manner of teaching		
Purpose of course	To supply the basic knowledge and skills required for understanding and simple practical applications of FEM.	
Effects of education	See Table 4.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Lecture: Approximate methods in mechanics of structures - Finite Element Method, Finite Difference Method, Boundary Element Method. Approximate solutions of 2D Poisson equation. FEM versus Ritz method. Basic relations in analysis of truss structures. Simple finite elements for 2D and 3D stress analysis. Typical algorithms of FEM in static linear stress analysis, popular commercial FE software packages. Accuracy of FE analysis. Computer lab: Introduction to practical problems of FE modeling in ANSYS. 2D and 3D linear stress analysis. Static analysis of simple shell structure.	
Methods of evaluation	Assessment based on tests and results of computer lab work. Practical work: Project/laboratory classes, where students will built and analyse the results of simple FE models of structural elements.	
Methods of verification of effects of education	See Table 4.	
Exam	no	

Description of course

Literature	Recommended: Huebner K.H., Dewhirst D.L., Smith D.E., Byrom T.G.: The finite element method for engineers, J. Wiley & Sons 2001, Zienkiewicz O.C., Taylor R.: The Finite Element Method - different publishers and editions.
Website of the course	http://mel.pw.edu.pl/zwmik/ZWMiK/Dla-studentow2/Finite-Element-Method-1

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) presence of the lectures - 30 hours; b) presence in the labs – 15 hours; c) presence on consultation – 5 hours. 2) The number of hours of independent work of student – 65, including: a) preparation for tests and the presence at colloquia: 15 hours, b) preparation for lecture, analyse of the literature - 15 hours; c) preparing for the lab: 15 hours; d) preparation of reports from the lab: 20 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 - 50, including: a) presence of the lectures - 30 hours; b) presence in the labs – 15 hours; c) presence on consultation – 5 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits – 30 hours, including: a) presence at computer labs: 15 hours; b) preparation of reports from the lab: 15 hours.

E. Additional information

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Table 4. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK342_W1**
Description:	The knowledge about the stiffness matrices of different finite elements (truss, beam, 2D, 3D).
Verification:	Based on tests.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W1**
Description:	The knowledge about the stiffness matrices of different finite elements (truss, beam, 2D, 3D).
Verification:	Based on tests.
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W1**
Description:	The knowledge about the stiffness matrices of different finite elements (truss, beam, 2D, 3D).
Verification:	Based on tests.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W2**
Description:	The knowledge about the algorithms leading to

Table 4. Learning outcomes	
	FEM equations for static stress analysis.
Verification:	Based on tests.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W2**
Description:	The knowledge about the algorithms leading to FEM equations for static stress analysis.
Verification:	Based on tests.
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W2**
Description:	The knowledge about the algorithms leading to FEM equations for static stress analysis.
Verification:	Based on tests.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W3**
Description:	Knowledge of standard FEM algorithms and programs.
Verification:	Based on tests and practical FEM modeling.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W3**
Description:	Knowledge of standard FEM algorithms and programs.
Verification:	Based on tests and practical FEM modeling.
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_W3**
Description:	Knowledge of standard FEM algorithms and programs.
Verification:	Based on tests and practical FEM modeling.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK342_U1**
Description:	The ability to build 2D linear finite element model for stress analysis problem (the cases of: plane stress, plane strain, axisymmetry), to perform analysis, to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U1**
Description:	The ability to build 2D linear finite element model for stress analysis problem (the cases of: plane stress, plane strain, axisymmetry), to perform analysis, to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during

Table 4. Learning outcomes	
	computer labs.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U1**
Description:	The ability to build 2D linear finite element model for stress analysis problem (the cases of: plane stress, plane strain, axisymmetry), to perform analysis, to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U2**
Description:	The ability to build linear finite element model for 3D stress problem, to perform analysis , to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U2**
Description:	The ability to build linear finite element model for 3D stress problem, to perform analysis , to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U2**
Description:	The ability to build linear finite element model for 3D stress problem, to perform analysis , to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U3**
Description:	The ability to build linear finite element model for shell structure, to perform analysis , to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U3**

Table 4. Learning outcomes	
Description:	The ability to build linear finite element model for shell structure, to perform analysis , to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U3**
Description:	The ability to build linear finite element model for shell structure, to perform analysis , to present results in the form of tables, graphs, contour plots and to draw the adequate conclusions.
Verification:	Based on tests and the reports created during computer labs.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U4**
Description:	The ability to build and to solve linear finite element models for truss and frame structures under the applied forces and constraints.
Verification:	Based on tests.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ML.ANK342_U5**
Description:	The ability to find the equivalent nodal forces for simple cases of finite elements and loads.
Verification:	Based on tests.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	

Description of course

Code of course	ANK486	
Name of course	Mathematical Modeling and Process Identification	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering	
Coordinator of course	dr inż. Rafał Laskowski, prof. Janusz Lewandowski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	130	
C. Effects of education and manner of teaching		
Purpose of course	Ability to formulate and solve simple mathematical models of electrical equipment and installations. Knowledge of the application of mathematical modeling in power.	
Effects of education	See Table 5.	
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	The basic steps are aimed at the identification process: the development of the phenomenological model (equivalent circuit), the formulation of a mathematical model, the identification of the model and simulation of processes (solution model). The rules for creating diagrams substitute replacement patterns typical of machines, electrical equipment and installations. Models developed (analytical) and approximation. Models for steady state and transient Basic equations developed mathematical models of major system components of energy. Methods of identification models. Methods of solving models for steady state and transient. The use of mathematical modeling in operation: optimization of load distribution, the simulators. As part of the exercise is developed mathematical model of the waste heat boiler (one and two pressure) steam turbine, steam block a simplified model structure and emptied the tank of gas.	
Methods of evaluation	Two written tests during the semester. Final	

Description of course

	examination in the case of negative or unsatisfactory grades in colloquia.
Methods of verification of effects of education	See Table 5.
Exam	yes
Literature	1. Materials on the estudia page. 2. Materials provided by the lecturer.
Website of the course	http://estudia.meil.pw.edu.pl

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 55, including: a) presence of the lectures- 30 hours; b) presence in the exercises – 15 hours; c) presence on consultation -10 hours. 2) The number of hours of independent work of student: a) preparation for two tests - 15 hours; b) preparation for lecture, analyse of the literature - 15 hours; c) preparing for the exercies: 15 hours. TOTAL – 100 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,2 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 5. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK486_W1**
Description:	Has advanced knowledge of the modeling of processes and equipment in power.
Verification:	Final test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK486_W1**
Description:	Has advanced knowledge of the modeling of processes and equipment in power.
Verification:	Final test.
Field of study related learning outcomes	E2_W06
Area of study related learning outcomes	
Code of effect:	**ANK486_W1**
Description:	Has advanced knowledge of the modeling of processes and equipment in power.
Verification:	Final test.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANK486_W1**
Description:	Has advanced knowledge of the modeling of processes and equipment in power.

Table 5. Learning outcomes	
Verification:	Final test.
Field of study related learning outcomes	E2_W17
Area of study related learning outcomes	
Code of effect:	**ANK486_W2**
Description:	Has knowledge about the principles of identification models.
Verification:	Final test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK486_W2**
Description:	Has knowledge about the principles of identification models.
Verification:	Final test.
Field of study related learning outcomes	E2_W06
Area of study related learning outcomes	
Code of effect:	**ANK486_W2**
Description:	Has knowledge about the principles of identification models.
Verification:	Final test.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANK486_U1**
Description:	Knows how to make the process of identifying and create a mathematical model of the device.
Verification:	Final test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK486_U1**
Description:	Knows how to make the process of identifying and create a mathematical model of the device.
Verification:	Final test.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
Code of effect:	**ANK486_U1**
Description:	Knows how to make the process of identifying and create a mathematical model of the device.
Verification:	Final test.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANK486_U1**
Description:	Knows how to make the process of identifying and create a mathematical model of the device.
Verification:	Final test.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANK486_U1**
Description:	Knows how to make the process of identifying and create a mathematical model of the device.
Verification:	Final test.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANK486_U1**
Description:	Knows how to make the process of identifying

Table 5. Learning outcomes	
	and create a mathematical model of the device.
Verification:	Final test.
Field of study related learning outcomes	E2_U21
Area of study related learning outcomes	
Code of effect:	**ANK486_U2**
Description:	Can create complex models of power plants for the purpose of balancing and analysis of operating parameters.
Verification:	Final test.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANK486_U2**
Description:	Can create complex models of power plants for the purpose of balancing and analysis of operating parameters.
Verification:	Final test.
Field of study related learning outcomes	E2_U17
Area of study related learning outcomes	
Code of effect:	**ANK486_U3**
Description:	Student knows how to use the software and systems for modeling and identification devices.
Verification:	Final test.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANK486_U3**
Description:	Student knows how to use the software and systems for modeling and identification devices.
Verification:	Final test.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANK486_U3**
Description:	Student knows how to use the software and systems for modeling and identification devices.
Verification:	Final test.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	

Description of course

Code of course	ANK347	
Name of course	Numerical Methods in Heat Transfer	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering.	
Coordinator of course	prof. dr hab. inż. Jerzy Banaszek	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	Computer science (C language), Basics of fluid mechanics, heat transfer and partial differential equations. Courses: ANK423 Heat Transfer 1, ANW122 Fluid Mechanics 1, ANK481 Partial Differential Equations, ANW114 Computer Science 2.	
Limit of students	30	
C. Effects of education and manner of teaching		
Purpose of course	Fundamental knowledge of contemporary computer simulation techniques in fluid mechanics and heat transfer (such as control volume method and finite element method) and developed skills in their application to engineering problems (with the use of the commercial code Ansys Fluent and others).	
Effects of education	See Table 6.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	15h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Lecture: 1. From reality to its computer simulation - successive stages of a model development. 2. Mathematical model of incompressible fluid flow and heat transfer – integral and differential conservation equations. 3. Methods of geometrical domain discretization. 4. Review of contemporary numerical methods in heat transfer and fluid flow – Control Volume Finite Difference Method (CVFDM), Finite Element Method (FEM). 5. Solving steady-state and transient diffusion on control volume and finite element grids. 6. Special numerical techniques for convective-diffusive	

Description of course

	transport – upwind schemes in CVFDM and FEM. 7. Error analysis of computer simulation – consistence, stability, convergence, accuracy estimation on a grid of a moderate density. 8. Review of effective computational algorithms in CVFDM and FEM modelling of incompressible fluid convection. 9. Solution methods for linear algebraic equations – a review. 10. Introduction to turbulence modelling. 11. Credibility of a computer simulation – verification and validation, examples of credibility assessment. Computer Lab: 1. Introduction to the principles of using ANSYS GAMBIT – step-by-step division of 2D geometrically complex domain into control-volumes, structural and non-structural grids, types of domains and boundary conditions, application of advanced functions in local mesh refinement. 2. Introduction to the principles of using ANSYS Fluent to solve fluid flow and heat transfer problems – mesh reading in and diagnostics, boundary and initial conditions, material properties, solver settings, graphical presentation of results (post processing), User Defined Files. 3. Examples of modelling with the code Fluent: 3D natural thermal and solutal convection, thermal radiation, convection in porous media, heat transfer in a turbine blade or others.
Methods of evaluation	The assessment comprises two parts: (1) lecture assessment by a final test; (2) laboratory assessment by a practical test in the lab. A final grade comprises 70% of the lecture test grade and 30% of the laboratory test grade.
Methods of verification of effects of education	See Table 6.
Exam	no
Literature	1. S.V. Patankar, „Numerical heat transfer and fluid flow”, Mc Graw-Hill, 1980. 2. H.K. Versteeg and W. Malalasekera, „An introduction to computational fluid dynamics. The finite volume method”, second edition, Pearson Prentice House, London, 2007. 3. R.W. Lewis, P. Nithiarasu, K.N. Seetharamu, „Fundamentals of the Finite Element Method for Heat and Fluid Flow”, John Wiley & Sons, 2004. 4. C. Hirsch, „Numerical computation of internal and external flows”, volume I & volum II, John Wiley & Sons, Chichester, 1988, or second edition, 2007. 5. O.C. Zienkiewicz, R.L. Taylor & P. Nithiarasu, „The Finite element method for fluid dynamics, sixth edition”, Elsevier, Amsterdam, 2005. 6. Y. Yaluria, K.E. Torrance „Computational Heat Transfer”, Hemisphere, 1986. 7. Fluent Web page. 8.WWW Cfd-online.com.
Website of the course	-

D. Student’s activity

Description of course

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher – 55, including: a) attendance at the lectures - 30 hours; b) attendance at the labs – 15 hours; c) consultancy meetings – 10 hours. 2) The number of hours of independent work of student - 20 hours of work dedicated to expanding their own theoretical knowledge with the use of the recommended literature and computer exercises for learning the operation of commercial simulation codes problems of fluid mechanics and heat transfer engineering applications. TOTAL : 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,2 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 labs – 15 hours; c) consultancy meetings – 10 hours.
Number of ECTS credits on practical activities on the course	1.4 ECTS credits - 35 hours, includes: 1) 15 - hours of laboratory work; 2) 10 - consultations with the computer program; 3) 10 hours of self - work in the computer laboratory.

E. Additional information

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Table 6. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK347_W1**
Description:	A student comprises fundamental assumptions, advantages and limitations of computer simulations of fluid flow and heat transfer processes.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK347_W1**
Description:	A student comprises fundamental assumptions, advantages and limitations of computer simulations of fluid flow and heat transfer processes.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANK347_W1**
Description:	A student comprises fundamental assumptions, advantages and limitations of computer simulations of fluid flow and heat transfer processes.
Verification:	Knowlegde of the lecture assessment by a final

Table 6. Learning outcomes	
	test
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANK347_W2**
Description:	A student knows basics of contemporary numerical methods of fluid flow and heat transfer modelling, in particular the Control Volume Method and the Finite Element Method.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK347_W2**
Description:	A student knows basics of contemporary numerical methods of fluid flow and heat transfer modelling, in particular the Control Volume Method and the Finite Element Method.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANK347_W2**
Description:	A student knows basics of contemporary numerical methods of fluid flow and heat transfer modelling, in particular the Control Volume Method and the Finite Element Method.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANK347_W3**
Description:	A student is familiar with basic methods for error analysis of numerical solutions for problems described by partial differential equations.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANK347_W3**
Description:	A student is familiar with basic methods for error analysis of numerical solutions for problems described by partial differential equations.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANK347_W3**
Description:	A student is familiar with basic methods for error analysis of numerical solutions for problems described by partial differential equations.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	

Table 6. Learning outcomes	
Code of effect:	**ANK347_W4**
Description:	A student acquires a fundamental theoretical knowledge concerning possible methods of the credibility analysis of fluid flow and heat transfer simulation models.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK347_W4**
Description:	A student acquires a fundamental theoretical knowledge concerning possible methods of the credibility analysis of fluid flow and heat transfer simulation models.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANK347_W4**
Description:	A student acquires a fundamental theoretical knowledge concerning possible methods of the credibility analysis of fluid flow and heat transfer simulation models.
Verification:	Knowlegde of the lecture assessment by a final test
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANK347_U1**
Description:	A student is able to construct a numerical model, to reasonably choose both a proper discretization method and its solution algorithm.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANK347_U1**
Description:	A student is able to construct a numerical model, to reasonably choose both a proper discretization method and its solution algorithm.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK347_U1**
Description:	A student is able to construct a numerical model, to reasonably choose both a proper discretization method and its solution algorithm.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANK347_U2**
Description:	A student gets skills in using commercial codes (such as GAMBIT and ANSYS FLUENT) in numerical simulation of engineering problems, including skills in C language programming,

Table 6. Learning outcomes	
	generation and applying User Defined Functions and User Defined Memories.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANK347_U2**
Description:	A student gets skills in using commercial codes (such as GAMBIT and ANSYS FLUENT) in numerical simulation of engineering problems, including skills in C language programming, generation and applying User Defined Functions and User Defined Memories.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANK347_U2**
Description:	A student gets skills in using commercial codes (such as GAMBIT and ANSYS FLUENT) in numerical simulation of engineering problems, including skills in C language programming, generation and applying User Defined Functions and User Defined Memories.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ANK347_U3**
Description:	A student can properly discuss numerical calculation results from the point of view of both analysed phenomena physics and an approximate model accuracy.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANK347_U3**
Description:	A student can properly discuss numerical calculation results from the point of view of both analysed phenomena physics and an approximate model accuracy.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U11
Area of study related learning outcomes	
Code of effect:	**ANK347_U3**
Description:	A student can properly discuss numerical calculation results from the point of view of both analysed phenomena physics and an approximate model accuracy.
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANK347_U3**
Description:	A student can properly discuss numerical calculation results from the point of view of both analysed phenomena physics and an approximate model accuracy.

Table 6. Learning outcomes	
Verification:	Practical test in the lab.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	

Description of course

Code of course	NK481A	
Name of course	Partial Differential Equations	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Mathematics and Information Science	
Coordinator of course	Prof. Andrzej Fryszkowski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	ANW102 - Calculus 1 ANW90 - Calculus 2 ANW91 - Calculus 3	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	To familiarize students with the foundations of the theory of Partial Differential Equations, selected PDE-based models and solution techniques.	
Effects of education	See Table 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	1. DEs of the first order - the method of characteristics for quasi-linear PDE. The Cauchy problem. 2. Classification of the 2nd-order PDEs. Canonical forms of hyperbolic, parabolic and elliptic PDEs. 3. Solution of the Cauchy problem for the string. D'Alembert formula for a nonhomogeneous equation. 4. Initial/boundary value problem for the string of finite length. Oscillation of rectangular and circular membrane. 5. Solution of the initial/boundary value problem for the rod by means of the method of separation of variables. 6. Fourier integral, Cauchy problem for heat transfer equation in infinite domain, maximum principle for a heat transfer problem. 7. Elliptic equations and properties of harmonic functions. Dirichlet and neumann type boundary conditions for the Laplace equation.	
Methods of evaluation	Midterm test - 55 p. Final exam - 45 p. Evaluation of the progress/activity during tutorial meetings - 5 p. Total up to 100 p., at least 51 p. to pass the course.	

Description of course

Methods of verification of effects of education	See Table 7.
Exam	yes
Literature	1. Salsa S.: Partial differential equations in action. From modelling to Theory. Springer, 2009. 2. Olver P.: Introduction to Partial Differential Equations. Springer, 2014. 3. Tyn Myint-U, Debnath L.: Linear Partial Differential Equations for Scientists and Engineers, Birkhauser, 2007.
Website of the course	-

D. Student's activity

Number of ECTS credits	4
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) presence of the lectures- 15 hours; b) presence in the exercises – 30 hours; c) presence on consultation – 5 hours. 2) The number of hours of independent work of student – 50 hours, including: • Systematic preparation for classes - 30 hours. • Preparing for exams - 20 hours.
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) presence of the lectures- 15 hours; b) presence in the exercises – 30 hours; c) presence on consultation – 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 7. Learning outcomes

General academic profile - knowledge

Code of effect:	**NK481A_W1**
Description:	Student is familiar with the basic theoretical concepts in the theory of PDEs: linear, nearly-linear and quasi-linear. Student knows the method of characteristics for the 1st-order quasi-linear PDE.
Verification:	Test and exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**NK481A_W2**
Description:	Student knows the classification of the nearly-linear PDEs of the second order.
Verification:	Test and exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**NK481A_W3**
Description:	Student is familar with the formulation of basic boundary value problems for 2nd-order hyperbolic, parabolic and elliptic PDEs. Student knows basic examples of application of such

Table 7. Learning outcomes	
	problems in physics and engineering.
Verification:	Test and exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**NK481A_W4**
Description:	Student knows the method of separation of variables.
Verification:	Test and exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**NK481A_U1**
Description:	Student can transform a PDE (in 2D case) to a canonical form.
Verification:	Test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**NK481A_U1**
Description:	Student can transform a PDE (in 2D case) to a canonical form.
Verification:	Test.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**NK481A_U2**
Description:	Student can solve a simple initial/boundary value problem for a hyperbolic and parabolic PDEs using the method of separation of variables.
Verification:	Test and exam.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**NK481A_U2**
Description:	Student can solve a simple initial/boundary value problem for a hyperbolic and parabolic PDEs using the method of separation of variables.
Verification:	Test and exam.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	

Description of course

Code of course	HES21	
Name of course	HES 21	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of 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	HES	
Group of courses	HES	
Type of course	Elective	
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 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	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 8.	
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 8. Learning outcomes

Description of course

Code of course	ANFKT_PE1	
Name of course	Elective course(s) NPE1	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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	Nuclear Power Engineering	
Group of courses	Elective	
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	-	
C. Effects of education and manner of teaching		
Purpose of course	Detailed data contains syllabus of specific course.	
Effects of education	See Table 9.	
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 9.	
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 9. Learning outcomes

Description of course

Code of course	ANS664	
Name of course	Elements of Nuclear Physics	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering.	
Coordinator of course	Prof. dr hab. Piotr Magierski	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	Understanding the microscopic structure of matter and the fundamental rights and principles as are imposed on the microworld. Understanding the physical processes used in the production of energy in nuclear reactors and in the stars.	
Effects of education	See Table 10.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	15h
	Laboratory	30h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Lectures: 1. Structure of matter, elementary particles. Fundamental interactions. Typical length and energy scales related to atoms and nuclei. 2. Structure of atomic nucleus. Sizes and masses. Nuclear chart. Range of stability of atomic nuclei. 3. Binding energy of a nucleus. Separation energies. Valley of stability. Decay channels. Magic numbers. 4. Excitation modes od atomic nuclei. Total and differential cross section. 5. Properties of nuclear interaction. Deuteron properties. 6.Nuclear models: liquid drop model, independent particle model (shell model), collective models. 7. Accelerators, detectors, interaction of particles with medium. 8. Radioactivity. Law of radioactive decay. Nuclear transmutation. Decay chains. 9. Decay channels: alpha, beta, gamma, fission. 10. Nuclear reactions. Models of nuclear reactions. 11. Spontaneous and induced fission. Chain reaction.	

Description of course

	12. Neutron physics. Interaction of neutrons with matter. 13. Thermonuclear synthesis. Synthesis of light elements in stars, supernova explosion, r-process. 14. Thermonuclear synthesis on Earth: methods and problems. 15. Challenges for contemporary nuclear physics. Recent experiments.
Methods of evaluation	The final evaluation of the course is staged based on the results of tutorials (T) and labs (L) with the following weights: 2/3*T+1/3*L The grade T is the mean value of grades of two tests consisting of both theoretical and computational parts. The grade L is the mean value of grades obtained for each of 5 laboratory exercises.
Methods of verification of effects of education	See Table 10.
Exam	no
Literature	1) J-l. Basdevant, J. Rich, M. Spiro, Fundamentals in Nuclear Physics. From Nuclear Structure to Cosmology 2) W.N. Cottingham, D.A. Greenwood An introduction to Nuclear Physics, Cambridge Univ. Press 3) K. Heyde Basic Ideas and Concepts in Nuclear Physics, Inst. Of Phys. Publ. 4) B. Povh, K. Rith, C. Scholz, F. Zetsche Particles and Nuclei. An Introduction to the Physical Concepts
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 - 80, including: 1. attendance at the lectures- 30 hours; 2. attendance at the exercises -15 hours; 3. attendance at the labs - 30 hours; 4. consultancy meetings - 5 hours. 2) The number of hours of independent work of student – preparation to tutorials and labs: 35 hours.
Number of ECTS credits on the course with direct participation of academic teacher	3,2 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 -15 hours; c) attendance at the labs - 30 hours; d) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 10. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS664_W1**
Description:	Advanced knowledge of nuclear physics.
Verification:	Written test.
Field of study related learning outcomes	E2_W13

Table 10. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ANS664_W2**
Description:	Knowledge about material structure and nuclear conversions.
Verification:	Written test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS664_U1**
Description:	Skills of description of nuclear conversion processes.
Verification:	Written test.
Field of study related learning outcomes	E2_U07
Area of study related learning outcomes	
Code of effect:	**ANS664_U1**
Description:	Skills of description of nuclear conversion processes.
Verification:	Written test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS664_U2**
Description:	Skills of solving nuclear physics problems.
Verification:	Written test.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS664_K1**
Description:	Sklills of knowledge transfer of physics fundamentals.
Verification:	Written test.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	

Description of course

Code of course	ANFKT_PE1	
Name of course	Elective course(s) PE1	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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	Elective	
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 11.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	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 11.	
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 11. Learning outcomes

Description of course

Code of course	ANS635	
Name of course	Algorithms and Program for Heat Balances	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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	Specialistic	
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	ANK405 - Theory of Heat Machines	
Limit of students	130	
C. Effects of education and manner of teaching		
Purpose of course	After completing the course, students will acquire professional skills and advanced tools for modeling, simulation and optimization of heat balance energy systems.	
Effects of education	See Table 12.	
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	Commercial programs to balance thermal systems. Installation of energy as an object balancing. The balance of mass, energy and momentum for steady state and transient. Formulation of equations of balance. Automating processes to formulate equations, matrix methods, the use of graphs, object-oriented methods. Methods for solving systems of algebraic and differential equations.	
Methods of evaluation	Project and final test.	
Methods of verification of effects of education	See Table 12.	
Exam	no	
Literature	Manual of Aspen Hysys□, 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 - 35, including: a) attendance at the lectures – 15 godz./hours; b) attendance at the exercises – 15 godz./hours; c) consultancy	

Description of course

	meetings – 5 godz./hours. 2) The number of hours of independent work of student - 20 hours, including: • working on the project - 12 hours; • preparation for final test – 8 hours. TOTAL - 55 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	1,3 ECTS credits – including: a) attendance at the exercises – 15 hours; b) consultancy meetings – 5 hours; c) working on the project - 12 hours.

E. Additional information

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Table 12. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS635_W1**
Description:	Knowledge in the field of mathematical modeling of electrical equipment and installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS635_W1**
Description:	Knowledge in the field of mathematical modeling of electrical equipment and installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANS635_W1**
Description:	Knowledge in the field of mathematical modeling of electrical equipment and installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W06
Area of study related learning outcomes	
Code of effect:	**ANS635_W1**
Description:	Knowledge in the field of mathematical modeling of electrical equipment and installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANS635_W1**
Description:	Knowledge in the field of mathematical modeling of electrical equipment and installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
Code of effect:	**ANS635_W1**
Description:	Knowledge in the field of mathematical modeling of electrical equipment and installations.

Table 12. Learning outcomes	
Verification:	Project, final test.
Field of study related learning outcomes	E2_W17
Area of study related learning outcomes	
Code of effect:	**ANS635_W2**
Description:	Knowledge of balancing energy installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANS635_W2**
Description:	Knowledge of balancing energy installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W06
Area of study related learning outcomes	
Code of effect:	**ANS635_W2**
Description:	Knowledge of balancing energy installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANS635_W2**
Description:	Knowledge of balancing energy installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
Code of effect:	**ANS635_W2**
Description:	Knowledge of balancing energy installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W17
Area of study related learning outcomes	
Code of effect:	**ANS635_W2**
Description:	Knowledge of balancing energy installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS635_W3**
Description:	Knowledge of load distribution optimization of energy systems.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W17
Area of study related learning outcomes	
Code of effect:	**ANS635_W3**
Description:	Knowledge of load distribution optimization of energy systems.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANS635_W3**
Description:	Knowledge of load distribution optimization of energy systems.
Verification:	Project, final test.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power

Table 12. Learning outcomes	
	installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U07
Area of study related learning outcomes	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U22
Area of study related learning outcomes	
Code of effect:	**ANS635_U1**
Description:	Skills of modeling devices and power installations.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ANS635_U2**
Description:	Ability balancing energy systems and optimization of their parameters.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS635_U2**
Description:	Ability balancing energy systems and optimization of their parameters.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANS635_U2**
Description:	Ability balancing energy systems and

Table 12. Learning outcomes	
	optimization of their parameters.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANS635_U2**
Description:	Ability balancing energy systems and optimization of their parameters.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U18
Area of study related learning outcomes	
Code of effect:	**ANS635_U2**
Description:	Ability balancing energy systems and optimization of their parameters.
Verification:	Project, final test.
Field of study related learning outcomes	E2_U22
Area of study related learning outcomes	
Code of effect:	**ANS635_U3**
Description:	Ability to use commercial software for computational modeling issues, balancing and optimization of systems
Verification:	project, final test
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS635_U3**
Description:	Ability to use commercial software for computational modeling issues, balancing and optimization of systems
Verification:	project, final test
Field of study related learning outcomes	E2_U13
Area of study related learning outcomes	
Code of effect:	**ANS635_U3**
Description:	Ability to use commercial software for computational modeling issues, balancing and optimization of systems
Verification:	project, final test
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS635_K1**
Description:	It is capable of advanced computational problem by using additional materials.
Verification:	Project, final test.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANS635_K1**
Description:	It is capable of advanced computational problem by using additional materials.
Verification:	Project, final test.
Field of study related learning outcomes	E2_K04
Area of study related learning outcomes	

Description of course

Code of course	ANS500	
Name of course	Energy Efficiency	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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; dr inż. Jacek Szymczyk	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialistic	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	1 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students	50	
C. Effects of education and manner of teaching		
Purpose of course	Students who successfully complete the course should be able to: • Gain general knowledge on energy efficiency policy in the EU and Poland. • Get familiar with variety of energy efficiency measures applied in industry. • Understand fundamentals of energy management systems and energy audits methodology. • Learn the objectives and methods of the Demand Side Management. • Get familiar with the protocol on energy measurement and verification, including statistical approach to measured data. • Understand basic economics of energy efficiency.	
Effects of education	See Table 13.	
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	NERGY EFFICIENCY BASIC. Basic Concepts Related to Energy Efficiency. Fundamental Definitions. Energy efficiency measures. Role of Energy Efficiency in Economy and Environment Protection. Statistics of energy efficiency. Benefits of Energy Efficiency. Barriers to Energy Efficiency. Legal. Institutional. Financial. Technological. Energy Prices. Diversity of Stakeholders. Potential of Energy Efficiency. Technical. Economic. Market ENERGY EFFICIENCY POLICY IN EU. Energy Efficiency in EU Sustainable Energy Policy. Energy Efficient Scenarios. Strategic EU documents:	

Description of course

	Green Paper on Energy Efficiency. Energy Efficiency Action Plan. Climate Change Program. EU directives on energy efficiency e.g. CHP Directive, Building Performance Directive, Eco Design Directive, Emission Trading Directive, Energy Services Directive, Home Appliances Directives, Taxation of Energy Products Directive, Gas Directive, Electricity Directive. Energy Efficiency in Emission Trading Scheme. BAT on Energy Efficiency. Exemplary Role of the Public Sector. Energy Efficiency and Renewable Energy Sources. Involvement of the Energy Sector. Perspective in the EU. ENERGY EFFICIENCY LAW IN POLAND., Energy Law. Energy Efficiency Law. Secondary legislation. Thermomodernisation Law. National Energy Efficiency Action Plan (NEEAP). ENERGY EFFICIENCY MEASURES. Obligatory and voluntary approach. Long Term Agreements. Role of Companies and Sector Chambers. Energy Services. White Certificate System. Outsourcing. International Standardization and Harmonization. Minimal Energy Efficiency Regulations. Energy Management Systems. Standard EN 16001. Relations Between Different Certificates Schemes. Green Procurement. Energy Fund. Carbon Fund. Energy Conduction Codes: Energy Star, Motor Challenge, Green Buildings, Climate Change Commitments, Green Light. Public Campaigns. Benchmarking. Information and Labeling. Integrated Resource Planning. Definitions. Projections of the End-Use Energy Demand. Fundamentals of Electric Power Planning. Least-Cost Planning Criteria. Electricity Production Costs. Smart metering. Intermittent Renewable Sources. Demand Side Management. Load Curve. Baseline. Energy Pricing. Electricity Tariffs and Energy Efficiency Program Costs. DSM Cost Effectiveness. Case Study. Supply and Demand Sides Integration. Electricity Production Costs. Supply System Integration. Supply Resources Screening. Dispatch Strategies. Supply-Side Loss Reduction. Intermittent RES. Combining DSM and Supply Resources Options. Ranking the Resources Options by Marginal Costs. ENERGY AUDITS. Methodology for energy auditing. Choosing the Calculation Level. Collecting Data. Unitary Gross Annual Energy Savings. Total Gross Annual Energy Savings. Total ESD Annual Energy Savings. Total ESD Annual Energy Savings for Lifetime. Savings Measurements and Verification. International Performance of Measurements and Verification Protocol. Requirements for Energy Audits and Energy Auditors. Accreditation and Certification

Description of course

	Schemes for Energy Auditors. Energy Manager and Energy Auditor. Energy Auditors Trainings. Harmonised Top-Down Calculation Model. Harmonised Bottom-Up Calculation Model. Savings Lifetimes. Monitoring and Reporting. Regular Inspection, Commissioning and Decommissioning. ENERGY EFFICIENCY TECHNOLOGIES. Concept of Clean Energy. Generation. Review of energy efficient technologies. Transport of Energy. End Use of Energy. Energy Efficiency in Electronics and Information and Communication Technologies. Energy Storage. Costs of Technologies. ENERGY EFFICIENCY IN INDUSTRY. Model Energy Efficiency Industrial Plan. Energy Management System Implementation. Practical Approach. Electrical Drives. Lighting. Fans. Pumps. Transport. Electroheating. Energy-Efficiency Measures of Industrial Combined Heat And Power (CHP). District Heating. Waste Heat. Steps to Develop a Project. Case Studies. UNCERTAINITY OF MEASUREMENTS. Errors of Modeling, Sampling and Measurement. Expressing Uncertainty. Basic Statistical Terms. Confidence and Precision Levels. Acceptable Uncertainty. Mean (Y). Variance (S2). Standard Deviation (S). Standard Error (SE). Precision. Modeling. Modeling Errors. Using Out of Range Data. Omission of Relevant Variables. Inclusion of Irrelevant Variables. Sampling. Metering. Combining Components of Uncertainty. Example Uncertainty Analysis. FINANCING OF ENERGY EFFICIENCY INVESTMENTS. Third Party Financing. Energy Performance Contracting. ESCO. Banking instruments. Procedures of Financial Institutions. Grants. Joint Implementation and Energy Efficiency Projects. Revolving Funds. Risk Management. Barriers to Financing. EU Programs. Cohesion Fund. Structural Funds. Energy efficiency in the National Development Program 2014-2020. FUNDAMENTALS OF ECONOMICS OF ENERGY CONSERVATION. Discount Rate. Net Present Rate. Life Cycle Cost. Internal Rate of Return. Simple Payback. Costs of Saved Energy. Costs of Saved Capacity.
Methods of evaluation	Weekly active participation in discussions – ability to present, argue and defend own opinions supported by concrete evidences, e.g. policy documents, statistics, research papers. Tests and quizzes during lectures. Passing all laboratories.
Methods of verification of effects of education	See Table 13.
Exam	no
Literature	1) Swisher J.N., Jannuzzi R.M., Redlinger R.Y.: Integrated Resource Planning, UNEP, 1997. 2)

Description of course

	Third Party Financing, Energy Charter Secretariat, http://www.encharter.org 3) Financing Energy Efficiency, Energy Charter Secretariat, http://www.encharter.org 4) International Performance Measurement and Verification Protocol. Concepts and Options for Determining Energy and Water Savings, Volume 1. Efficiency Valuation Organization, http://www.evo-world.org
Website of the course	http://itc.pw.edu.pl/IT/Moodle

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 - 35, including: a) attendance at the lectures- 15 hours; b) attendance at the labs – 15 hours; c) consultancy meetings – 5 hours. 2) The number of hours of independent work of student: • 10 h to prepare a presentation and prepare for group discussions; • 10 h to prepare for the laboratory and preparing reports of the laboratory. TOTALY: 55 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 labs – 15 hours; c) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	1 ECTS credits, including: a)attendance at the labs – 15 hours; b) The number of hours of independent work of student: 10 h to prepare for the laboratory and preparing reports of the laboratory.

E. Additional information

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Table 13. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK500_W1**
Description:	Student has in-depth knowledge on energy efficiency of machines, devices and technological processes in industry.
Verification:	Active participation in discussions. Making a public presentation (in a group). Tests and quizzes during lectures.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANK500_W2**
Description:	Student understands technical and economic conditions and constraints of energy efficiency improvements in industry.
Verification:	Active participation in discussions. Making a public presentation (in a group). Tests and quizzes during lectures.

Table 13. Learning outcomes	
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANK500_U1**
Description:	Student can prepare a public presentation based on literature research and own laboratory measurements in English.
Verification:	Active participation in discussions. Making a public presentation (in a group). Tests and quizzes during lectures.
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
Code of effect:	**ANK500_U2**
Description:	Student can assess energy efficiency of machines and technological processes and value economic advantages of the energy efficiency improvement applied.
Verification:	Active participation in discussions. Tests and quizzes during lectures. Preparation and defence of laboratory reports.
Field of study related learning outcomes	E2_U17
Area of study related learning outcomes	
Code of effect:	**ANK500_U3**
Description:	Student can in practice assess energy efficiency of machines and technological processes and provide guidance on energy efficiency improvements.
Verification:	Active participation in discussions. Tests and quizzes during lectures. Preparation and defence of laboratory reports.
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK500_ K1**
Description:	Student is aware of importance of energy efficiency in increasing energy security and limiting impact of energy process on the environment
Verification:	Active participation in discussions. Making a public presentation (in a group). Tests and quizzes during lectures.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ANK500_K2**
Description:	Student knows his/her role in the struggle to increase awareness of end users on importance of rational use of energy.
Verification:	Active participation in discussions. Making a public presentation (in a group). Tests and quizzes during lectures.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	

Description of course

Code of course	ML.ANK371	
Name of course	Business Law	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Administration and Social Sciences	
Coordinator of course	dr Dominik Sypniewski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	150	
C. Effects of education and manner of teaching		
Purpose of course	The course aims at introducing students basic concepts of business law. Firstly students are familiarized with basic concepts of jurisprudence, introduction to constitutional law, sources of Polish and European business law. The course covers basic concepts of civil and commercial law, including property law, contracts, intellectual property law partnerships and companies. The last part of course concerns administrative aspects of conducting business activities including: registration in the National Court Register or in the Economic Activity Records; different forms of restrictions: concessions, regulated activities and permissions and finally basic concepts of labour law, competition law and tax law.	
Effects of education	See Table 14.	
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. Introduction to jurisprudence. Basic concepts. 2. Constitutional Law. 3. Sources of Polish and European business law. 4. Civil Law (1) – general provisions. 5. Civil Law (2) – property law. 6. Civil Law (3) – contracts. 7. Civil Law (4) – intellectual property law. 8. Partnerships. 9. Companies. 10. The National Court Register & the Economic Activity Records. 11. Concessions, Regulated Activities and Permissions. 12. Labour Law. 13.	

Description of course

	Competition Law. 14. Introduction to tax law.
Methods of evaluation	mutiple choice test
Methods of verification of effects of education	See Table 14.
Exam	no
Literature	1. M. Możdzeń-Marcinkowski, Introduction to Polish Administrative Law, C.H. Beck, Warsaw 2009. 2. J. Jabłońska-Błońca, Introduction to Law, LexisNexis, Warsaw 2008. 3. R. Lewandowski, Polish Commercial Law: An Introduction, C.H. Beck 2007. 4. Documents and slideshows delivered by the 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 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 - 15 hours; • Preparing for final test - 6 hours; • Homework – 5 hours. TOTAL: 53 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,3 ECTS credits – number of 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	-

E. Additional information

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Table 14. Learning outcomes

General academic profile - knowledge

Code of effect:	**ML.ANK371_W01**
Description:	Student has a basic knowledge of the legal aspects of doing business.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_W01**
Description:	Student has a basic knowledge of the legal aspects of doing business.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_W02**
Description:	Student has a basic knowledge of various forms of conducting business activity and contracts in business.
Verification:	Multiple choice test.

Table 14. Learning outcomes	
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_W02**
Description:	Student has a basic knowledge of various forms of conducting business activity and contracts in business.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_W22
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_W03**
Description:	Student knows and understands the basic concepts and principles of the protection of industrial property and copyright law.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_W03**
Description:	Student knows and understands the basic concepts and principles of the protection of industrial property and copyright law.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_W21
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANK371_U01**
Description:	Student can obtain information on the regulation in the field of business activity and determinants of business activity.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_U23
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_U01**
Description:	Student can obtain information on the regulation in the field of business activity and determinants of business activity.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANK371_K01**
Description:	Student is aware of the legal environment of business and rules of liability in business.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_K01**
Description:	Student is aware of the legal environment of business and rules of liability in business.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**ML.ANK371_K02**
Description:	Student is aware of the diversity of legal forms of business and can choose the form appropriate

Table 14. Learning outcomes	
	for a specific type of business.
Verification:	Multiple choice test.
Field of study related learning outcomes	E2_K06
Area of study related learning outcomes	

Description of course

Code of course	ANK385	
Name of course	Neural Networks	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering	
Coordinator of course	dr inż. Cezary Rzymkowski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	To provide an overview of artificial neural networks – fundamentals, methods and modern application.	
Effects of education	See Table 15.	
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	Lectures - list of topics: - Feedforward neural networks with supervised and unsupervised training. - Recurrent neural networks. - Some applications of neural networks to various areas of engineering. - Modeling with neural networks: principles and model design methodology. - Neural Identification of controlled dynamical systems and recurrent networks. - Closed-loop control learning. - Discrimination (clasification) . - Self-organizing maps and unsupervised classification. - Neural networks for optimization.	
Methods of evaluation	One midterm and final tests. Final grade based on achieved number of points (40% - midterm test, 60% - final test).	
Methods of verification of effects of education	See Table 15.	
Exam	no	
Literature	Dreyfus G.: Neural Networks - Methodology and Applications, Springer-Verlag Berlin Heidelberg 2005. Handouts distributed by teacher or available at: http://tmr.meil.pw.edu.pl (zakładka Dla Studentów)	

Description of course

Website of the course	http://tmr.meil.pw.edu.pl (zakładka Dla Studentów)

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- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student • Systematic preparation for classes - 20 hours; • Preparing for midterm test -10 hours; • Preparing for final test - 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- 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 15. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK385_W1**
Description:	Student knows basic ideas and knows how to use them in design of artificial neural networks .
Verification:	Test 1.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK385_W2**
Description:	Student knows priciples of design of linear and nonlinear (also multilayer) artificial unidirectional networks.
Verification:	Test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK385_W3**
Description:	Student knows how to construct artificial networks with feedback, including Hopfield networks.
Verification:	Test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK385_W4**
Description:	Student knows principles and methods of teaching various kinds of the networks.
Verification:	Test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK385_W5**
Description:	Student has basic knowledge on the genetic

Table 15. Learning outcomes	
	algorithms.
Verification:	Test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANK385_W6**
Description:	Student has basic knowledge about areas od possible applications of artificial neural networks, including the control systems.
Verification:	Test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANK385_U1**
Description:	Student is able to recognize/indicate a technical problem appropriate to be solved by means of neural networks.
Verification:	Test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANK385_U2**
Description:	Student is able to design a teaching algorithms for a simple network.
Verification:	Test.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ANK385_U3**
Description:	Student is able to use a genetic algorithm to solve an optimization problem.
Verification:	Test.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	
Code of effect:	**ANK385_U4**
Description:	Student is capable of finding in the literature and Internet information needed to design a network having an appropriate structure for a given problem.
Verification:	Test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	

Description of course

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

Description of course

	the semester.
Methods of verification of effects of education	See Table 16.
Exam	no
Literature	Recommended reading for extended knowledge might be selected chapters from: 1. Woodhouse N.M.J.: Special Relativity. Springer 2003. 2. Hayt W.H., Buck J.A.: Engineering Electromagnetics. 8th ed., McGraw-Hill, 2012. 3. Griffiths D.J.: Introduction to Electrodynamics, 4th Ed. Addison-Wesley, 2012. 4. Zangwill A.: Modern electrodynamics. Cambridge UP, 2012.
Website of the course	

D. Student's activity

Number of ECTS credits	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 hours, including: a) attendance at the lectures -30 hours; b) consultancy meetings - 3 hours. 2) The number of hours of independent work of student – 42 hours, including: Preparation to lectures (based of the recommended reading) – 18 h Preparation to the tests: 2*12=24 h Total workload 75 hours
Number of ECTS credits on the course with direct participation of academic teacher	1.3 ECTS credits – number of hours that require the presence of a teacher – 33, including: a) attendance at the lectures – 30 hours; b) consultancy meetings - 3 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 16. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK480_W01**
Description:	Student has a basic, systematic knowledge on electromagnetic and optical phenomena, sufficient to understand principles of operation of typical measuring and diagnostic devices.
Verification:	Test no. 2
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANK480_W02**
Description:	Student has a basic knowledge on space-time structure, symmetry concepts and their relation to conservation principles formulated for fundamental physical quantities and fields.
Verification:	Test no. 1
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANK480_U01**

Table 16. Learning outcomes	
Description:	Student can use the physical principles to solve simple problems in the relativistic mechanics and wave optics.
Verification:	Tests no. 1 and 2.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
Code of effect:	**ANK480_U02**
Description:	Student can use the physical principles to solve simple problems in the relativistic mechanics and wave optics
Verification:	Tests no. 2
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
Code of effect:	**ANK480_U03**
Description:	Student van explain principles of operation of typical devices which are using wave optical phenomena and understands implied capabilities.
Verification:	Tests no. 2
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK480_K01**
Description:	Student is aware of the necessity for continuous skill/knowledge development by a self-study, needed in order to follow recent progress in science-based technologies.
Verification:	Interaction with student during lectures and consultancy meetings.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	

Description of course

Code of course	ANS599	
Name of course	Statistical and Nonequilibrium Thermodynamics	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering.	
Coordinator of course	prof. dr hab. inż. Tomasz Wiśniewski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	Thermodynamics 1 (ML.ANW116); Thermodynamics 3 (ML.ANK413).	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	Knowledge of link between microscopic, statistical phenomena and macroscopic behaviour of materials. Knowledge of cross-effects and their applications.	
Effects of education	See Table 17.	
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. Fundamentals of kinetic theory of gases and transport theory. 2. Boltzmann equation. 3. Microstate and macrostate. 4. Classical and quantum statistics. Partition function. 5. Statistical interpretation of thermodynamic functions. 6. Local formulation of the 2nd Law of Thermodynamics. 7. Postulates of the linear non-equilibium thermodynamics. Generalized forces and fluxes. 8. Onsager's and Curie's principles. Properties of stationary states. Cross-effects. 9. Thermo-diffusion and Dufour effect. 10 Thermoelectric phenomena. 11. Non-equilibrium phase transitions. Wilson line. Tutorials: 1. Examples of electro-kinetic applications. 2. Examples of thermoelectric applications, 3. Examples of thermionic applications. and thermo-electromagnetic applications.	
Methods of evaluation	Two tests - solution of two complex problems in	

Description of course

	statistical and non-equilibrium thermodynamics.
Methods of verification of effects of education	See Table 17.
Exam	no
Literature	1) T.L. Hill: “An Introduction to Statistical Thermodynamics”. 2) A. Bejan: “Advanced Engineering Thermodynamics”, John Wiley & Sons, Inc. 3) D.V. Ragone: “Thermodynamics of Materials”, John Wiley & Sons, Inc. 4) 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 - 20 hours; • preparing for test - 20 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

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Table 17. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS599_W1**
Description:	Student knows basis for the application of mathematical statistics to describe the behavior of matter and physical processes associated with thermodynamics.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics, test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS599_W2**
Description:	Knows the impact of the atomic structure and probability distributions for different particles on the macroscopic properties of selected substances.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANS599_W3**

Table 17. Learning outcomes	
Description:	Student knows the principles of nonequlibrium and statistical thermodynamics, the occurrence of cross effects and the effects associated with lack of thermodynamic equilibrium in the selected devices and processes.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.
Field of study related learning outcomes	E2_W06
Area of study related learning outcomes	
Code of effect:	**ANS599_W4**
Description:	Student knows the basis of application of exergy in multicomponent systems.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS599_U1**
Description:	Student can obtain from the literature and the Internet information about the applications of statistical thermodynamics and complex non-equilibrium processes.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS599_U2**
Description:	Student is able to prepare a report presenting the solution of a problem regarding statistical thermodynamics and non-equilibrium thermodynamics with the corresponding description.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
Code of effect:	**ANS599_U3**
Description:	Student can determine the directions of further studies to use of statistical and non-equilibrium thermodynamics for descrption of thermal processes.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANS599_U4**
Description:	Student has the ability to bind the properties of matter at the microscopic level (atoms, molecules) with selected properties at the macroscopic level (continuum) and the analysis of cross effects occurring in different types of applications.
Verification:	Solution of two complex problems in statistical and non-equilibrium thermodynamics.

Table 17. Learning outcomes	
Field of study related learning outcomes	E2_U11
Area of study related learning outcomes	

Description of course

Code of course	ANFKT_PE2	
Name of course	Elective course(s) NPE2	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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	Nuclear Power Engineering	
Group of courses	Elective	
Type of course	Elective	
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 18.	
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 18.	
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 18. Learning outcomes

Description of course

Code of course	ANS667	
Name of course	Contemporary Nuclear Reactor Systems (LWR, HWR)	
Version of course	2013	

A. Place of the course in system of studies

Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Rafał Laskowski	

B. General characteristic of the course

Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	1. Knowledge of methods of energy conversion. 2. Knowledge of the basic processes of energy.	
Limit of students		

C. Effects of education and manner of teaching

Purpose of course	Nuclear reactors: history and presence. Classification of nuclear reactors. Types of nuclear reactors. Idea, working parameters and design of a pressurised water reactor (PWR). PWR control and power control. Basics of mathematical modelling for PWRs. Latest PWR safety solutions and systems. Idea, working parameters, design and power control of a boiling water reactor (BWR). Idea, working parameters, design and power control of a heavy water reactor (HWR). Reactor building materials. PWR, BWR and HWR behaviour during reactivity accidents. Idea, working parameters and design of a research reactor. PWR, BWR and CANDU simulators.	
Effects of education	See Table 19.	
Form of didactic studies and number of hours per semester	Lecture	45h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	L1. History and development of nuclear reactors. Role of nuclear power engineering globally and in selected countries. Basic types of nuclear reactors. Classification of nuclear reactors according to the type of fission reaction, coolant, fuel and purpose (3h). L2-5. Pressurised water reactor (PWR): design, idea, diagrams, performance, working parameters, fuel elements and core design, auxiliary systems and devices,	

Description of course

	reactor performance limits. Role and functions of common primary and secondary circuit machines and devices (pressurizer, pump, steam generator, turbine, condenser, steam separator, reheater). Power plant working parameters: T-s and h-s diagrams. Various types of containments (12h). L6. PWR power control systems (3h). L7. Basics of mathematical modelling for a PWR. Calculations of the reactor power, pump performance, and coolant mass flow rate (3h). L8. Presentation of third-generation reactors with a focus on EPR, AP600/1000, WWER (AES) and ATMEA, and of boiling water reactors ABWR, ESBWR and KERENA, including their basic safety features (3h). L9. Students' presentations on PWRs (3h). L10. Design, idea and diagrams of boiling water reactors (BWR). BWR power control, working parameters, auxiliary systems and devices, and containment (3h). L11. Design, idea and diagrams of heavy water reactors (HWR). HWR power control, working parameters, auxiliary systems and devices, and containment (3h). L12. Reactor building materials and their properties (3h). L13. Reactivity accidents. PWR, BWR and CANDU simulators (3h). L14. Research reactors (3h). L15. Students' presentations on BWRs and HWRs (3h).
Methods of evaluation	Assessment of students' presentations on topics concerning PWR, BWR and HWR. P1 -Final Test (examination).
Methods of verification of effects of education	See Table 19.
Exam	yes
Literature	1. Pressurized Water Reactor (PWR), Reactor Concepts Manual, USNRC Technical Training Center. 2. R. T. Lahey, F. J. Moody "The Thermal-Hydraulics of a Boiling Water Nuclear Reactor". 3. ABWR – general discription. 4. http://www.areva.com. 5. www.areva-np.com / BROCHURE-EPR-US-2.pdf. 6. www.iaea.org. 7. https://canteach.candu.org/Pages/Welcome.aspx. 8. Presentations of the lectures (http://itc.pw.edu.pl/materialy).
Website of the course	-

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 50, including: a) attendance at the lectures- 45 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 15 hours; • preparing for exam -10 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)

Description of course

	attendance at the lectures- 45 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 19. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS667_W1**
Description:	Understanding of basic types of PWR, BWR, and HWR nuclear reactors.
Verification:	Test/exam.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W2**
Description:	Understanding the structure, heat diagrams, working parameters, performance, and limitations of the reactors, as well as materials used to build them.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W2**
Description:	Understanding the structure, heat diagrams, working parameters, performance, and limitations of the reactors, as well as materials used to build them.
Verification:	Test/exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS667_W3**
Description:	Familiarisation with the latest solutions concerning safety systems.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W3**
Description:	Familiarisation with the latest solutions concerning safety systems.
Verification:	Test/exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS667_W4**
Description:	Understanding the structure concept of basic types of PWR, BWR, and HWR nuclear reactors.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W5**
Description:	Understanding the mechanism of power control

Table 19. Learning outcomes	
	in the reactors.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W6**
Description:	Understanding the purposes, functions and designs of research reactors.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W6**
Description:	Understanding the purposes, functions and designs of research reactors.
Verification:	Test/exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS667_W7**
Description:	Familiarisation with PWR, BWR and CANDU simulators.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W8**
Description:	Understanding of third-generation reactors and their development lines.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS667_W9**
Description:	Knowledge of reactor building materials and their properties.
Verification:	Test/exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS667_U1**
Description:	Ability to perform basic calculations, e.g. of a reactor and pump power.
Verification:	Final test.
Field of study related learning outcomes	E2_U22
Area of study related learning outcomes	
Code of effect:	**ANS667_U1**
Description:	Ability to perform basic calculations, e.g. of a reactor and pump power.
Verification:	Final test.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANS667_U2**
Description:	Ability to perform a simulation using a PWR, BWR and CANDU simulator, and to interpret and verify its results.
Verification:	Final test.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	

Table 19. Learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS667_K1**
Description:	Knows how to convey knowledge of nuclear reactors.
Verification:	Final test.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	

Description of course

Code of course	ANS673	
Name of course	Nuclear Fuels and Fuel Cycles	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	The Faculty of Power and Aeronautical Engineering	
Coordinator of course	dr inż. Grzegorz Niewiński	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ML.ANS671 Contemporary nuclear reactor systems (LWR, HWR)	
Limit of students	-	
C. Effects of education and manner of teaching		
Purpose of course	Introduction to the nuclear fuel cycle.	
Effects of education	See Table 20.	
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	Fissile nuclides, resources. Uranium ore processing, enrinchment methods. Metalic vs. ceramic fuel. Fertile nuclides, resources. Production of fis sile isotopes In nu clear reactors. Separation of fissile isotopes from spent fuel. Closed and open fuel cycles. Storage and transport of fresh fuel, spent fuel and radioactive waste. Transmutation of radioactive waste.	
Methods of evaluation	Final test.	
Methods of verification of effects of education	See Table 20.	
Exam	no	
Literature	Material from lecture.	
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 - 35, including: a) attendance at the lectures- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for classes - 10 hours; • preparing for final test -10 hours. TOTAL – 55 hours.	

Description of course

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- 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 20. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS673_W1**
Description:	Knowledge about nuclear fuel cycle, components and classification.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS673_W2**
Description:	Knowledge about nuclear fuels (shape, type, material. enchirement) and what facters determine them.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS673_W2**
Description:	Knowledge about nuclear fuels (shape, type, material. enchirement) and what facters determine them.
Verification:	Final test.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANS673_W2**
Description:	Knowledge about nuclear fuels (shape, type, material. enchirement) and what facters determine them.
Verification:	Final test.
Field of study related learning outcomes	E2_W12
Area of study related learning outcomes	
Code of effect:	**ANS673_W3**
Description:	Knowledge about nuclear resources, methods of exploration and exploitation of energy resources.
Verification:	Final test.
Field of study related learning outcomes	E2_W12
Area of study related learning outcomes	
Code of effect:	**ANS673_W3**
Description:	Knowledge about nuclear resources, methods of exploration and exploitation of energy resources.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS673_W4**

Table 20. Learning outcomes	
Description:	Knowledge about methods of conversion nuclear fuels and fuel enrichement strategy criteria.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS673_W4**
Description:	Knowledge about methods of conversion nuclear fuels and fuel enrichement strategy criteria.
Verification:	Final test.
Field of study related learning outcomes	E2_W12
Area of study related learning outcomes	
Code of effect:	**ANS673_W5**
Description:	Knowledge about manuacturing methods of nuclear fuel for different reactor types.
Verification:	Final test.
Field of study related learning outcomes	E2_W04
Area of study related learning outcomes	
Code of effect:	**ANS673_W5**
Description:	Knowledge about manuacturing methods of nuclear fuel for different reactor types.
Verification:	Final test.
Field of study related learning outcomes	E2_W12
Area of study related learning outcomes	
Code of effect:	**ANS673_W5**
Description:	Knowledge about manuacturing methods of nuclear fuel for different reactor types.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS673_W6**
Description:	Knowledge about burned fuel and itc conversion and assembly.
Verification:	Final test.
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS673_W6**
Description:	Knowledge about burned fuel and itc conversion and assembly.
Verification:	Final test.
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	
Code of effect:	**ANS673_W6**
Description:	Knowledge about burned fuel and itc conversion and assembly.
Verification:	Final test.
Field of study related learning outcomes	E2_W12
Area of study related learning outcomes	
Code of effect:	**ANS673_W6**
Description:	Knowledge about burned fuel and itc conversion and assembly.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	

General academic profile - skils

Table 20. Learning outcomes	
Code of effect:	**ANS673_U1**
Description:	Skills to calculate required amount of fuel in the fuel cycle.
Verification:	Final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS673_U1**
Description:	Skills to calculate required amount of fuel in the fuel cycle.
Verification:	Final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS673_U1**
Description:	Skills to calculate required amount of fuel in the fuel cycle.
Verification:	Final test.
Field of study related learning outcomes	E2_U17
Area of study related learning outcomes	
Code of effect:	**ANS673_U1**
Description:	Skills to calculate required amount of fuel in the fuel cycle.
Verification:	Final test.
Field of study related learning outcomes	E2_U26
Area of study related learning outcomes	
Code of effect:	**ANS673_U2**
Description:	Skills to determine procedures of handling nuclear fuels and nuclear waste.
Verification:	Final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS673_U2**
Description:	Skills to determine procedures of handling nuclear fuels and nuclear waste.
Verification:	Final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS673_U3**
Description:	Skills to choose optimal enrichment ferl technology and strategy of manufacturing fuel.
Verification:	Final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS673_U3**
Description:	Skills to choose optimal enrichment ferl technology and strategy of manufacturing fuel.
Verification:	Final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS673_U3**
Description:	Skills to choose optimal enrichment ferl technology and strategy of manufacturing fuel.
Verification:	Final test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	

Table 20. Learning outcomes	
Code of effect:	**ANS673_U3**
Description:	Skills to choose optimal enrichment ferl technology and strategy of manufacturing fuel.
Verification:	Final test.
Field of study related learning outcomes	E2_U17
Area of study related learning outcomes	
Code of effect:	**ANS673_U3**
Description:	Skills to choose optimal enrichment ferl technology and strategy of manufacturing fuel.
Verification:	Final test.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANS673_U3**
Description:	Skills to choose optimal enrichment ferl technology and strategy of manufacturing fuel.
Verification:	Final test.
Field of study related learning outcomes	E2_U22
Area of study related learning outcomes	
Code of effect:	**ANS673_U4**
Description:	Knows how to work in a group and present their results.
Verification:	Presentation, oral response.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS673_U4**
Description:	Knows how to work in a group and present their results.
Verification:	Presentation, oral response.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS673_U4**
Description:	Knows how to work in a group and present their results.
Verification:	Presentation, oral response.
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANS673_U4**
Description:	Knows how to work in a group and present their results.
Verification:	Presentation, oral response.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS673_K1**
Description:	Able to assess the impact of NPP on the environment and pass this knowledge to people not connected with the specialty.
Verification:	Final test, oral response.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	

Description of course

Code of course	ANS671	
Name of course	Nuclear Reactor Modeling and Simulation	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Rafał Laskowski	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	To familiarize students with the processes of nuclear and specifications of thermal-hydraulic processes occurring in the reactor.. Identify methods of deterministic and stochastic in modeling of nuclear processes. Familiarize students with specific, structure and operation of modern nuclear codes and putting them to use. Performance modeling of thermal-hydraulic processes in nuclear reactors. To familiarize students with the specificity, structure and operation thermal-hydraulic codes for nuclear reactors. To familiarize students with the construction and operation of simple nuclear reactors simulators.	
Effects of education	See Table 21.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	15h
	Laboratory	30h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Introduction. Nuclear reactions occurring in the reactor. The deterministic approach in solving neutron transport problems. Approximate methods. Nuclear databases. Construction of the deterministic modern codes. Stochastic approach in reactor physics. Monte Carlo method. Construction of modern stochastic codes. Mass, momentum and energy balance equations for closed and open systems- lumped parameter model in steady and transient state. Pressure drops and pressure loss coefficients during the	

Description of course

	flow of fluids. Mass, momentum and energy balance equations in the differential form. Laminar and turbulent flow. The flow of a compressible single-phase fluid from the tank. Critical flow for single-phase and two-phase fluids (Moody Model and Fauske Model). Heat transfer for single and two-phase flows, heat transfer during boiling, critical heat flux. Natural convection and circulation. Thermal - hydraulic analysis of reactor core. Mass, momentum and energy balance equations for two-phase flows. Classification of two-phase flows. Instability in two-phase flow. Mathematical model of primary loop of PWR including pressurizer. Mathematical model of BWR. Methods of numerical solutions of thermal-hydraulic problems. Examples of computational codes.
Methods of evaluation	Final test.
Methods of verification of effects of education	See Table 21.
Exam	no
Literature	1. E.E. Lewis "Fundamentals of Nuclear Reactor Physics". 2. N.E. Todreas "Nuclear Systems I - Thermal Hydraulic Fundamentals". 3. N.E. Todreas "Nuclear Systems II - Elements of Thermal Hydrolic Design". 4. R.L. Murray "Nuclear Energy, An Introduction to the Concepts, Systems, and Applications of Nuclear Processes". 5. Materials provided by the lecturer.
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 - 80, including: a) attendance at the lectures- 30 hours; b) attendance at the exercises – 15 hours; c) attendance at the labs - 30 hours; d) consultancy meetings - 5 hours. 2) The number of hours of independent work of student • systematic preparation for the lectures - 25 hours; • systematic preparation for the exercises - 15 hours; • systematic preparation for the labs - 20 hours; • preparing for final test- 15 hours. TOTAL – 155 hours.
Number of ECTS credits on the course with direct participation of academic teacher	3,2 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 – 15 hours; c) attendance at the labs - 30 hours; d) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	2 ECTS credits, including: • attendance at the labs - 30 hours; • systematic preparation for the labs - 20 hours.

E. Additional information

Description of course

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Table 21. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS671_W1**
Description:	The student knows the mechanisms of interaction of neutrons with matter and nuclear reactions induced by neutrons.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W2**
Description:	The student knows the basic principles and concepts of neutron transport issues and forms of the neutron transport equations.
Verification:	Final test.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANS671_W2**
Description:	The student knows the basic principles and concepts of neutron transport issues and forms of the neutron transport equations.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W3**
Description:	The student knows the description of a nuclear reactor, based on approximately one-grouped diffusion, and the basics of the theory of homogeneous reactor, including definitions of the neutron multiplication factor, reactivity, critical dimensions, the critical state.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W4**
Description:	The student knows the causes and effects of changes in reactivity during reactor operation and the physical processes behind the determination of temperature coefficient of reactivity.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W5**
Description:	The student has knowledge of the methods of mathematical modeling in nuclear reactors.
Verification:	Final test
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W6**
Description:	The student has the knowledge and skills in the

Table 21. Learning outcomes	
	use of comercial codes for nuclear calculations.
Verification:	Final test
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS671_W6**
Description:	The student has the knowledge and skills in the use of comercial codes for nuclear calculations.
Verification:	Final test
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W7**
Description:	The student has skills in the use of modern thermal-hydraulic codes for nuclear reactors.
Verification:	Final test
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS671_W7**
Description:	The student has skills in the use of modern thermal-hydraulic codes for nuclear reactors.
Verification:	Final test
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS671_U1**
Description:	The student can perform calculations for macroscopic cross sections for individual reactions induced by neutrons.
Verification:	Final test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS671_U2**
Description:	The student is able to model the processes occurring in a nuclear reactor, and evaluate (simulate) the impact of changes in the main parameters.
Verification:	Final test.
Field of study related learning outcomes	E2_U23
Area of study related learning outcomes	
Code of effect:	**ANS671_U2**
Description:	The student is able to model the processes occurring in a nuclear reactor, and evaluate (simulate) the impact of changes in the main parameters.
Verification:	Final test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS671_U3**
Description:	The student has abilities and skills in thermal-flow modeling.
Verification:	Final test.
Field of study related learning outcomes	E2_U21
Area of study related learning outcomes	
Code of effect:	**ANS671_U3**
Description:	The student has abilities and skills in thermal-

Table 21. Learning outcomes	
	flow modeling.
Verification:	Final test.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	

Description of course

Code of course	ANS666	
Name of course	Nuclear Reactor Physics	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Nikołaj Uzunow	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANS664 Elements of Nuclear Physics.	
Limit of students	15	
C. Effects of education and manner of teaching		
Purpose of course	1. To present the physical base of the processes taking place in nuclear reactor cores. 2. To present the main quantities used for their description. 3. To present the process of neutron transport. 4. To present the reactor in a critical state. 5. To present the changes in reactivity during reactor operation. 6. To present the fundamentals of nuclear reactor kinetics and dynamics.	
Effects of education	See Table 22.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	15h
	Laboratory	30h
	Project type of course	0h
	Computer lessons	0h
Contents of education	Lectures Neutron-induced nuclear reactions. Microscopic cross-sections. Materials used in nuclear technology. Basic quantities in reactor physics. Neutron transport, incl. diffusion approximation and energy discretisation. Critical reactor. Neutron multiplication factor. Critical dimensions. Reactivity. Changes in reactivity during operation. Temperature reactivity factor. Delayed neutrons. Reactor kinetics. Reactor dynamics. Exercises Calculations on basic neutron-related and reactor-related quantities (e.g. macroscopic cross-sections, neutron multiplication factor, etc.). Laboratory (on the MARIA reactor): Control rods’ reactivity weight. Fast and thermal neuron flux. Radioactivity release from reactor building. Cooling system performance. Reactor	

Description of course

	simulator.
Methods of evaluation	Exercises: calculation homework based on calculations performed during exercises. Laboratory: report from the performed exercises on the MARIA reactor. Lectures: examination. The final grade is a combination of the grades from the exam, homework, and laboratory reports.
Methods of verification of effects of education	See Table 22.
Exam	no
Literature	1. E. E. Lewis: Fundamentals of Nuclear Reactor Physics. Elsevier, 2008. 2. H. Anglart: Applied Reactor Technology, OWPW, Warszawa, 2013.
Website of the course	estudia.meil.pw.edu.pl

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 - 80, including a) attendance at the lectures- 30 hours; b) attendance at the exercises – 15 hours; c) attendance at the labs - 30 hours; d) consultancy meetings - 5 hours. 2) The number of hours of independent work of student • systematic preparation for the lectures - 25 hours; • systematic preparation for the exercises - 15 hours; • systematic preparation for the labs - 20 hours; • preparing for final test - 15 hours. TOTAL – 155 hours.
Number of ECTS credits on the course with direct participation of academic teacher	3,2 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 – 15 hours; c) attendance at the labs - 30 hours; d) consultancy meetings - 5 hours..
Number of ECTS credits on practical activities on the course	2 ECTS credits, including: • attendance at the labs - 30 hours; • systematic preparation for the labs - 20 hours.

E. Additional information

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Table 22. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS666_W1**
Description:	Knowledge of mechanisms of interaction of neutrons with matter and nuclear reactions induced by neutrons.
Verification:	Exam, home work.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	

Code of effect:	**ANS666_W1**
Description:	Knowledge of mechanisms of interaction of neutrons with matter and nuclear reactions induced by neutrons.

Table 22. Learning outcomes	
Verification:	Exam, home work.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W10**
Description:	Knows the share of delayed neutrons and their role in controlling the chain reaction and the concepts and principles description of the dynamics of nuclear reactors.
Verification:	Exam, laboratory reports.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W10**
Description:	Knows the share of delayed neutrons and their role in controlling the chain reaction and the concepts and principles description of the dynamics of nuclear reactors.
Verification:	Exam, laboratory reports.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W2**
Description:	Knowledge mechanism and the balance of the chain reaction, the necessary conditions for the implementation of chain reactions and nuclides in the participating.
Verification:	Exam, home work.
Field of study related learning outcomes	E2_W11
Area of study related learning outcomes	
Code of effect:	**ANS666_W2**
Description:	Knowledge mechanism and the balance of the chain reaction, the necessary conditions for the implementation of chain reactions and nuclides in the participating.
Verification:	Exam, home work.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W3**
Description:	Knowledge of fundamental assumption of neutron transport theory.
Verification:	Exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W3**
Description:	Knowledge of fundamental assumption of neutron transport theory.
Verification:	Exam.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS666_W3**
Description:	Knowledge of fundamental assumption of neutron transport theory.
Verification:	Exam.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W4**

Table 22. Learning outcomes	
Description:	Knowledge of theoretical fundaments of neutron transport equations simplification i.e. PN, P1 and dyfussion.
Verification:	Exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W4**
Description:	Knowledge of theoretical fundaments of neutron transport equations simplification i.e. PN, P1 and dyfussion.
Verification:	Exam.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS666_W4**
Description:	Knowledge of theoretical fundaments of neutron transport equations simplification i.e. PN, P1 and dyfussion.
Verification:	Exam.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W5**
Description:	Knows the mechanism of slowing down neutrons in the matter and issue the so-called. capture resonance.
Verification:	Exam, home work.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W5**
Description:	Knows the mechanism of slowing down neutrons in the matter and issue the so-called. capture resonance.
Verification:	Exam, home work.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W6**
Description:	Knows the mechanism of thermal neutron scattering and conditions of thermal equilibrium and thermal neutron transport equation.
Verification:	Exam.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W6**
Description:	Knows the mechanism of thermal neutron scattering and conditions of thermal equilibrium and thermal neutron transport equation.
Verification:	Exam.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W7**
Description:	Knows the description of a nuclear reactor, based on approximately jednogrupowym diffusion, and the basis of the theory of homogeneous reactor, including the definitions of the neutron multiplication factor, reactivity, critical

Table 22. Learning outcomes	
	dimensions, the critical state.
Verification:	Exam, homework, laboratory reports.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W7**
Description:	Knows the description of a nuclear reactor, based on approximately jednogrupowym diffusion, and the basis of the theory of homogeneous reactor, including the definitions of the neutron multiplication factor, reactivity, critical dimensions, the critical state.
Verification:	Exam, homework, laboratory reports.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W8**
Description:	Knows the causes and effects of changes in reactivity during operation of the reactor and the physical processes behind the term of reactivity temperature coefficient.
Verification:	Exam, homework, laboratory reports.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W8**
Description:	Knows the causes and effects of changes in reactivity during operation of the reactor and the physical processes behind the term of reactivity temperature coefficient.
Verification:	Exam, homework, laboratory reports.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS666_W9**
Description:	Familiar with the basic theory of perturbations and issues describe the kinetics of nuclear reactors.
Verification:	Exam, laboratory reports.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS666_W9**
Description:	Familiar with the basic theory of perturbations and issues describe the kinetics of nuclear reactors.
Verification:	Exam, laboratory reports.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS666_U1**
Description:	Can perform a simple calculation of the efficiency of slowing down neutrons in thermal reactors.
Verification:	Homework.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS666_U1**
Description:	Can perform a simple calculation of the

Table 22. Learning outcomes	
	efficiency of slowing down neutrons in thermal reactors.
Verification:	Homework.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS666_U1**
Description:	Can perform a simple calculation of the efficiency of slowing down neutrons in thermal reactors.
Verification:	Homework.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANS666_U2**
Description:	Able to carry out simple calculations the parameters of the reactor in a critical condition.
Verification:	Homework.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS666_U2**
Description:	Able to carry out simple calculations the parameters of the reactor in a critical condition.
Verification:	Homework.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	
Code of effect:	**ANS666_U2**
Description:	Able to carry out simple calculations the parameters of the reactor in a critical condition.
Verification:	Homework.
Field of study related learning outcomes	E2_U14
Area of study related learning outcomes	
Code of effect:	**ANS666_U3**
Description:	Able to prepare and carry out the measurement of the neutron flux and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS666_U3**
Description:	Able to prepare and carry out the measurement of the neutron flux and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS666_U3**
Description:	Able to prepare and carry out the measurement of the neutron flux and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS666_U3**
Description:	Able to prepare and carry out the measurement of the neutron flux and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	

Table 22. Learning outcomes	
Code of effect:	**ANS666_U4**
Description:	He knows how to plan and carry out the measurement of the release of gases and aerosols in the reactor building and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS666_U4**
Description:	He knows how to plan and carry out the measurement of the release of gases and aerosols in the reactor building and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ANS666_U4**
Description:	He knows how to plan and carry out the measurement of the release of gases and aerosols in the reactor building and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS666_U4**
Description:	He knows how to plan and carry out the measurement of the release of gases and aerosols in the reactor building and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS666_U5**
Description:	Able to prepare and carry out the measurement of the reactivity of the control rods of a nuclear reactor and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS666_U5**
Description:	Able to prepare and carry out the measurement of the reactivity of the control rods of a nuclear reactor and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS666_U5**
Description:	Able to prepare and carry out the measurement of the reactivity of the control rods of a nuclear reactor and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS666_U5**

Table 22. Learning outcomes	
Description:	Able to prepare and carry out the measurement of the reactivity of the control rods of a nuclear reactor and interpret the results.
Verification:	Laboratory reports.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS666_K1**
Description:	He is aware of the complexity of the processes occurring in nuclear reactors and the associated need for nuclear energy in the best technologies and highest quality standards.
Verification:	Exam.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANS666_K1**
Description:	He is aware of the complexity of the processes occurring in nuclear reactors and the associated need for nuclear energy in the best technologies and highest quality standards.
Verification:	Exam.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	

Description of course

Code of course	ANFKT_PE2	
Name of course	Elective course(s) PE2	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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	Elective	
Type of course	Elective	
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 23.	
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 23.	
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 23. Learning outcomes

Description of course

Code of course	ANS645
Name of course	Advanced Heat Transfer
Version of course	2013.

A. Place of the course in system of studies

Level of education	Second cycle studies
Form and mode of studies	full-time
Profile of studies	General academic profile
Specialisation	Power Engineering
Place of teaching of course	Faculty of Power and Aeronautical Engineering
Place of realization of course	The Faculty of Power and Aeronautical Engineering
Coordinator of course	Prof. Piotr Furmański

B. General characteristic of the course

Block of courses	Power Engineering
Group of courses	Specialistic
Type of course	Compulsory
Language of course	angielski
Nominal semester	2 (r.a. 2019/2020)
Time of completion in the academic year	winter semester
Preliminary requirements	Fluid Mechanics 1 (ML.ANW122). Heat Transfer 1 (ML.ANK423). Thermodynamics 1 (ML.ANW116). Thermodynamics 2 (ML.ANK412). Thermodynamics 3 (ML.ANK413).
Limit of students	

C. Effects of education and manner of teaching

Purpose of course	Knowledge of complex, conjugated heat transfer modes in turbulent fluid flows, two-phase fluid flows, flow through porous media and during phase change. Knowledge of basic equipment used for heat transfer, thermal properties of materials and their measurement.	
Effects of education	See Table 24.	
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. Methods of measurement of heat fluxes and temperature visualisation (infra-red thermography, liquid crystals thermography, thermocolours). 2. Thermal contact resistance. 3. Heat transfer in turbulent and two-phase flows. 4. Heat transfer with phase change (solidification, frost formation, icing). 5. Heat transfer in porous media and suspensions. 6. Thermal insulations and protection against high and low temperatures. 7. Heat exchangers and heat pipes. 8. Radiation in transparent and semitransparent media. Tutorials: 1. Examples of calculation of temperature distribution and heat transfer during turbulent flows. 2. Examples of calculations of temperature distribution and heat transfer during	

Description of course

	two-phase fluid flows. 3. Examples of calculations of temperature distribution and heat transferand during fluid flow in porous media. 2. Application of effectiveness and NTU methods in heat exchangers. 3. Examples of calculation of radiative heat transfer in transparent and semitransparent media.
Methods of evaluation	1) Theoretical test. 2) Solution of two complex problems in heat transfer and presentation of the chosen topic in heat transfer.
Methods of verification of effects of education	See Table 24.
Exam	no
Literature	1) A. Bejan: “Heat Transfer”, John Wiley & Sons, Inc. 2) A. Bejan, A.D. Kraus: “Heat Transfer Handbook”, John Wiley & Sons, Inc. 3) M. Kaviany: “Principles of Heat Transfer in porous Media”, Springer 4) K. D. Hagen: “Heat Transfer with Applications” Prantice- Hall, Inc. 5) J.R.Mahan: “Radiation Heat Transfer”, John Wiley & Sons, Inc. 6) 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 - 15 hours. 2) The number of hours of independent work of student: a) preparation for exercise - 10 hours; b) preparing a presentation selected theme - 15 hours; c) resolving individual examples of computational -15 hours. TOTAL – 75 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits – the presence of a teacher - 35, including: a) attendance at the lectures - 15 hours; b) attendance at the exercises -15 hours; c) consultancy meetings - 15 hours.
Number of ECTS credits on practical activities on the course	2 ECTS - accounting exercises, examples of calculations, preparation of presentation of selected theme.

E. Additional information

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Table 24. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS645_W1**
Description:	The student acquires knowledge about methods of temperature visualization, modelling of heat transfer in porous media, during turbulent and two-phase flows as well as of radiative heat transfer in non-participating and participating media.

Table 24. Learning outcomes	
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS645_W2**
Description:	The students knows the basic methods of solution of flow and heat transfer problems in porous media as well as radiative heat transfer
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS645_W3**
Description:	The student knows how to mathematically describe processes of convective heat transfer in homogeneous and heterogeneous media as well as complex heat transfer accounting for thermal radiation.
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer
Field of study related learning outcomes	E2_W05
Area of study related learning outcomes	
Code of effect:	**ANS645_W4**
Description:	The student knows heat transfer problems associated with conversion of solar radiation and geothermal energy
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer
Field of study related learning outcomes	E2_W09
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS645_U1**
Description:	The students is able to find information about complex heat transfer problems in different technical applications and processes and analyze its contents.
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS645_U2**
Description:	The student is able to prepare a presentation about heat transfer problems in different processes and technical appliances.
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer.
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
Code of effect:	**ANS645_U3**
Description:	The student is able to prepare oral presentation using PowerPoint related to heat transfer problems in different appliances.
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer.

Table 24. Learning outcomes	
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANS645_U4**
Description:	The student is able to find information referring to application of heat transfer in different processes and appliances, analyze it and expand his/her knowledge of these problems.
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANS645_U5**
Description:	The student is able to apply selected analytical and numerical methods in solution of heat transfer problems including thermal radiation.
Verification:	Preparing of presentation on the selected topic and solution of problems in heat transfer.
Field of study related learning outcomes	E2_U09
Area of study related 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	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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	Specialistic	
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	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: • 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 25.	
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	Lecture: • 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 conversionefficiency for selected processes and devices. Possibility of energy storage. • Renewable sources; sun as an energy source, conversion of solar radiation	

Description of course

	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. • Prospectivepower 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.
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 several students with individually assigned subjects.
Methods of verification of effects of education	See Table 25.
Exam	yes
Literature	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.
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 thatrequire the presence of a teacher - 47, including: a) attendanceat the lectures - 30hours; b) attendanceat the exercises- 15hours; c) consultancymeetings – 2 hours. 2) The number of hours of independent work of student: 10 hours for completion of homeworkproject.
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) attendanceat the lectures - 30hours; b)

Description of course

	attendanceat the exercises – 15 hours; e) consultancymeetings – 2 hours.
Number of ECTS credits on practical activities on the course	

E. Additional information

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Table 25. 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	E2_W09
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	E2_W11
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	E2_W09
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANS 534_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	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS 534_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	E2_U19
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.

Table 25. Learning outcomes	
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	E2_U19
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	E2_K03
Area of study related learning outcomes	

Description of course

Code of course	ANK382	
Name of course	Engineering Project	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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 Błaszczyk	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialistic	
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	ANW113 Electric Circuits 1. ANK317 Electric Circuits 2. ANW135 Electronics 1. ANW333 Electric Machines 1. ANK381 Electric Power Systems 1.	
Limit of students	30 - project	
C. Effects of education and manner of teaching		
Purpose of course	The objective of this project is to enable students to take their projects from the initial "idea stage" to the final "product and presentation stage." The project gives students an opportunity to demonstrate the knowledge and skills you have already acquired in their engineering studies, by completing a specific engineering project. Students in teams will work on an individual project of a complex nature in order to develop a solution to an engineering problem. In addition to the technical engineering development work, the project may require consideration of issues such as legal aspects, customer specifications, standardisation, cost analysis, and product testing and delivery. As the use of computers in engineering continues to increase, it is important that engineering students are able to develop intuitive, practical skills through effective use of professional software commonly applied in industry and R&D.	
Effects of education	See Table 26.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	60h
	Computer lessons	0h
Contents of education	The core work in the project is based on a specific commercial software taught and used at the department e.g. FLUENT, ANSYS, MATLAB,	

Description of course

	SYMULINK, Excel so that students get skilled in using software in projects they may encounter in engineer's practice. The project is basically team oriented 3-4 person groups are a standard but in special cases individual work is also permissible. A list of indicative projects will be pre-defined by the tutor but proposal from students are also accepted. The themes should be as much as possible interdisciplinary, combining topics from different research and engineering areas, e.g. innovative materials, thermodynamics, heat transfer, aerodynamics, fluid mechanics, innovation and design, managing complexity, materials failure, robotics, electronics and electrical engineering, solid mechanics and structural integrity, environmental monitoring. The themes should reflect real engineering's tasks from industry. Throughout of the project course attention will be paid to address properly principles and conventions of project management and execution. A tutor will advise and guide students, but they are expected to produce their work independently, without close supervision. Students start their team work with brainstorming their ideas and accessing information through "top-desk research" e.g. from libraries as well as over the internet. After finalizing their design plans, they embark on the main phase of designing, modelling and simulating the design using dedicated software. This is where the real design work takes place, as students apply their CAD skills to their project design. After completing the design in some cases there would be a phase of building and testing prototypes, but it would be done in the framework of dedicated students' circles. In the final obligatory stage students shall present their project to other students, faculty and industry representatives. Students will be required to give an oral and a poster presentation as well as a final report on their project.
Methods of evaluation	Completion of the project. Public presentation of the project to all students in the group - in the final obligatory stage students shall present their project to other students, faculty and industry representatives. Students will be required to give an oral and a poster presentation as well as a final report on their project.
Methods of verification of effects of education	See Table 26.
Exam	no
Literature	Delivered by the lecture depending on the theme and scope of project.
Website of the course	http://estudia.meil.pw.edu.pl/

Description of course

D. Student's activity

Number of ECTS credits	3
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher - 65, including: a) attendance at the design tutiorials - 60 hours; b) consultancy meetings – 5 hours. 2) The number of hours of independent work of student – 20 hours, prepare at project and its presentation during classes (group work) – 20 hours. TOTAL – 85 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,6 ECTS credits – number of hours that require the presence of a teacher - 65, including: a) attendance at the design tutiorials 60 hours; b) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits – including: a) attendance at the design tutiorials 60 hours; b) consultancy meetings – 5 hours; c) consultancy meetings – 5 hours; d) 20 hours, prepare at project and its presentation during classes (group work).

E. Additional information

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Table 26. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK382_W1**
Description:	Student knows advanced numerical methods of solving mathematical models and is familiar with commercial design supporting software.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANK382_W2**
Description:	Student knows the methods of design of heat power end electric power machines and system and can practically use advanced design supporting software.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANK382_U1**
Description:	Student can applied mathematical modelling to solve engineering design tasks and use commercial software in the design process.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	

General academic profile - social competences

Code of effect:	**ANK487_K1**
Description:	Student can work in a team.
Verification:	Delivering the project.

Table 26. Learning outcomes	
Field of study related learning outcomes	E2_K03
Area of study related learning outcomes	

Description of course

Code of course	ANS535	
Name of course	Future Power Technologies	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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	Specialistic	
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	After completing the course the student has a basic knowledge of the possible directions of energy development, including the legal and economic conditions.	
Effects of education	See Table 27.	
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	Selected elements of the theory of energy conversion. Current trends in energy development. Technical and economic considerations. Overview of promising energy technologies (gas-steam systems, combustion techniques, gasification of fuels, fuel cells, nuclear reactors and fusion, etc..). Ecological determinants of energy.	
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 27.	
Exam	no	
Literature		
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 - 35, including: a) attendance at the lectures- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student – 25, including: • systematic	

Description of course

	preparation for classes - 15 hours; • preparing for test -10 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 - 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	

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Table 27. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS535_W1**
Description:	Has knowledge of new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	
Code of effect:	**ANS535_W1**
Description:	Has knowledge of new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_W09
Area of study related learning outcomes	
Code of effect:	**ANS535_W1**
Description:	Has knowledge of new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_W10
Area of study related learning outcomes	
Code of effect:	**ANS535_W1**
Description:	Has knowledge of new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_W12
Area of study related learning outcomes	
Code of effect:	**ANS535_W1**
Description:	Has knowledge of new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS535_W2**
Description:	Has knowledge about the new regulations and the impact of external factors on the energetics.
Verification:	Final test.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS535_W2**
Description:	Has knowledge about the new regulations and the impact of external factors on the energetics.
Verification:	Final test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	

General academic profile - skils

Table 27. Learning outcomes	
Code of effect:	**ANS535_U1**
Description:	Knows how to evaluate possibilities and merits of the investment in new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS535_U1**
Description:	Knows how to evaluate possibilities and merits of the investment in new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANS535_U1**
Description:	Knows how to evaluate possibilities and merits of the investment in new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_U07
Area of study related learning outcomes	
Code of effect:	**ANS535_U1**
Description:	Knows how to evaluate possibilities and merits of the investment in new energy technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS535_U2**
Description:	Knows how to prepare a pre-conception of the use of new technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANS535_U2**
Description:	Knows how to prepare a pre-conception of the use of new technologies.
Verification:	Final test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS535_K1**
Description:	Know the new trends in energy and knows how to be promoted.
Verification:	Final test.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**ANS535_K1**
Description:	Know the new trends in energy and knows how to be promoted.
Verification:	Final test.
Field of study related learning outcomes	E2_K05
Area of study related learning outcomes	

Description of course

Code of course	ANK491	
Name of course	Intermediate Master Project	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialistic	
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		
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 28.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	90h
	Computer lessons	0h
Contents of education	Detailed course content depends on the subject and character of the work (design and construction, computational, experimental).	
Methods of evaluation	The evaluation shall assess the appropriate separation of tasks, analysis of the literature, the solution of the problem and its written presentation.	
Methods of verification of effects of education	See Table 28.	
Exam	no	
Literature	Books and academic textbooks, journals, internet	
Website of the course		
D. Student’s activity		
Number of ECTS credits	6	
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher – 89, including: a) consultancy meetings - 85 hours. b) final completion of the course – 4 hours 2) The number of hours of independent	

Description of course

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

E. Additional information

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Table 28. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK491_W1**
Description:	Has knowledge on development trends and most important new achievements in power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANK491_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANK491_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can suggest improvements of existing technical solutions.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANK491_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can suggest improvements of existing technical solutions.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
Code of effect:	**ANK491_U3**

Table 28. Learning outcomes	
Description:	Can set the goals of further education and organise his/her learning process.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANK491_U4**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Has language skills in scientific fields and disciplines relevant to the field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANK491_U4**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Has language skills in scientific fields and disciplines relevant to the field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANK491_U4**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Has language skills in scientific fields and disciplines relevant to the

Table 28. Learning outcomes	
	field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK491_K1**
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Understands the need for life-long learning; can inspire and organise the learning process of other people. can think and act in a creative and entrepreneurial way.
Verification:	On going evaluation the progress of work.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANK491_K1**
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Understands the need for life-long learning; can inspire and organise the learning process of other people. can think and act in a creative and entrepreneurial way.
Verification:	On going evaluation the progress of work.
Field of study related learning outcomes	E2_K04
Area of study related learning outcomes	
Code of effect:	**ANK491_K1**
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Understands the need for life-long learning; can inspire and organise the learning process of other people. can think and act in a creative and entrepreneurial way.
Verification:	On going evaluation the progress of work.
Field of study related learning outcomes	E2_K06
Area of study related learning outcomes	

Description of course

Code of course	ANS559	
Name of course	Information Systems in Management	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering	
Coordinator of course	dr inż. Jerzy Kuta	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	130	
C. Effects of education and manner of teaching		
Purpose of course	• Name the components of an information system and describe system characteristics. • Describe how to select and organize computer system components to support information system objectives. • Define general data management concepts and terms. • Identify and describe Internet, intranet, and extranet and discuss how organizations are using them. • Define the terms SCADA, ,Enterprise Resource Planning, decision support systems (DSS), artificial intelligence systems (AI), and expert systems (ES,)transaction processing, and electronic commerce. • Have knowledge of modern information systems in power industry. • Build own application for data acquisition and managing. • Be able to configure routers and firewall against external attack.	
Effects of education	See Table 29.	
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	Since control systems, SCADA through application software systems to support energy trading, management of renovations to the functionality of ERP systems. Laboratory exercises in selected software modules. Shows the application on-line (a combination of systems, power plants) and build their own applications (industrial software configuration). Cyber security problems in the power industry.	

Description of course

Methods of evaluation	Final test.
Methods of verification of effects of education	See Table 29.
Exam	no
Literature	• Website about Management_Information_Systems : http://www.dmoz.org/Business/Management/Management_Science/Management_Information_Systems/. • Journal “Information Systems in Management”: http://ism.wzim.sggw.pl/. • Course instructions.
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 - 35, including: a) attendance at the lectures- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student – 25, including: • systematic preparation for classes - 15 hours; • preparing for test -10 hours. TOTAL – 60 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits – the presence of a teacher - 35, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 29. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS559_W1**
Description:	Has knowledge of modern information systems.
Verification:	Final test.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS559_W2**
Description:	Familiar with modern information technologies and their application in industry.
Verification:	Final test.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANS559_W2**
Description:	Familiar with modern information technologies and their application in industry.
Verification:	Final test.
Field of study related learning outcomes	E2_W16
Area of study related learning outcomes	
Code of effect:	**ANS559_W2**
Description:	Familiar with modern information technologies and their application in industry.
Verification:	Final test.
Field of study related learning outcomes	E2_W17

Table 29. Learning outcomes	
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS559_U1**
Description:	Know how to use typical systems found in power.
Verification:	Final test.
Field of study related learning outcomes	E2_U24
Area of study related learning outcomes	

Description of course

Code of course	ANK445	
Name of course	Project Management	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	-	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Power and Aeronautical Engineering	
Coordinator of course	dr hab. inż. Wojciech Bujalski	
B. General characteristic of the course		
Block of courses	Directional	
Group of courses	Obligatory	
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	100	
C. Effects of education and manner of teaching		
Purpose of course	A basic understanding of investment planning and preparation process, with a use of Project Management methodology. Knowledge on a development of an investment process in power sector, with respect to Polish conditions.	
Effects of education	See Table 30.	
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	Basis of project management methodology. Classification of projects (investment projects, development projects, modernisations). Phases of the project implementation. The project supervision and administration. Basis of risk management in projects management. Basic knowledge on investment projects economic analyses.	
Methods of evaluation	Final test, participation in lectures.	
Methods of verification of effects of education	See Table 30.	
Exam	no	
Literature	1. Materials provided by lecturer. 2. PMBOK, Mantel, Samuel J. Ed., Mantel, Samuel J. Ed., USA. 3. Project Management: A Managerial Approach, 2008.	
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 - 35, including: a) attendance at the	

Description of course

	lectures - 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student – 25, including: • systematic preparation for classes - 15 hours; • preparing for test -10 hours. TOTAL – 60 hours.
Number of ECTS credits on the course with direct participation of academic teacher	1,5 ECTS credits – the presence of a teacher - 35, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 30. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK445_W1**
Description:	Knows basic rules of Project Management.
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANK445_W1**
Description:	Knows basic rules of Project Management.
Verification:	Test.
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ANK445_W1**
Description:	Knows basic rules of Project Management.
Verification:	Test.
Field of study related learning outcomes	E2_W22
Area of study related learning outcomes	
Code of effect:	**ANK445_W2**
Description:	Knows rules governing investment works in power industry.
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANK445_W2**
Description:	Knows rules governing investment works in power industry.
Verification:	Test.
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ANK445_W2**
Description:	Knows rules governing investment works in power industry.
Verification:	Test.
Field of study related learning outcomes	E2_W22
Area of study related learning outcomes	
Code of effect:	**ANK445_W3**
Description:	Knows basic methods for assessing earning power of investment.

Table 30. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ANK445_W3**
Description:	Knows basic methods for assessing earning power of investment.
Verification:	Test.
Field of study related learning outcomes	E2_W22
Area of study related learning outcomes	
Code of effect:	**ANK445_W3**
Description:	Knows basic methods for assessing earning power of investment.
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANK445_W4**
Description:	Knows basic terminology of Project Management.
Verification:	Test.
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ANK445_W5**
Description:	Knows rules of risk management.
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANK445_W5**
Description:	Knows rules of risk management.
Verification:	Test.
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ANK445_W5**
Description:	Knows rules of risk management.
Verification:	Test.
Field of study related learning outcomes	E2_W22
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANK445_U1**
Description:	Has the ability to define ventures as projects as it is regarded in Project Management.
Verification:	Test.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ANK445_U2**
Description:	Has the ability to participate in project management process.
Verification:	Test.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ANK445_U3**
Description:	Has the ability to create a simple assessment of earning power of an investment.
Verification:	Test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	

Table 30. Learning outcomes	
Code of effect:	**ANK445_U3**
Description:	Has the ability to create a simple assessment of earning power of an investment.
Verification:	Test.
Field of study related learning outcomes	E2_U17
Area of study related learning outcomes	
Code of effect:	**ANK445_U4**
Description:	Has the ability to create risk management rules in a project.
Verification:	Test.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ANK445_U4**
Description:	Has the ability to create risk management rules in a project.
Verification:	Test.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANK445_U4**
Description:	Has the ability to create risk management rules in a project.
Verification:	Test.
Field of study related learning outcomes	E2_U23
Area of study related learning outcomes	
Code of effect:	**ANK445_U5**
Description:	Has the ability to identify risk in projects.
Verification:	Test.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ANK445_U5**
Description:	Has the ability to identify risk in projects.
Verification:	Test.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK445_K1**
Description:	Able to work in a creative way and enterprising.
Verification:	Assessment tasks.
Field of study related learning outcomes	E2_K06
Area of study related learning outcomes	

Description of course

Code of course	ANK382	
Name of course	Engineering Project	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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 Błaszczyk	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANW113 Electric Circuits 1. ANK317 Electric Circuits 2. ANW135 Electronics 1. ANW333 Electric Machines 1. ANK381 Electric Power Systems 1.	
Limit of students	30 projekt	
C. Effects of education and manner of teaching		
Purpose of course	The objective of this project is to enable students to take their projects from the initial "idea stage" to the final "product and presentation stage." The project gives students an opportunity to demonstrate the knowledge and skills you have already acquired in their engineering studies, by completing a specific engineering project. Students in teams will work on an individual project of a complex nature in order to develop a solution to an engineering problem. In addition to the technical engineering development work, the project may require consideration of issues such as legal aspects, customer specifications, standardisation, cost analysis, and product testing and delivery. As the use of computers in engineering continues to increase, it is important that engineering students are able to develop intuitive, practical skills through effective use of professional software commonly applied in industry and R&D.	
Effects of education	See Table 31.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	60h
	Computer lessons	0h
Contents of education	The core work in the project is based on a specific commercial software taught and used at the department e.g. FLUENT, ANSYS, MATLAB,	

Description of course

	SYMULINK, Excel so that students get skilled in using software in projects they may encounter in engineer's practice. The project is basically team oriented 3-4 person groups are a standard but in special cases individual work is also permissible. A list of indicative projects will be pre-defined by the tutor but proposal from students are also accepted. The themes should be as much as possible interdisciplinary, combining topics from different research and engineering areas, e.g. innovative materials, thermodynamics, heat transfer, aerodynamics, fluid mechanics, innovation and design, managing complexity, materials failure, robotics, electronics and electrical engineering, solid mechanics and structural integrity, environmental monitoring. The themes should reflect real engineering's tasks from industry. Throughout of the project course attention will be paid to address properly principles and conventions of project management and execution. A tutor will advise and guide students, but they are expected to produce their work independently, without close supervision. Students start their team work with brainstorming their ideas and accessing information through "top-desk research" e.g. from libraries as well as over the internet. After finalizing their design plans, they embark on the main phase of designing, modelling and simulating the design using dedicated software. This is where the real design work takes place, as students apply their CAD skills to their project design. After completing the design in some cases there would be a phase of building and testing prototypes, but it would be done in the framework of dedicated students' circles.
Methods of evaluation	Completion of the project. Public presentation of the project to all students in the group - in the final obligatory stage students shall present their project to other students, faculty and industry representatives. Students will be required to give an oral and a poster presentation as well as a final report on their project.
Methods of verification of effects of education	See Table 31.
Exam	no
Literature	Delivered by the lecture depending on the theme and scope of project.
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 - 65, including: a) attendance at the design tutiorials 60 hours; b) consultancy

Description of course

	meetings – 5 hours. 2) The number of hours of independent work of student – 20 hours, prepare at project and its presentation during classes (group work). TOTAL – 85 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,6 ECTS credits – number of hours that require the presence of a teacher - 65, including: a) attendance at the design tutiorials 60 hours; b) consultancy meetings – 5 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits – 85 hours, including: a) attendance at the design tutiorials 60 hours; b) consultancy meetings – 5 hours; c) 20 hours, prepare at project and its presentation during classes (group work).

E. Additional information

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Table 31. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK382_W1**
Description:	Student knows advanced numerical methods of solving mathematical models and is familiar with commercial design supporting software.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_W03
Area of study related learning outcomes	
Code of effect:	**ANK382_W2**
Description:	Student knows the methods methods of design of heat power end electric power machines and system and can practically use advanced design supporting software.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANK382_U1**
Description:	Student can applied mathematical modelling to solve engineering design tasks and use commercial software in the design process.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_U09
Area of study related learning outcomes	

General academic profile - social competences

Code of effect:	**ANK382_K1**
Description:	Student can work in a team.
Verification:	Delivering the project.
Field of study related learning outcomes	E2_K03
Area of study related learning outcomes	

Description of course

Code of course	ANS670	
Name of course	GenIV Nuclear Reactor Systems (HTR,FBR)	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Nikołaj Uzunow	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANS664 Elements of Nuclear Physics. ANS666 Nuclear Reactor Physics.	
Limit of students	15	
C. Effects of education and manner of teaching		
Purpose of course	1. To present the theoretical base, and the technology of GenIV high-temperature reactors. 2. To present the theoretical base, and the technology of fast breeder reactors. 3. To present the technology of GenIV small modular reactors (light-water and liquid-metal).	
Effects of education	See Table 32.	
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	Concept of high-temperature reactors. Materials. TRISO fuel elements. GenII and GenIV design solutions. Performance. Realisation constraints. Physical base of fast-neutron reactors. Design concepts. Materials. Realisation constraints. Examples of successful installations. Performance. Possible use of fast reactors. Gen IV small modular reactors – concepts of light-water and fast reactors. Possible advantages of wide implementation.	
Methods of evaluation	Final examination.	
Methods of verification of effects of education	See Table 32.	
Exam	yes	
Literature	1. R. A. Knief „Nuclear Energy Technology”, McGraw-Hill, Middletown, 1981. 2. A. E. Waltar, and A. B. Reynolds “Fast Breeder Reactors”, Pergamon Press, 1981.	
Website of the course	estudia.meil.pw.edu.pl	

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 - 35, including: a) attendance at the lectures- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student – 20, incl. preparation to the classes.
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- 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	0,5 ECTS – 20 hours of student's individual work on preparation to the classes.

E. Additional information

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Table 32. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS670_W1**
Description:	Has advanced knowledge of the high-temperature reactor technology, including the proposed new generation of IV solutions, and possible industrial applications of this type of reactors.
Verification:	Exam
Field of study related learning outcomes	E2_W04
Area of study related learning outcomes	
Code of effect:	**ANS670_W1**
Description:	Has advanced knowledge of the high-temperature reactor technology, including the proposed new generation of IV solutions, and possible industrial applications of this type of reactors.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS670_W1**
Description:	Has advanced knowledge of the high-temperature reactor technology, including the proposed new generation of IV solutions, and possible industrial applications of this type of reactors.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS670_W1**
Description:	Has advanced knowledge of the high-temperature reactor technology, including the proposed new generation of IV solutions, and possible industrial applications of this type of

Table 32. Learning outcomes	
	reactors.
Verification:	Exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS670_W1**
Description:	Has advanced knowledge of the high-temperature reactor technology, including the proposed new generation of IV solutions, and possible industrial applications of this type of reactors.
Verification:	Exam
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS670_W2**
Description:	Has advanced knowledge of the fast reactor technology.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS670_W2**
Description:	Has advanced knowledge of the fast reactor technology.
Verification:	Exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS670_W2**
Description:	Has advanced knowledge of the fast reactor technology.
Verification:	Exam
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS670_W2**
Description:	Has advanced knowledge of the fast reactor technology.
Verification:	Exam
Field of study related learning outcomes	E2_W04
Area of study related learning outcomes	
Code of effect:	**ANS670_W2**
Description:	Has advanced knowledge of the fast reactor technology.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS670_W3**
Description:	Have knowledge about. Technologies power reactors PWR low-power, BWR and FBR, including the proposed new solution generation IV.
Verification:	Exam
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS670_W3**
Description:	Have knowledge about. Technologies power reactors PWR low-power, BWR and FBR, including the proposed new solution generation IV.

Table 32. Learning outcomes	
Verification:	Exam
Field of study related learning outcomes	E2_W04
Area of study related learning outcomes	
Code of effect:	**ANS670_W3**
Description:	Have knowledge about. Technologies power reactors PWR low-power, BWR and FBR, including the proposed new solution generation IV.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS670_W3**
Description:	Have knowledge about. Technologies power reactors PWR low-power, BWR and FBR, including the proposed new solution generation IV.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS670_W3**
Description:	Have knowledge about. Technologies power reactors PWR low-power, BWR and FBR, including the proposed new solution generation IV.
Verification:	Exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS670_U1**
Description:	Able to assess the performance and performance-generation IV reactors (HTR, FBR, SMR).
Verification:	Exam
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS670_U1**
Description:	Able to assess the performance and performance-generation IV reactors (HTR, FBR, SMR).
Verification:	Exam
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANS670_U1**
Description:	Able to assess the performance and performance-generation IV reactors (HTR, FBR, SMR).
Verification:	Exam
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS670_U1**
Description:	Able to assess the performance and performance-generation IV reactors (HTR, FBR, SMR).
Verification:	Exam
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS670_U1**
Description:	Able to assess the performance and performance-generation IV reactors (HTR, FBR, SMR).
Verification:	Exam
Field of study related learning outcomes	E2_U19

Table 32. Learning outcomes	
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS670_K1**
Description:	He can pass the knowledge on new developments in the field of nuclear energy.
Verification:	Exam
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANS670_K1**
Description:	He can pass the knowledge on new developments in the field of nuclear energy.
Verification:	Exam
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**ANS670_K2**
Description:	Is aware of the environmental impact of power generation IV reactors ..
Verification:	Exam
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	

Description of course

Code of course	ANK491	
Name of course	Intermediate Master Project	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	-	
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	The aim of the course is to get the student's ability to perform advanced design, especially through the work of their own, 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 33.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	90h
	Computer lessons	0h
Contents of education	Detailed course content depends on the subject and character of the work (design and construction, computational, experimental).	
Methods of evaluation	The evaluation shall assess the appropriate separation of tasks, analysis of the literature, the solution of the problem and its written presentation.	
Methods of verification of effects of education	See Table 33.	
Exam	no	
Literature	Books and academic textbooks, journals, Internet.	
Website of the course		
D. Student’s activity		
Number of ECTS credits	6	
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher – 89, including: a) consultancy meetings - 85 hours. b) final completion of the course – 4 hours 2) The number of hours of independent	

Description of course

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

E. Additional information

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Table 33. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANK491_W1**
Description:	Has knowledge on development trends and most important new achievements in power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANK491_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANK491_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can suggest improvements of existing technical solutions.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANK491_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can suggest improvements of existing technical solutions.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
Code of effect:	**ANK491_U3**

Table 33. Learning outcomes	
Description:	Can set the goals of further education and organise his/her learning process.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANK491_U4**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Has language skills in scientific fields and disciplines relevant to the field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANK491_U4**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Has language skills in scientific fields and disciplines relevant to the field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANK491_U4**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Has language skills in scientific fields and disciplines relevant to the

Table 33. Learning outcomes	
	field of study, in accordance with the requirements for the B2 level of the Common European Framework of Reference for Languages, knows the terminology and symbols specific for power engineering.
Verification:	The final report evaluated by the teacher
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANK491_K1**
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Understands the need for life-long learning; can inspire and organise the learning process of other people. can think and act in a creative and entrepreneurial way
Verification:	On going evaluation the progress of work.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANK491_K1**
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Understands the need for life-long learning; can inspire and organise the learning process of other people. can think and act in a creative and entrepreneurial way
Verification:	On going evaluation the progress of work.
Field of study related learning outcomes	E2_K04
Area of study related learning outcomes	
Code of effect:	**ANK491_K1**
Description:	Can appropriately set priorities for realisation of a task set by him-/herself or others. Understands the need for life-long learning; can inspire and organise the learning process of other people. can think and act in a creative and entrepreneurial way
Verification:	On going evaluation the progress of work.
Field of study related learning outcomes	E2_K06
Area of study related learning outcomes	

Description of course

Code of course	NS679	
Name of course	Nuclear Energy and International Security	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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 Grzegorz Kostrzewa-Zorbas, dr Nikołaj Uzunow	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANS664 Elements of Nuclear Physics. ANS666 Nuclear Reactor Physics. ANS671 Contemporary Nuclear Reactor Systems (LWR, HWR).	
Limit of students	15	
C. Effects of education and manner of teaching		
Purpose of course	The course provides the knowledge on the role of nuclear weapons in international security and on the international regulations for nuclear materials and technology used in nuclear weapons, nuclear power industry and other applications. Covered are several major topics: the doctrine of nuclear deterrence, especially that of NATO; the nuclear non-proliferation regime; international law pertaining to nuclear weapons; nuclear terrorism and the relationship between international security and nuclear safety; and the contribution of nuclear energy to energy security and economic security.	
Effects of education	See Table 34.	
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	INTERACTIVE LECTURES Nuclear warfare and other military and intelligence uses of nuclear energy. Unique potential and status of nuclear weapons as compared to other weapons of mass destruction and to conventional weapons. Theory, history and geography of nuclear deterrence. Inteligence uses of nuclear energy. Nuclear policy and strategy of NATO, USA, Russia, France, UK, PRC and other nations. Nuclear weapons in the ethics and law of war (armed conflict). Nuclear	

Description of course

	weapons, the UN Security Council and the global balance of power. Radiological weapons. Nuclear terrorism. Nuclear arms control: limitations, reductions, confidence building, nuclear weapons free environments and zones, disarmament. IAEA and the international nuclear non-proliferation regime: political, legal and organizational dimensions. NPT as a triple deal between NWSs and NNWSs. History and dynamics of nuclear proliferation. Real, virtual, threshold and potential nuclear arsenals. Nuclear power plants, research and other reactors, the fuel cycle and international security. Threat reduction programs targeted at nuclear reactors and the fuel cycle. Nuclear power, energy security and economic security of nations and regions of the world. STRATEGIC GAMES IN COMPUTER LABORATORY Strategic Game 1. Focus on NATO, Europe, nuclear strategy and warfare. Strategic Game 2. Focus on nuclear proliferation in the world.
Methods of evaluation	1. Final test (40% of final grade). 2. Exercises in computer lab – strategic games (40% of final grade). 3. Students active participation in lectures (20% of final grade).
Methods of verification of effects of education	See Table 34.
Exam	no
Literature	BOOKS, YEARBOOKS AND DOCUMENTS: Combating Weapons of Mass Destruction: The Future of International Nonproliferation Policy. Edited by Nathan E. Busch and Daniel H. Joyner. Athens, Georgia, USA: University of Georgia Press, 2009. Lawrence Freedman. The Evolution of Nuclear Strategy. 3rd edition. Houndmills, Basingstoke, Hampshire, UK; New York, USA: Palgrave Macmillan, 2003. Charles S Grace. Nuclear Weapons: Principles, Effects and Survivability. London, UK; New York, USA: Brassey's (UK), 1994. International Court of Justice. Legality of the Threat or Use of Nuclear Weapons. Advisory Opinion of 8 July 1996. International Institute of Strategic Studies. The Military Balance 2014. London, UK; New York, USA: Routledge, 2014. Multilateral Approaches to the Nuclear Fuel Cycle. Vienna, Austria: International Atomic Energy Agency, 2005. North Atlantic Treaty Organization. Active Engagement, Modern Defence: Strategic Concept for the Defence and Security of the Members of the North Atlantic Treaty Organization. Adopted by Heads of State and Government at the NATO Summit in Lisbon, 19-20 November 2010. Safeguards Techniques and Equipment: 2011 Edition. Vienna, Austria: International Atomic Energy Agency,

Description of course

	2011. Spent Fuel Reprocessing Options. Vienna, Austria: International Atomic Energy Agency, 2008. Stockholm International Peace Research Institute. SIPRI Yearbook 2014. Armaments, Disarmament and International Security. Oxford, UK: Oxford University Press, 2014. Carlton Stoiber, Alec Baer, Norbert Pelzer, Wolfram Tonhauser. Handbook on Nuclear Law. Vienna, Austria: International Atomic Energy Agency, 2003. Strategy in the Contemporary World: An Introduction to Strategic Studies. Edited by John Baylis, James J. Wirtz, and Colin S. Gray. 4th Edition. Oxford, UK: Oxford University Press, 2013. ONLINE RESOURCES International Atomic Energy Agency. www.iaea.org. Missile Technology Control Regime. www.mtcr.info. Nuclear Suppliers Group. www.nuclearsuppliersgroup.org. United Nations Office for Disarmament Affairs. Nuclear Weapons. www.un.org/disarmament/WMD/Nuclear. Zangger Committee. www.zanggercommittee.org.
Website of the course	estudia.meil.pw.edu.pl

D. Student's activity

Number of ECTS credits	2
Number of hours of student's work to achieve effects of education	1) Number of hours that require the presence of a teacher: 35, including: a) attendance at lectures: 15 hours; b) attendance at labs: 15 hours; c) consultancy meetings: 5 hours. 2) Number of hours of independent work of student: 40, including: a) readings: 25 hours; b) preparation for exercises: 10 hours; c) preparation for final test: 5 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 lectures: 15 hours; b) attendance at labs: 15 hours; c) consultancy meetings: 5 hours.
Number of ECTS credits on practical activities on the course	0,5 ECTS credits – number of hours of practical work of student: 10 for preparation for exercises.

E. Additional information

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Table 34. Learning outcomes

General academic profile - knowledge

Code of effect:	**NS679_W1**
Description:	Knows the international regulations for nuclear materials (nuclear weapons and nuclear power).
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**NS679_W2**
Description:	Have knowledge about role of nuclear weapons in ensuring international security.

Table 34. Learning outcomes	
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**NS679_W3**
Description:	He knows the role of nuclear energy in ensuring energy security and international law.
Verification:	Test.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**NS679_W3**
Description:	He knows the role of nuclear energy in ensuring energy security and international law.
Verification:	Test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**NS679_U1**
Description:	Can justify the doctrine of nuclear deterrence and the need for an inventory of nuclear materials.
Verification:	Test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**NS679_U1**
Description:	Can justify the doctrine of nuclear deterrence and the need for an inventory of nuclear materials.
Verification:	Test.
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**NS679_U1**
Description:	Can justify the doctrine of nuclear deterrence and the need for an inventory of nuclear materials.
Verification:	Test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**NS679_U1**
Description:	Can justify the doctrine of nuclear deterrence and the need for an inventory of nuclear materials.
Verification:	Test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**NS679_K1**
Description:	He can pass the knowledge on international nuclear safety.
Verification:	Test.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**NS679_K2**
Description:	Is aware of the opportunities and threats posed by the use of nuclear materials for military and

Table 34. Learning outcomes	
	civilian.
Verification:	Test.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	

Description of course

Code of course	ML.ANS701	
Name of course	Nuclear Instrumentation and Control	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Konrad Świrski	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANS671.Contemporary nuclear reactor systems (LWR, HWR), ANS666 .Nuclear reactor physics.	
Limit of students	30	
C. Effects of education and manner of teaching		
Purpose of course	Course providing professional knowledge about Nuclear Power Plant Instrumentation and Control and especially focus on DCS (Distributed Control System) application in nuclear industry. The lectures cover the whole NPP I&C topics – from revision of fundamentals of process control, trough specific requirements of nuclear plants and measurements / radiometry in nuclear up to finally functionality, design and architecture of DCS used in NPP plants. Lectures are combined with laboratory exercises which enable to prepare own engineering application on industrial DCS and simulation of processes and design accidents in nuclear plant. Objectives of the course: C1. Familiarize the student / graduate student with modern trends of process automation systems (DCS). C2. Presentation of the functionality and architecture of DCS. C3. Presentation of the nuclear energy generation problems regarding control and safety systems. C4. Familiarize students with the solutions of modern instrumentation for NPP. C5. To familiarize students with DCS solution for nuclear plants. C6. To provide knowledge about legal framework regarding nuclear industry and especially control and safety problems and information systems for NPP .	
Effects of education	See Table 35.	
Form of didactic studies and number of hours per semester	Lecture	30h
	Exercise type of course	0h

Description of course

	Laboratory	30h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The form of lectures and classes: W-1--- Introduction – Process control fundamentals – revision. W-2,3--- Introduction – Distributed Control Systems. L1-L5 -- DCS systems laboratory 1. W-4--- Nuclear power specifics (I&C and software). W-5--- Measurements and Instrumentation in nuclear plant I. W-6--- Measurements and Instrumentation in nuclear plant II. W-7--- Nuclear plant control – fundamentals. W-8--- NPP safety systems. W-9--- Severe accidents safety systems. W-10--- Control systems of nuclear plants. W-11--- Nuclear plant control system – demo. W-12, 13--- Nuclear plant information systems and cybersecurity. L6 -L10-- Nuclear plant laboratory. W-14--- Legal framework of NPP control. W-15---Final test.	
Methods of evaluation	Lectures P1 - the final test (test), F1 - assessment test, F2 – P4 project evaluation, F3 – P9 project evaluation, F4 - P12 project evaluation. Labs F5 – L5 – individual project evaluation, F10 – L10 – Lab project evaluation.	
Methods of verification of effects of education	See Table 35.	
Exam	no	
Literature	Teaching materials to the subject available at the Institute of Heat Engineering (web portal) http://energetyka.itc.pw.edu.pl/npp_ic	
Website of the course	www.energetyka.itc.pw.edu.pl/npp_ic	

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 - 65, including a) attendance at the lectures- 30 hours; b) attendance at the labs - 30 hours; c) consultancy meetings - 5 hours. 2) The number of hours of independent work of student 2) The number of hours of independent work of student – indyvidual projects, review of the literature – 25 hours.
Number of ECTS credits on the course with direct participation of academic teacher	2,6 ECTS credits – number of hours that require the presence of a teacher - 65, including a) attendance at the lectures- 30 hours; b) attendance at the labs - 30 hours; c) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	3 ECTS credits

E. Additional information

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Table 35. Learning outcomes

General academic profile - knowledge	
Code of effect:	**ML.ANS701_W1**
Description:	Student has the knowledge of modern instrumentation systems and control systems for NPP.
Verification:	Final test, projects.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ML.ANS701_W1**
Description:	Student has the knowledge of modern instrumentation systems and control systems for NPP.
Verification:	Final test, projects.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ML.ANS701_U1**
Description:	Student understand the nature of nuclear industry safety.
Verification:	Final test, projects.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ML.ANS701_U1**
Description:	Student understand the nature of nuclear industry safety.
Verification:	Final test, projects.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ML.ANS701_U2**
Description:	Student can describe base alghoritms of nuclear reactor control.
Verification:	Project P5.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ML.ANS701_K1**
Description:	Understands the importance of nuclear safety problem and potential threads of nuclear accidents.
Verification:	Final test, projects.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ML.ANS701_K1**
Description:	Understands the importance of nuclear safety problem and potential threads of nuclear accidents.
Verification:	Final test, projects.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	

Description of course

Code of course	ANS676	
Name of course	Nuclear Power Plant Operation and Maintenance	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Grzegorz Niewiński	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	Introduction to the basics of construction and operation of nuclear power plant.	
Effects of education	See Table 36.	
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	Preparation for operation. Planning of core fuelling. Maintenance planning and organisation. Planned and forced shut-down of a nuclear unit. Start-up and power increase after planned and forced shut-down. Organisation principles of fuel and waste management. Water processing. Ventilation. Control and protection systems. IT In NPP operation. Preparation for liquidation.	
Methods of evaluation	Final test.	
Methods of verification of effects of education	See Table 36.	
Exam	no	
Literature	Material from lecture.	
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 - 35, including: a) attendance at the lectures- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student: • systematic preparation for the lectures - 15 hours; • preparing for final test- 10 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 - 35, including: a) attendance at the lectures - 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 36. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS676_W1**
Description:	Knowledge of nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS676_W1**
Description:	Knowledge of nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS676_W1**
Description:	Knowledge of nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS676_W1**
Description:	Knowledge of nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W18
Area of study related learning outcomes	
Code of effect:	**ANS676_W2**
Description:	Has knowledge about the operating procedures in nuclear power.
Verification:	Final test.
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS676_W2**
Description:	Has knowledge about the operating procedures in nuclear power.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS676_W3**
Description:	Knowledge of the construction of nuclear power plants, the primary and secondary systems in nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS676_W3**
Description:	Knowledge of the construction of nuclear power

Table 36. Learning outcomes	
	plants, the primary and secondary systems in nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS676_W3**
Description:	Knowledge of the construction of nuclear power plants, the primary and secondary systems in nuclear power plant.
Verification:	Final test.
Field of study related learning outcomes	E2_W04
Area of study related learning outcomes	
Code of effect:	**ANS676_W4**
Description:	Has knowledge of the sample structure of organizational power, knows how raised are qualified employees EJ.
Verification:	Final test.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS676_U1**
Description:	Knows how to acquire knowledge about modern nuclear energy devices and their characteristics.
Verification:	Final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS676_U1**
Description:	Knows how to acquire knowledge about modern nuclear energy devices and their characteristics.
Verification:	Final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS676_U2**
Description:	Able to assess the operational performance of nuclear power plants, count the basic technical and economic indicators of investment, cost structure.
Verification:	Final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS676_U2**
Description:	Able to assess the operational performance of nuclear power plants, count the basic technical and economic indicators of investment, cost structure.
Verification:	Final test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS676_U2**
Description:	Able to assess the operational performance of nuclear power plants, count the basic technical and economic indicators of investment, cost structure.
Verification:	Final test.

Table 36. Learning outcomes	
Field of study related learning outcomes	E2_U17
Area of study related learning outcomes	
Code of effect:	**ANS676_U2**
Description:	Able to assess the operational performance of nuclear power plants, count the basic technical and economic indicators of investment, cost structure.
Verification:	Final test.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANS676_U3**
Description:	Knows how to work in a group and present their results.
Verification:	Final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS676_U3**
Description:	Knows how to work in a group and present their results.
Verification:	Final test.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS676_U3**
Description:	Knows how to work in a group and present their results.
Verification:	Final test.
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANS676_U3**
Description:	Knows how to work in a group and present their results.
Verification:	Final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS676_K1**
Description:	Has knowledge about nuclear energy and knows how to popularize it.
Verification:	Final test.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	

Description of course

Code of course	ANS675	
Name of course	Nuclear Power Plant Safety	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Nikołaj Uzunow	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANS664 Elements of Nuclear Physics. ANS666 Nuclear Reactor Physics. ANS671 Contemporary Nuclear Reactor Systems (LWR, HWR).	
Limit of students	15	
C. Effects of education and manner of teaching		
Purpose of course	1. To present the main rules and principles of radiological protection. 2. To present calculation methods in radiological protection. 3. To present the main objective and principles of nuclear safety. 4. To present design, construction and operation aspects of nuclear safety. 5. To present and analyse the most serious accidents in nuclear power plants.	
Effects of education	See Table 37.	
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	Lectures: Types and sources of ionizing radiation. Interaction of ionizing radiation with matter. Main principles of radiological protection. Quantities and measuring units. Dose limits and other related legislation. Main goal of nuclear safety. Specificity of danger from nuclear reactors. Defence in depth. Safety principles. Safety aspects: design, construction, and operation. Classification of accidents. Analysis of the most important accidents. Exercises: Calculations related to dose assessment, protection methods (e.g. shields), introduction to working space design.	
Methods of evaluation	Two-stage assesment: 1. Colloquium on radiological protection, including theoretical and	

Description of course

	practical (calculation) questions. 2. Examination on nuclear safety. The final grade is a combination of the colloquium and examination results.
Methods of verification of effects of education	See Table 37.
Exam	yes
Literature	1. J.C. Lee, N. J. McCormick "Risk and Safety Analysis of Nuclear Systems", J. Wiley & Sons, New Jersey, 2011. 2. E. Browne, R. Firestone "Table of Radioactive Isotopes" J. Wiley Interscience Publ., New York, 1986.
Website of the course	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: 50, incl. preparation to the course, calculation homework, and preparation of a report on a nuclear accident.
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 - 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	1.5 ECTS credits – number of hours of student's practical work – 50, incl. preparation for the classes, calculation homework, report preparation.

E. Additional information

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Table 37. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS675_W1**
Description:	Has knowledge of the types and sources of ionizing radiation and its interaction with matter.
Verification:	Colloquium.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W2**
Description:	He knows the rules and techniques of radiological protection.
Verification:	Colloquium.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W3**
Description:	Has knowledge of the levels and the principles of defense in depth, used in the design of power.
Verification:	Exam.
Field of study related learning outcomes	E2_W07

Table 37. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ANS675_W3**
Description:	Has knowledge of the levels and the principles of defense in depth, used in the design of power.
Verification:	Exam.
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	
Code of effect:	**ANS675_W3**
Description:	Has knowledge of the levels and the principles of defense in depth, used in the design of power.
Verification:	Exam.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W3**
Description:	Has knowledge of the levels and the principles of defense in depth, used in the design of power.
Verification:	Exam.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS675_W3**
Description:	Has knowledge of the levels and the principles of defense in depth, used in the design of power.
Verification:	Exam.
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS675_W4**
Description:	Knows the rules of safety of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W4**
Description:	Knows the rules of safety of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS675_W4**
Description:	Knows the rules of safety of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS675_W4**
Description:	Knows the rules of safety of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS675_W4**
Description:	Knows the rules of safety of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W08

Table 37. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ANS675_W5**
Description:	He knows the technical aspects of nuclear power plant safety.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS675_W5**
Description:	He knows the technical aspects of nuclear power plant safety.
Verification:	Exam
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	
Code of effect:	**ANS675_W5**
Description:	He knows the technical aspects of nuclear power plant safety.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W5**
Description:	He knows the technical aspects of nuclear power plant safety.
Verification:	Exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS675_W5**
Description:	He knows the technical aspects of nuclear power plant safety.
Verification:	Exam
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
Code of effect:	**ANS675_W6**
Description:	He knows the role of nuclear regulatory and international organizations in ensuring the safety of NPPs.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W6**
Description:	He knows the role of nuclear regulatory and international organizations in ensuring the safety of NPPs.
Verification:	Exam
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANS675_W6**
Description:	He knows the role of nuclear regulatory and international organizations in ensuring the safety of NPPs.
Verification:	Exam
Field of study related learning outcomes	E2_W20
Area of study related learning outcomes	
Code of effect:	**ANS675_W7**
Description:	He knows the concepts and general principles of

Table 37. Learning outcomes	
	security analysis.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS675_W7**
Description:	He knows the concepts and general principles of security analysis.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W8**
Description:	Knows the latest and forward-looking solutions for safety systems of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W07
Area of study related learning outcomes	
Code of effect:	**ANS675_W8**
Description:	Knows the latest and forward-looking solutions for safety systems of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W08
Area of study related learning outcomes	
Code of effect:	**ANS675_W8**
Description:	Knows the latest and forward-looking solutions for safety systems of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS675_W8**
Description:	Knows the latest and forward-looking solutions for safety systems of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS675_W8**
Description:	Knows the latest and forward-looking solutions for safety systems of nuclear power plants.
Verification:	Exam
Field of study related learning outcomes	E2_W15
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS675_U1**
Description:	Able to compare and assess the safety, depending on the technique used.
Verification:	Exam
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS675_U1**
Description:	Able to compare and assess the safety, depending on the technique used.
Verification:	Exam
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANS675_U1**

Table 37. Learning outcomes	
Description:	Able to compare and assess the safety, depending on the technique used.
Verification:	Exam
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS675_U1**
Description:	Able to compare and assess the safety, depending on the technique used.
Verification:	Exam
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS675_U1**
Description:	Able to compare and assess the safety, depending on the technique used.
Verification:	Exam
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ANS675_U2**
Description:	Able to solve the task of engineering related to radiological protection.
Verification:	Colloquium.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS675_U2**
Description:	Able to solve the task of engineering related to radiological protection.
Verification:	Colloquium.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANS675_U2**
Description:	Able to solve the task of engineering related to radiological protection.
Verification:	Colloquium.
Field of study related learning outcomes	E2_U16
Area of study related learning outcomes	
Code of effect:	**ANS675_U2**
Description:	Able to solve the task of engineering related to radiological protection.
Verification:	Colloquium.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS675_U2**
Description:	Able to solve the task of engineering related to radiological protection.
Verification:	Colloquium.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS675_K1**
Description:	Is aware of the validity of the safety of nuclear power plants and the need to raise awareness about the latest developments in this field.
Verification:	Exam.
Field of study related learning outcomes	E2_K01

Table 37. Learning outcomes	
Area of study related learning outcomes	
Code of effect:	**ANS675_K1**
Description:	Is aware of the validity of the safety of nuclear power plants and the need to raise awareness about the latest developments in this field.
Verification:	Exam.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ANS675_K1**
Description:	Is aware of the validity of the safety of nuclear power plants and the need to raise awareness about the latest developments in this field.
Verification:	Exam.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	

Description of course

Code of course	ANS702	
Name of course	Thermonuclear Synthesis	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Physics	
Coordinator of course	prof. Jan Pluta	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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	ANS664 Elements of Nuclear Physics.	
Limit of students	15	
C. Effects of education and manner of teaching		
Purpose of course	Familiarize students with the theoretical foundations of thermonuclear fusion, and current and future-oriented technologies in this field.	
Effects of education	See Table 38.	
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	W1. Introduction to plasma physics basic concepts. Plasma in Universe, on Earth and in techniques. Enumeration of basic ways of plasma description. W2. Interactions of plasma with electromagnetic fields and waves. W3. Basic thermonuclear reactions, conditions of their occurrence, comparison with fission reactions. W4. Introduction to Magnetic Confinement Fusion (MCF). Differences between tokamak and stellarator concepts. Principle of operation and structure of these types of devices. W5. Detailed construction with some description of main components of tokamaks and stellarators. W6. Description of plasma behavior in MCF reactors including instabilities and the methods of plasma heating and control systems. W7. The issues of the plasma-wall interactions, material choice for plasma facing components, fuel cycle and fuel retention. W8. Semi-semester test. W9. Inertial Confinement Fusion (ICF) - direct and indirect drive versions, conventional and alternative methods. W10. Detailed presentation of the	

Description of course

	examples of the ICF approaches on the basis of NIF (indirect method) and HiPER (alternative/fast ignition). W11. Plasma diagnostics (pt.1). W12. Plasma diagnostics (pt. 2). W13. Research on the development of the prototypes of the fusion power plants employing MCF, ICF and hybrid methods. W14. Z-pinches, plasma focus devices – ideas and applications. Thermonuclear fusion trivia – cold fusion mythology. W15. Final test.
Methods of evaluation	Colloquium, final test.
Methods of verification of effects of education	See Table 38.
Exam	no
Literature	1. Materials provided by the lecturer. 2. Script / materials available at WF PW and IFPiLM.
Website of the course	fizyka.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 - 35, including a) attendance at the lectures- 30 hours; b) consultancy meetings - 5 hours. 2) The number of hours of independent work of student • systematic preparation for the lectures - 10 hours; • preparing for colloquium , final test- 15 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- 30 hours; b) consultancy meetings - 5 hours.
Number of ECTS credits on practical activities on the course	-

E. Additional information

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Table 38. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS702_W1**
Description:	Has knowledge of the concepts necessary to the classical description of the phenomena occurring in the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS702_W1**
Description:	Has knowledge of the concepts necessary to the classical description of the phenomena occurring in the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANS702_W2**
Description:	Has knowledge of the interaction of plasma with

Table 38. Learning outcomes	
	electromagnetic fields and electromagnetic waves.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS702_W2**
Description:	Has knowledge of the interaction of plasma with electromagnetic fields and electromagnetic waves.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANS702_W3**
Description:	Has knowledge of the issues fusion reactors in the configuration of magnetic and inertial maintain the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS702_W3**
Description:	Has knowledge of the issues fusion reactors in the configuration of magnetic and inertial maintain the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANS702_W3**
Description:	Has knowledge of the issues fusion reactors in the configuration of magnetic and inertial maintain the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
Code of effect:	**ANS702_W4**
Description:	It has knowledge of plasma diagnostics applied to various types of plasma phenomena occurring in nature and in technology, particularly in fusion reactors.
Verification:	Final test.
Field of study related learning outcomes	E2_W01
Area of study related learning outcomes	
Code of effect:	**ANS702_W4**
Description:	It has knowledge of plasma diagnostics applied to various types of plasma phenomena occurring in nature and in technology, particularly in fusion reactors.
Verification:	Final test.
Field of study related learning outcomes	E2_W02
Area of study related learning outcomes	
Code of effect:	**ANS702_W4**
Description:	It has knowledge of plasma diagnostics applied to various types of plasma phenomena occurring in nature and in technology, particularly in fusion reactors.

Table 38. Learning outcomes	
Verification:	Final test.
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS702_U1**
Description:	It can calculate the frequency plasma, Larmour radius, Debye length, critical frequency and other parameters of the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS702_U1**
Description:	It can calculate the frequency plasma, Larmour radius, Debye length, critical frequency and other parameters of the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS702_U1**
Description:	It can calculate the frequency plasma, Larmour radius, Debye length, critical frequency and other parameters of the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS702_U1**
Description:	It can calculate the frequency plasma, Larmour radius, Debye length, critical frequency and other parameters of the plasma.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
Code of effect:	**ANS702_U2**
Description:	Can use basic size measured in plasma (concentration, temperature, magnetic field) to determine the most important parameters (eg. Frequency plasma, Larmour radius, Debye length, critical frequency, etc..).
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS702_U2**
Description:	Can use basic size measured in plasma (concentration, temperature, magnetic field) to determine the most important parameters (eg. Frequency plasma, Larmour radius, Debye length, critical frequency, etc..).
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS702_U2**
Description:	Can use basic size measured in plasma (concentration, temperature, magnetic field) to determine the most important parameters (eg.

Table 38. Learning outcomes	
	Frequency plasma, Larmour radius, Debye length, critical frequency, etc..).
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS702_U2**
Description:	Can use basic size measured in plasma (concentration, temperature, magnetic field) to determine the most important parameters (eg. Frequency plasma, Larmour radius, Debye length, critical frequency, etc..).
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
Code of effect:	**ANS702_U3**
Description:	Able to identify problems related to specific issues (maintenance of plasma, plasma-wall interaction, fuel cycle, plasma heating, economic, etc.). Fusion energy.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS702_U3**
Description:	Able to identify problems related to specific issues (maintenance of plasma, plasma-wall interaction, fuel cycle, plasma heating, economic, etc.). Fusion energy.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS702_U3**
Description:	Able to identify problems related to specific issues (maintenance of plasma, plasma-wall interaction, fuel cycle, plasma heating, economic, etc.). Fusion energy.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS702_U3**
Description:	Able to identify problems related to specific issues (maintenance of plasma, plasma-wall interaction, fuel cycle, plasma heating, economic, etc.). Fusion energy.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
Code of effect:	**ANS702_U3**
Description:	Able to identify problems related to specific issues (maintenance of plasma, plasma-wall interaction, fuel cycle, plasma heating, economic, etc.). Fusion energy.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	

Table 38. Learning outcomes	
Code of effect:	**ANS702_U3**
Description:	Able to identify problems related to specific issues (maintenance of plasma, plasma-wall interaction, fuel cycle, plasma heating, economic, etc.). Fusion energy.
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANS702_U4**
Description:	He can choose the appropriate diagnostics to perform indirect measurements of selected physical quantities in the plasma depending on its parameters and the type
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS702_U4**
Description:	He can choose the appropriate diagnostics to perform indirect measurements of selected physical quantities in the plasma depending on its parameters and the type
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS702_U4**
Description:	He can choose the appropriate diagnostics to perform indirect measurements of selected physical quantities in the plasma depending on its parameters and the type
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U06
Area of study related learning outcomes	
Code of effect:	**ANS702_U4**
Description:	He can choose the appropriate diagnostics to perform indirect measurements of selected physical quantities in the plasma depending on its parameters and the type
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U08
Area of study related learning outcomes	
Code of effect:	**ANS702_U4**
Description:	He can choose the appropriate diagnostics to perform indirect measurements of selected physical quantities in the plasma depending on its parameters and the type
Verification:	Colloquium, final test.
Field of study related learning outcomes	E2_U10
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS702_K1**
Description:	Is aware of the importance for humanity and for nature development of environmentally friendly energy.
Verification:	Final test

Table 38. Learning outcomes	
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ANS702_K2**
Description:	can discuss the merits of social, environmental and economic issues related to energy and fusion energy in particular, and to provide fair and based on scientific information on these topics.
Verification:	Final test.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	
Code of effect:	**ANS702_K2**
Description:	can discuss the merits of social, environmental and economic issues related to energy and fusion energy in particular, and to provide fair and based on scientific information on these topics.
Verification:	Final test.
Field of study related learning outcomes	E2_K07
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	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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	Specialistic	
Type of course	Elective	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements	Detailed data contains syllabus of specific course.	
Limit of students	Detailed data contains syllabus of specific course.	
C. Effects of education and manner of teaching		
Purpose of course	Detailed data contains syllabus of specific course.	
Effects of education	See Table 39.	
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 39.	
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 39. Learning outcomes

Description of course

Code of course	ANW138	
Name of course	Master Diploma Seminar	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialistic	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	The aim of the course is to familiarize with the methods of collecting information on a given topic and its presentation in a public forum.	
Effects of education	See Table 40.	
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 40.	
Exam	no	

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.
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 40. Learning outcomes

General academic profile - skils

Code of effect:	**ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANW138_U2**
Description:	Can analyse and compare the applied technical solutions, in particular for devices, objects,

Table 40. Learning outcomes	
	systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANW138_U2**
Description:	Can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
Code of effect:	**ANW138_U3**
Description:	Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results.
Verification:	Prepared and evaluated report, oral presentation of the work..
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
Code of effect:	**ANW138_U4**
Description:	Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANW138_K1**
Description:	Understands the need for life-long learning; can inspire and organise the learning process of other people.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANW138_K2**
Description:	Can cooperate and work in a team, assuming various roles. Is aware of the social role of a technical university graduate, in particular understands the need to formulate and deliver, especially via mass media, information and opinions on technical achievements and other aspects of engineering activity; strives to make the information and opinions widely understandable, presenting various points of view.
Verification:	Prepared and evaluated report, oral presentation of the work.

Table 40. Learning outcomes	
Field of study related learning outcomes	E2_K03
Area of study related learning outcomes	
Code of effect:	**ANW138_K2**
Description:	Can cooperate and work in a team, assuming various roles. Is aware of the social role of a technical university graduate, in particular understands the need to formulate and deliver, especially via mass media, information and opinions on technical achievements and other aspects of engineering activity; strives to make the information and opinions widely understandable, presenting various points of view.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**ANW138_K3**
Description:	Is aware of the importance of engineering activity and understands its non-technical aspects and consequences, such as its impact on the environment and the responsibility for ensuing decisions.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	

Description of course

Code of course	ANW137	
Name of course	Master Diploma Thesis	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Power Engineering	
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. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Power Engineering	
Group of courses	Specialistic	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	3 (r.a. 2019/2020)	
Time of completion in the academic year	summer semester	
Preliminary requirements		
Limit of students		
C. Effects of education and manner of teaching		
Purpose of course	The aim of the course is to get the student's ability to perform advanced design, especially through the work of their own. In particular, the solution of the problem, selection of literature, research methods, presentation and critical analysis of the results. The exact specification depends on the subject of work.	
Effects of education	See Table 41.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	225h
	Computer lessons	0h
Contents of education	Detailed course content depends on the subject and character of the work (design and construction, computational, experimental).	
Methods of evaluation	Teacher (promoter of the Thesis) and the reviewer assumed execution of tasks. In case of a positive evaluation followed the final assessment is issued by the exam committee during the final exam.	
Methods of verification of effects of education	See Table 41.	
Exam	yes	
Literature	Books and academic textbooks, journals, Internet.	
Website of the course		
D. Student’s activity		
Number of ECTS credits	20	
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher – 226, including: a) consultancy meetings - 225 hours, b) final exam – 1 hours. 2) The number of hours of independent work of student – 300.	

Description of course

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

E. Additional information

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Table 41. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANW137_W1**
Description:	Has knowledge on development trends and most important new achievements in power engineering.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANW137_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANW137_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANW137_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can analyse and compare the applied technical solutions, in particular for devices, objects,

Table 41. Learning outcomes	
	systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANW137_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare

Table 41. Learning outcomes	
	an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U07
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	

Description of course

Code of course	ANS678	
Name of course	Internship at a Nuclear Installation	
Version of course	2013	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Nikołaj Uzunow	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
Type of course	Compulsory	
Language of course	angielski	
Nominal semester	4 (r.a. 2019/2020)	
Time of completion in the academic year	winter semester	
Preliminary requirements	ANS664 Elements of Nuclear Physics. ANS666 Nuclear Reactor Physics. ANS671 Contemporary Nuclear Reactor Systems (LWR, HWR). ANS672 Nuclear Reactor Modelling and Simulation. ANS673 Nuclear Fuels and Fuel Cycles. ANS675 NPP Safety. ANS701 Nuclear Instrumentation and Control.	
Limit of students	1	
C. Effects of education and manner of teaching		
Purpose of course	There are three main objectives of this course: 1. to acknowledge the student to the installation; i.e. the technological processes, operation rules and procedures, safety principles, etc.; 2. to involve the student into actual operation and/or research activities, being realised at the installation; 3. to create conditions appropriate to preparation of a master thesis by the student.	
Effects of education	See Table 42.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	Computer lessons	0h
Contents of education	The content is individual and depends on the technology specification of the installation and operation and/or research activity being realised by the student.	
Methods of evaluation	The student is being assessed based on a certificate, issued by the host (a person, responsible for the internship realisation on site). The certificate should include: 1. The time schedule of the internship. 2. A description the operation and/or research activities, in which the student has been involved. 3. An assessment of	

Description of course

	the student’s work (attitude, conscientiousness, commitment, intelligence) and its results.
Methods of verification of effects of education	See Table 42.
Exam	no
Literature	The student is supposed to be prepared to the specific conditions of the internship; i.e., to know and understand the technological processes. He is also obliged to obey the relevant rules and procedures.
Website of the course	estudia.meil.pw.edu.pl

D. Student’s activity

Number of ECTS credits	8
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher - 15, including: consultancy meetings - 15 hours. The consultancy meetings should concern the future master degree thesis, which is supposed to be based on this internship. Their purpose is to clarify the subject and relevant research/operation/engineering activities to be realised. 2) The number of hours of independent work of student 360 hours; i.e., at least two full months. It is perceived as a minimum period for a sensible technological internship at a nuclear installation. Within it the student is supposed to get acquainted to the technology processes, operation procedures, safety rules, etc. He is also to clarify the master degree thesis, based on this internship, and collect the indispensable data, knowledge and skills. The preparatory work on the thesis is also to be done within this time.
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 - 15, including: consultancy meetings - 15 hours.
Number of ECTS credits on practical activities on the course	8 ECTS credits – all the practical work, connected with fulfilling the requirements concerning the internship; i.e., work on site (operation/research/engineering), and homework (data processing/reporting/preparation).

E. Additional information

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Table 42. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANS678_W1**
Description:	The student knows and understands the physical processes being realised at the installation.
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his knowledge on the physical and

Table 42. Learning outcomes	
	operational processes.
Field of study related learning outcomes	E2_W13
Area of study related learning outcomes	
Code of effect:	**ANS678_W2**
Description:	The student knows and understands the rules and procedures concerning the installation operation.
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his knowledge on the physical and operational processes.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
Code of effect:	**ANS678_W3**
Description:	The student has a specific knowledge on the operation/research activities, in which he has been involved.
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his knowledge on the physical and operational processes.
Field of study related learning outcomes	E2_W19
Area of study related learning outcomes	
General academic profile - skils	
Code of effect:	**ANS678_U1**
Description:	The student is able to analyse technological processes in relation to operation/research activities
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his skills concerning process analysis and working in a group, and capability to prepare a master thesis.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS678_U1**
Description:	The student is able to analyse technological processes in relation to operation/research activities
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his skills concerning process analysis and working in a group, and capability to prepare a master thesis.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	

Table 42. Learning outcomes	
Code of effect:	**ANS678_U2**
Description:	The student has skills to perform operation/research activities individually or in a group.
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his skills concerning process analysis and working in a group, and capability to prepare a master thesis.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS678_U2**
Description:	The student has skills to perform operation/research activities individually or in a group.
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his skills concerning process analysis and working in a group, and capability to prepare a master thesis.
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANS678_U3**
Description:	The student is able to use the acquainted knowledge and skills to prepare a relevant master degree thesis
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his skills concerning process analysis and working in a group, and capability to prepare a master thesis.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANS678_U3**
Description:	The student is able to use the acquainted knowledge and skills to prepare a relevant master degree thesis
Verification:	The student is being assessed based on a certificate, issued by the host, and on consultancy meetings with a teacher. This assessment concerns the student’s work and its results, esp. his skills concerning process analysis and working in a group, and capability to prepare a master thesis.
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANS678_K1**

Table 42. Learning outcomes	
Description:	The student is able to pass the knowledge on the operation/research activities he has been involved into
Verification:	The student is being assessed based on consultancy meetings with a teacher. This assessment concerns the student’s capability to present the acquainted knowledge.
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	

Description of course

Code of course	ANW138	
Name of course	Master Diploma Seminar	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
Place of teaching of course	Faculty of Power and Aeronautical Engineering	
Place of realization of course	Faculty of Mathematics and Information Science	
Coordinator of course	Prof. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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 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 43.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	0h
	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 43.	
Exam	no	

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.
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 43. Learning outcomes

General academic profile - skils

Code of effect:	**ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANW138_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well. Can set the goals of further education and organise his/her learning process.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U05
Area of study related learning outcomes	
Code of effect:	**ANW138_U2**
Description:	Can analyse and compare the applied technical solutions, in particular for devices, objects,

Table 43. Learning outcomes	
	systems, processes and services. Can suggest improvements of existing technical solutions. .
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANW138_U2**
Description:	Can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services. Can suggest improvements of existing technical solutions. .
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
Code of effect:	**ANW138_U3**
Description:	Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	
Code of effect:	**ANW138_U4**
Description:	Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
General academic profile - social competences	
Code of effect:	**ANW138_K1**
Description:	Understands the need for life-long learning; can inspire and organise the learning process of other people.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_K01
Area of study related learning outcomes	
Code of effect:	**ANW138_K2**
Description:	Can cooperate and work in a team, assuming various roles. Is aware of the social role of a technical university graduate, in particular understands the need to formulate and deliver, especially via mass media, information and opinions on technical achievements and other aspects of engineering activity; strives to make the information and opinions widely understandable, presenting various points of view.
Verification:	Prepared and evaluated report, oral presentation of the work

Table 43. Learning outcomes	
Field of study related learning outcomes	E2_K03
Area of study related learning outcomes	
Code of effect:	**ANW138_K2**
Description:	Can cooperate and work in a team, assuming various roles. Is aware of the social role of a technical university graduate, in particular understands the need to formulate and deliver, especially via mass media, information and opinions on technical achievements and other aspects of engineering activity; strives to make the information and opinions widely understandable, presenting various points of view.
Verification:	Prepared and evaluated report, oral presentation of the work
Field of study related learning outcomes	E2_K07
Area of study related learning outcomes	
Code of effect:	**ANW138_K3**
Description:	Is aware of the importance of engineering activity and understands its non-technical aspects and consequences, such as its impact on the environment and the responsibility for ensuing decisions.
Verification:	Prepared and evaluated report, oral presentation of the work.
Field of study related learning outcomes	E2_K02
Area of study related learning outcomes	

Description of course

Code of course	ANW137	
Name of course	Master Diploma Thesis	
Version of course	2013.	
A. Place of the course in system of studies		
Level of education	Second cycle studies	
Form and mode of studies	full-time	
Profile of studies	General academic profile	
Specialisation	Nuclear Power Engineering	
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. Paweł Pyrzanowski	
B. General characteristic of the course		
Block of courses	Nuclear Power Engineering	
Group of courses	Specialistic	
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 aim of the course is to get the student's ability to perform advanced design, especially through the work of their own. In particular, the solution of the problem, selection of literature, research methods, presentation and critical analysis of the results. The exact specification depends on the subject of work.	
Effects of education	See Table 44.	
Form of didactic studies and number of hours per semester	Lecture	0h
	Exercise type of course	0h
	Laboratory	0h
	Project type of course	225h
	Computer lessons	0h
Contents of education	Detailed course content depends on the subject and character of the work (design and construction, computational, experimental).	
Methods of evaluation	Teacher (promoter of the Thesis) and the reviewer assumed execution of tasks In case of a positive evaluation followed the final assessment is issued by the exam committee during the final exam.	
Methods of verification of effects of education	See Table 44.	
Exam	yes	
Literature	Books and academic textbooks, journals, Internet.	
Website of the course		
D. Student’s activity		
Number of ECTS credits	20	
Number of hours of student’s work to achieve effects of education	1) Number of hours that require the presence of a teacher – 226, including: a) consultancy meetings - 225 hours, b) final exam – 1 hours. 2) The number of hours of independent work of student - 300.	

Description of course

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

E. Additional information

Notes	
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Table 44. Learning outcomes

General academic profile - knowledge

Code of effect:	**ANW137_W1**
Description:	Has knowledge on development trends and most important new achievements in power engineering.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_W14
Area of study related learning outcomes	

General academic profile - skils

Code of effect:	**ANW137_U1**
Description:	Can gather information from literature, databases and other chosen sources, also in English or another foreign language which is a language of international communication in power engineering; can integrate the information obtained, interpret it and evaluate critically, as well as draw conclusions, and formulate and justify opinions well.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U01
Area of study related learning outcomes	
Code of effect:	**ANW137_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U15
Area of study related learning outcomes	
Code of effect:	**ANW137_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can analyse and compare the applied technical solutions, in particular for devices, objects,

Table 44. Learning outcomes	
	systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U19
Area of study related learning outcomes	
Code of effect:	**ANW137_U2**
Description:	Can evaluate the usefulness and possibility of application of modern achievements (techniques and technologies) in power engineering. Can analyse and compare the applied technical solutions, in particular for devices, objects, systems, processes and services. Can suggest improvements of existing technical solutions.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U20
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U04
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare

Table 44. Learning outcomes	
	an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U07
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U02
Area of study related learning outcomes	
Code of effect:	**ANW137_U3**
Description:	Can communicate using various techniques in the professional environment and other environments, also in English or another foreign language which is a language of international communication in power engineering. Can prepare a scientific study in Polish and a short scientific text in a foreign language regarded as basic for power engineering, and present his/her own research results. Can prepare and give an oral presentation on detailed issues from the field of power engineering in Polish and in a foreign language. Can use information and communication techniques appropriate to realise tasks typical for power engineering, can prepare an article for publication presenting his/her own analyses.
Verification:	Assessment of master thesis and the diploma examination
Field of study related learning outcomes	E2_U03
Area of study related learning outcomes	