Warsaw University of Technology

Faculty of Power and Aeronautical Engineering

CATALOGUE OF COURSES

Graduate studies (M.Sc. degree)
Tok 2016

Warsaw 2018

FIELDS OF STUDIES AND SPECIALIZATIONS

The graduate studies last 3 semesters and conclude with the Master of Science degree. They are offered in two specializations. Please see the table below:

Field of Studies	*Specialization*
Aerospace Engineering	Aerospace Engineering
Power Engineering	Power Engineering
	Nuclear Power engineering

The program of M.Sc. studies is the same for all specializations during the first two semesters. The studies within a particular specialization can be launched when a sufficient number of students have been admitted by the Dean of the Faculty.

Heads of specializations:

- Aerospace Engineering – prof. Cezary Galiński
- Power Engineering – prof. Tadeusz Skoczkowski
- Nuclear Power Engineering – dr Nikołaj Uzunow

Regulations of Studies

Students must comply with the „Regulations of Studies of Warsaw University of Technology" accepted by the University Senate. Please see the following sections for more details.

Dean of the Faculty decides in matters not specified by the Regulations.

Course of studies

From the second semester students must design an individual study plan for next semesters, which includes the obligatory courses, especially the specialization courses that must be repeated, and possibly the courses included in the program for higher semesters of studies.

When designing the individual study plan for the next semester, students must decide on:

- Electives - if included in the programme. There is no separate list of electives. An elective can be any course which is not included in the programme of other fields of studies given in English. Dean of the Faculty approves optional electives, e.g. lectured by the Visiting Professors.

- Division and subject of intermediate projects.
- Division and scope of diploma seminar. The seminar provides knowledge and skills required in diploma project preparation.
- Division and subject of diploma project. The division is the same as in case of diploma seminar.

Students can also select from a range of foreign language or physical education courses.

Individual study plan for the next semester must be prepared according to the prerequisites given in the catalogue, i.e. courses which must be completed before the beginning of the current course.

After each semester, the student performance is assessed and the registration procedure for the next semester is performed. At the end of the study program all the requirements for graduation must be fulfilled.

Registration procedures for each semester

ECTS Credit System

During each course a certain number of ECTS points are earned in accordance with the course significance, difficulty and the student workload required. The total number of credit points that can be earned for all courses in each semester is 30.

Evaluation System

1. At the end of each semester, students obtain one final grade for each course (regardless of the course division into lectures, tutorials and laboratory work).
2. The grading scale starts with a failing grade 2 and consists of five passing grades: 3, $3^{1/2}$, 4, $4^{1/2}$, 5.
3. In exceptional cases, students may obtain “condition” *N* final grade, which means that the student performance during the semester is evaluated positively, but the student is not allowed to take the final exam (due to valid reasons). The lecturer defines the procedures in case of “condition” *N*. This grade obliges the student to complete the course by the end of the following semester the latest, so that he does not need to repeat it and pay extra fee. If the student fails to complete the course during the following semester, the course must be repeated. Consequently, the student is obliged to cover the costs of the course repetition according to University Regulations. There are no credit points for “condition” *N*.

Requirements for registration for each semester

1. In order to register for the next semester, students are required to have a sufficient number of credit points as given in the table below.

M. Sc. Programme			
Registration for semester	II	III	IV[*)]
Number of collected credits	22	50	80

[*)] Applies to 4 semester studies

2. Students who fail to collect the required number of points are removed from the study programme, with the exception of the last two semesters of studies, for which the student can re-register.
3. Students must repeat the failed course during the next available semester. Courses can be repeated twice. Students who fail to complete the course three times will be removed from the Faculty. Students are obliged to cover the costs of course repetition according to University Regulations.
4. Dean can approve student sick leave or leave of absence. First year students may obtain sick leave only.
5. In some cases, the Dean can grant a student who is on the leave, the right to take certain courses "in advance".
6. Duration of graduate studies must not be longer than five semesters. In case the student is granted the leave, duration of studies is prolonged accordingly.
7. Surplus credit points accumulated during B.Sc. studies are not transferred to M.Sc. studies. The M.Sc. studies always begin with zero credit points.

Requirements for graduation

Requirements for graduating with the M.Sc. degree are as follows:

- Completion of all courses in the M.Sc. study program,
- For Aerospace Engineering 4-week internship in industry (recommended)
- Collecting 90 ECTS points including the preparation of M.Sc. thesis
- Writing M.Sc. thesis and passing the final exam.

The final grade for the completed study program is an average of grades received for each course. Failing grades are not included in the average.

$$Average\ grade = \frac{\sum_{i \in Z} g_i \cdot O_i}{\sum_{i \in Z} g_i}$$

Z – number of completed courses,

g_i – number of ECTS points allocated to the course,

O_i – grade for the course.

Final examinations are held four times a year – in January, March, June and October.

Brief study schedule

Brief study schedule includes information on the course title and the number of hours per semester and week. Information about a course division into lectures, tutorials, laboratory work and projects as well as the number of credit points can be found in a table for each semester.

Complete information about courses can be found in the last part of the catalogue on courses contents.

LEGEND for the list of courses (following pages)

In the following section the list of courses is given, divided into suggested sequence during standard semesters of study.

In each semester the standard set of courses gives 30 ECTS points. In the case the required (named and specified) courses do not fill standard 30 ECTS points – then ELECTIVE courses should be taken in the amount summing the semester load to 30 ECTS. Compare remarks on elective courses in the section "Course of Studies".

In the headers of tables the following abbreviations/acronyms are used:

Lc – Lecture

T – Tutorial

Lb – Laboratory

P – Project

S – Seminar

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Field of Study Energetyka

Nuclear Power Engineering	Semester 1
	Semester 2
	Semester 3
	Semester 4

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Field of Study Energetyka
Field of Specialization Nuclear Power Engineering
Semester 1

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK348	Computational Fluid Dynamics	2	0	1	0	0	3
2.	ML.ANK415	Energy Transport	1	1	0	0	0	2
3.	ML.ANK342	Finite Element Method 1	2	0	1	0	0	4
4.	ML.ANK486	Mathematical Modelling and Process Identification	2	1	0	0	0	4
5.	ML.ANK347	Numerical Methods in Heat Transfer	2	0	1	0	0	3
6.	ML.ANK481A	Partial Differential Equations	2	1	0	0	0	4

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.EC02	Elective Courses 2 ECTS	0	0	0	0	0	2
2.	ML.ANS664	Elements of Nuclear Physics	2	1	1	0	0	4
3.	ML.ANK487	Energy Policy and Law	2	0	0	0	0	2
4.	ML.ANS700	Legal Frames for Nuclear Power Industry	1	0	0	0	0	2

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Field of Study Energetyka
Field of Specialization Nuclear Power Engineering
Semester 2

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK371	Business Law	2	1	0	0	0	2
2.	ML.ANK385	Neural Networks	2	0	0	0	0	3
3.	ML.ANK480	Physics 2	2	0	0	0	0	2
4.	ML.ANS599A	Statistical and Nonequilibrium Thermodynamics	2	0	0	0	0	3

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANS671	Contemporary Nuclear Reactor Systems (LWR, HWR)	3	0	0	0	0	4
2.	ML.EC02A	Elective Courses 2 ECTS A	0	0	0	0	0	2
3.	ML.ANS673	Nuclear Fuels and Fuel Cycles	2	0	0	0	0	2
4.	ML.ANS672	Nuclear Reactor Modelling and Simulation	2	1	2	0	0	6
5.	ML.ANS666	Nuclear Reactor Physics	2	1	2	0	0	6

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Field of Study Energetyka
Field of Specialization Nuclear Power Engineering
Semester 3

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANS559	Information Systems in Management	2	0	0	0	0	2
2.	ML.ANK445	Project Management	2	0	0	0	0	2

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.EC02B	Elective Courses 2 ECTS B	0	0	0	0	0	2
2.	ML.ANK382	Engineering Project	0	0	0	4	0	3
3.	ML.ANS670A	GenIV Nuclear Reactor Systems (HTR, FBR)	2	0	2	0	0	4
4.	ML.ANS703	Hazard Analysis in Nuclear Power Plants	2	0	0	0	0	2
5.	ML.ANK491	Intermediate Masters Project	0	0	0	6	0	6
6.	ML.ANS676	NPP Operation and Maintenance	2	0	0	0	0	2
7.	ML.ANS675A	NPP Safety	2	1	0	1	0	4
8.	ML.ANS688A	Nuclear energy and international security	2	0	1	0	0	3

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Field of Study Energetyka
Field of Specialization Nuclear Power Engineering
Semester 4

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANS678	Internship at a nuclear installation	0	0	0	0	20	8
2.	ML.ANW138	Master Diploma Seminar	0	0	0	2	0	2
3.	ML.ANW137	Master Diploma Thesis	0	0	0	15	0	20

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Sylabus

Course name:	**Business Law**
Course name in other language:	
Short name:	**BL**
Course number:	**ML.ANK371**
Course language:	**English**
Responsible for the course:	**dr Dominik Sypniewski**

				Lc,	T,	Lb,	P,	S,
ECTS:	**2**	Number of hours:						
Course level:	**Intermediate**	weekly:		**2,**	**1,**	0,	0,	0,
Form of grading:	**Continous assesment**	by semester:		**30,**	**15,**	0,	0,	0,

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**
	Power engineering	**graduate studies, full time**	**2**

Contents - short:

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.

Bibliography:

1. M. Możdzeń-Marcikowski, 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.

Course results:

After completing his course the students will be able to understand and prepare basic contracts. He will distinguish between different forms partnerships and companies. He will be able to set up a business and find basic information about business units in the National Court Register. He will have basic notions about different forms of job contracts and taxation.

Grading criteria:

Multiple choice test

Detailed contents:

1. Introduction to jurisprudence. Basic concepts
2. Constitutional Law

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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. Competition Law
14. Introduction to tax law
15. Test & Assessment

Additional remarks (by course staff):

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Sylabus

Course name:	**Computational Fluid Dynamics**
Course name in other language:	
Short name:	**CFD**
Course number:	**ML.ANK348**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Jacek Rokicki**

ECTS:	**3**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[**2,** 0, **1,** 0, 0,]
Form of grading:	**Exam**	by semester:	[**30,** 0, **15,** 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**7**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**6**

Contents - short:

Knowledge about methods and tools of computational fluid dynamics

Bibliography:

1. Hirsch, Charles, Numerical computation of internal and external flows, 2007
2. Versteeg, Henk Kaarle, An introduction to computational fluid dynamics, 2007

Course results:

Grading criteria:

2 tests on theoretical part, work and progress of each student are evaluated in the framework of the point system, individual semester project

Detailed contents:

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.

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Additional remarks (by course staff):

The laboratory groups can consist of at most 12 students

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Sylabus

Course name:	**Contemporary Nuclear Reactor Systems (LWR, HWR)**
Course name in other language:	**Współczesne reaktory jądrowe (LWR, HWR)**
Short name:	**CONUR**
Course number:	**ML.ANS671**
Course language:	**English**
Responsible for the course:	**dr inż. Rafał Laskowski**

			Lc	T	Lb	P	S
ECTS:	**4**	Number of hours:	Lc,	T,	Lb,	P,	S,
Course level:	**Advanced**	weekly:	**3,**	0,	0,	0,	0,
Form of grading:	**Exam**	by semester:	**45,**	0,	0,	0,	0,

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**

Contents - short:

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.

Bibliography:

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

Course results:

Understanding of basic types of PWR, BWR, and HWR nuclear reactors.
Understanding the structure, heat diagrams, working parameters, performance, and limitations of the reactors, as well as materials used to build them.

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Ability to perform basic calculations, e.g. of a reactor and pump power.
Familiarisation with the latest solutions concerning safety systems.
Understanding the structure concept of basic types of PWR, BWR, and HWR nuclear reactors.
Understanding the mechanism of power control in the reactors.
Understanding the purposes, functions and designs of research reactors.
Familiarisation with PWR, BWR and CANDU simulators.
Ability to perform a simulation using a PWR, BWR and CANDU simulator, and to interpret and verify its results.
Understanding of third-generation reactors and their development lines.
Knowledge of reactor building materials and their properties.

Grading criteria:

Assessment of students' presentations on topics concerning PWR, BWR and HWR.
Final Test (examination).

Detailed contents:

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, 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).

Additional remarks (by course staff):

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Sylabus

Course name:	**Elective Courses 2 ECTS**
Course name in other language:	**Elective Courses 2 ECTS**
Short name:	**EC02**
Course number:	**ML.EC02**
Course language:	**Polish**
Responsible for the course:	**Brak Danych**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
:		weekly:	[0, 0, 0, 0, 0,]
Form of grading:	**Continous assesment**	by semester:	[0, 0, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**

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Sylabus

Course name:	**Elective Courses 2 ECTS A**
Course name in other language:	**Elective Courses 2 ECTS A**
Short name:	**EC02A**
Course number:	**ML.EC02A**
Course language:	**English**
Responsible for the course:	**Brak Danych**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
:		weekly:	[0, 0, 0, 0, 0,]
Form of grading:	**Continous assesment**	by semester:	[0, 0, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**

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Sylabus

Course name:	**Elective Courses 2 ECTS B**
Course name in other language:	**Elective Courses 2 ECTS B**
Short name:	**EC02B**
Course number:	**ML.EC02B**
Course language:	**English**
Responsible for the course:	**Brak Danych**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
:		weekly:	[0, 0, 0, 0, 0,]
Form of grading:	**Continous assesment**	by semester:	[0, 0, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**

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Sylabus

Course name:	**Elements of Nuclear Physics**
Course name in other language:	**Elementy Fizyki Jądrowej**
Short name:	**ELNUP**
Course number:	**ML.ANS664**
Course language:	**English**
Responsible for the course:	**prof. dr hab. Piotr Magierski**

ECTS:	**4**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	weekly:	[**2,**	**1,**	**1,**	0,	0,]
Form of grading:	**Exam**	by semester:	[**30,**	**15,**	**15,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**

Contents - short:

Structure of matter and fundamental interactions. Basic properties of atomic nuclei. Nuclear forces. Nuclear models. Nuclear reactions. Nuclei in nonequilibrium state: radioactivity,
spontaneous and induced fission. Methods of detection and acceleration of particles.

Bibliography:

1. J.-L. Basdevant, J. Rich, M. Spiro, Fundamentals in Nuclear Physics. From Nuclear Structure to Cosmology, Springer
2. E. Skrzypczak, Z. Szeflinski, "Wstęp do fizyki jądra atomowego i cząstek elementarnych", PWN
3. A. Strzałkowski. "Wstęp do fizyki jądra atomowego", PWN
4. K. Muchin, "Doświadczalna fizyka jądrowa", WNT

Course results:

During the course student gets acquainted with properties of atomic nuclei and nuclear interactions. After completing the course student is able to estimate binding energy of a given nucleus, determine some properties of its ground state and low-energy excitations, as well as determine possible decay channels. He/she possess an understanding
of physical processes taking place in nuclear reactors and stars.

Grading criteria:

Grading is based on the results of two written tests. In order to obtain a positive final
grade one has to pass both tests.

Detailed contents:

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.

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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.
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.

Additional remarks (by course staff):

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Sylabus

Course name:	**Energy Policy and Law**
Course name in other language:	
Short name:	**EPAL**
Course number:	**ML.ANK487**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tadeusz Skoczkowski**

ECTS:	**2**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	weekly:	[**2,**	0,	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[**30,**	0,	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**

Recommended prerequisites:

Electric Power Systems (ML.ANK381)

Contents - short:

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.

Bibliography:

1. Jaccard M.: Sustainable Fossil Fuels, Cambridge University Press, 2005.
2. Kleinpeter M.: Energy planning and policy, John Wiley & Sons, 1995.
3. Toward sustainable energy future, OECD/IEA, 2001, http://www.oecd.org/bookshop
4. World Energy Outlook, International Energy Agency, Paris.

Further Readings:
Selected readings from OECD/IEA and Energy Charter Secretariat websites (provided by lecturer).

Course results:

Understanding of the process of globalisation in the world's energy market.
To get familiar with objectives of the energy policy of the European Commission.

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Ability to understand business processes in energy market and market law regulations.
Ability to understand the EU energy law and environmental law influencing energy processes.
Ability to understand Polish energy law and main decrees related.
Ability to understand main research trends in the EU.
Ability to recognise benefits, driving forces and barriers to distributed generation.

Grading criteria:

Tests in lectures+final assessment.

Detailed contents:

1. Energy general. Role of Energy. World's Energy Resources. 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 Selected Countries (USA, China, India, Russia, Brazil). Global Energy Investments. Nuclear Option. Development of RES Energy. Role of Energy Efficiency. Climate Change Impact. International Energy Agency. Global strategic petroleum reserves. Energy Charter Treaty. International Atomic Energy Agency.
2. 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.
3. 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.
4. 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 Under Competition. Investment in Energy Sector. Latest EU Legislative Proposals.
5. Energy research and promotion. Energy in EU Framework Programs. SET-Plan. Intelligent Energy Europe Program.
6. Energy law in Poland. Energy Sector in Poland. 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. Feed-in Tariff. Green Certificates. Red Certificates. Weaknesses. Main Decrees to Energy Law. Tariff Decree. Connection Decree. Energy Efficiency Law. Objectives. Main Provisions. White Certificates. Energy Efficiency Financing. NEEAP. Development of Nuclear Law. Competition Law.
7. Environmental impact of energy sector. Energy Related Environmental Directives: IPPC, LCP. Environmental Accounting GHG Emission Reduction. EMAS. ISO 1400. EN 16001. 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

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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.
8. Legal status of Distributed Generation (DG). 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. RES Directives. National Renewable Energy Action Plans. RES Financing. RES in Selected Countries.

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Sylabus

Course name:	**Energy Transport**
Course name in other language:	**Transport energii**
Short name:	**ENTRA**
Course number:	**ML.ANK415**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Jerzy Banaszek**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[**1**, **1**, 0, 0, 0,]
Form of grading:	**Exam**	by semester:	[**15**, **15**, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**

Contents - short:

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.

Bibliography:

1. Y.A. Cengel and M.A. Boles,“Thermodynamics, An Engineering Approach”, Sixth Edition, Mc Graw Hill, Boston, 2008.
2. Y.A. Cegel, “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.

Course results:

After completing the course a student will be able to identify main sources of energy loss in various heat and mass transfer systems, and to perform an elementary quantitative analysis needed for the quality assessment of energy and mass transfer phenomena in various parts of power plant installations.

Grading criteria:

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.

Detailed contents:

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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 relations. Analogy of heat, mass and momentum transfer, Chilton-Colburn analogy and its practical application. 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).

Additional remarks (by course staff):

Handouts will be provided

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Sylabus

Course name:	**Engineering Project**
Course name in other language:	
Short name:	**ENPROJ**
Course number:	**ML.ANK382**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tadeusz Skoczkowski**

ECTS:	**3**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	weekly:	[0,	0,	0,	**4,**	0,]
Form of grading:	**Exam**	by semester:	[0,	0,	0,	**60,**	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**
	Power engineering	**graduate studies, full time**	**2**

Contents - short:

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.

Bibliography:

To be provided by the tutor.

Course results:

The course provides you with opportunities to develop and demonstrate the following learning outcomes.
Knowledge and understanding:
• understanding of and ability to apply the relevant knowledge, skills learnt up-to-date in other courses,
• ability to integrate engineering knowledge across traditional boundaries,
• refinement of skills in professional methods of design a specific engineering object aided by commercial software,
• familiarity with principles and conventions of project management and execution.
Cognitive skills:
• to gather, analyse, evaluate and use relevant material to complete the project,

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• to identify and refine objectives and content for the project within the constraints of a given broad project topic,
• to present the project results and draw well-grounded conclusions based on the evidence assembled.
Key skills:
• to organise yourself and your work appropriately,
• to produce a written report of 4 000-5 000 words on your specialist topic,
• to develop a self-awareness of the skills and activities needed to carry out a project by listing, describing, and practically demonstrating them.
Practical and/or professional skills:
• the course is specifically designed to equip you with the project-related skills which will contribute to your formation and development as a professional engineer.

Grading criteria:

final acceptance of the project

Detailed contents:

The core work in the project is based on a specific commercial software taught and used at the department e.g. FLUENT, ANSYS, MATLAB, 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.

Additional remarks (by course staff):

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Sylabus

Course name:	**Finite Element Method 1**
Course name in other language:	
Short name:	**FEM1**
Course number:	**ML.ANK342**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Grzegorz Krzesiński**

ECTS:	**4**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	weekly:	[**2,**	0,	**1,**	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[**30,**	0,	**15,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**4**

Recommended prerequisites:

Mechanics of Structures 1 (ML.ANW117), Mechanics of structures 3 (ML.ANK428)

Contents - short:

The course supplies the basic knowledge and skills required for understanding FEM and simple practical applications of the method. It consists of the theoretical part (30 hours of the lectures) and the practical ones (15 hours of the finite element modelling using ANSYS program).

Bibliography:

Lecture notes
Bijak-Żochowski M., Jaworski A., Krzesiński G., Zagrajek T.: Mechanika Materiałów i Konstrukcji, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2006
Zagrajek T., Krzesiński G., Marek P.: Metoda elementów skończonych w mechanice konstrukcji, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2006
Cook R. D.: Finite Element Modeling for Stress Analysis, John Wiley & Sons , 1995
Saeed Moaveni: Finite Element Analysis. Theory and Application with ANSYS, Paerson Ed. 2003

Course results:

After completing the course the students will be able to build simple FE models and will understand the applications and limitations of the method in stress analysis.

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Grading criteria:

Assesment based on 2 tests and the results of computer lab (the reports)

Detailed contents:

Lectures: Approximate methods – Finite Element Method, Finite Difference Method, Boundary Element Method. Approximate solutions of 2D Poisson equation. FEM versus Ritz method. Bars, beams, trusses and frames. Basic relations in 2D and 3D stress analysis.Typical algorithms of FEM in static linear stress analysis, popular commercial FE software packages.Accuracy of FE analysis.
Laboratory: Introduction to practical problems of FE modeling in ANSYS, 2D and 3D linear stress analysis, analysis of a simple shell structure.

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Sylabus

Course name:	**GenIV Nuclear Reactor Systems (HTR, FBR)**
Course name in other language:	
Short name:	**FUNUR**
Course number:	**ML.ANS670A**
Course language:	**English**
Responsible for the course:	**dr inż. Nikołaj Uzunow**

ECTS:	**4**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
:		weekly:	[	**2,**	0,	**2,**	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[	**30,**	0,	**30,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**

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Sylabus

Course name: **Hazard Analysis in Nuclear Power Plants**
Course name in other language:
Short name: **HANP**
Course number: **ML.ANS703**
Course language: **English**
Responsible for the course: **dr inż. Rafał Porowski**

ECTS:	**2**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
:		weekly:	[	**2,**	0,	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[	**30,**	0,	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**

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Sylabus

Course name:	**Information Systems in Management**
Course name in other language:	
Short name:	**ITSIM**
Course number:	**ML.ANS559**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Janusz Lewandowski**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[**2,** 0, 0, 0, 0,]
Form of grading:	**Continous assesment**	by semester:	[**30,** 0, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**
	Power engineering	**graduate studies, full time**	**3**

Contents - short:

Base knowledge of database management systems and SQL. Understanding structure of ERP systems and its role in improving the management processes

Bibliography:

Daniel Edmund O'Leary: “Enterprise Resource Planning Systems: Systems, Life Cycle, Electronic Commerce, and Risk”

Course results:

Grading criteria:

paper about one of ERP modules and final test

Detailed contents:

Database management systems, SQL language, database modelling. Materials Resource Planning, Enterprise Resource Planning, Typical modules and their tasks – CRM, SCM and others. Presentation of the chosen system. Integration with Data Acquisition and Control System. Internet portal business management.

Additional remarks (by course staff):

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Sylabus

Course name:	**Intermediate Masters Project**
Course name in other language:	
Short name:	**IMPRO**
Course number:	**ML.ANK491**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Paweł Pyrzanowski**

ECTS:	**6**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[0, 0, 0, **6,** 0,]
Form of grading:	**Exam**	by semester:	[0, 0, 0, **90,** 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**
	Power engineering	**graduate studies, full time**	**2**
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**graduate studies, full time**	**2**

Contents - short:

Solution of a given problem and the elaboration of a short report on the subject of performed work.

Bibliography:

Books and textbooks, scientific journals, the Internet.

Course results:

Gaining the ability: to solve problems, perform selection of relevant literature, choosing research methods, presentation of obtained results and its critical analysis.

Grading criteria:

Evaluation criteria: problem statement, literature overview, problem solution and its written presentation.

Detailed contents:

Detailed contents depend on the topic and the nature of work (design-prototyping, computational, experimental).

Additional remarks (by course staff):

The scope of work is terms to consultation between the student and his individual supervisor. The topic must be consistent with study programme and specialisation.

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Sylabus

Course name:	**Internship at a nuclear installation**
Course name in other language:	
Short name:	**INUIN**
Course number:	**ML.ANS678**
Course language:	**English**
Responsible for the course:	**dr inż. Nikołaj Uzunow**

ECTS:	**8**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
:		weekly:	[	0,	0,	0,	0,	**20,**]
Form of grading:	**Continous assesment**	by semester:	[	0,	0,	0,	0,	**300,**]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**4**

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Sylabus

Course name:	**Legal Frames for Nuclear Power Industry**
Course name in other language:	**Ramy prawne energetyki jądrowej**
Short name:	**LEGNU**
Course number:	**ML.ANS700**
Course language:	**English**
Responsible for the course:	**dr inż. Przemysław Żydak**

ECTS:	**2**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
:		weekly:	[**1,**	0,	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[**15,**	0,	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**

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Sylabus

Course name:	**Master Diploma Seminar**
Course name in other language:	**Seminarium dyplomowe magisterskie**
Short name:	**MDS**
Course number:	**ML.ANW138**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Paweł Pyrzanowski**

ECTS:	**2**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	weekly:	[	0,	0,	0,	**2,**	0,]
Form of grading:	**Exam**	by semester:	[	0,	0,	0,	**30,**	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**graduate studies, full time**	**3**
	Nuclear Power Engineering	**graduate studies, full time**	**4**
	Power engineering	**graduate studies, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**graduate studies, full time**	**3**
	Aerospace engineering	**graduate studies, full time**	**3**

Contents - short:

Gaining skills of information gathering and its critical analysis; learning presentation skills.

Bibliography:

Books, textbooks, scientific journals, the Internet

Course results:

Gaining the ability of information gathering, and performing its critical assessment (especially concerning information obtained from the Internet). Learning how to prepare short and concise presentations and how to present in limited time. Learning how to defend a thesis in front of an audience.

Grading criteria:

The elements that are subject to evaluation include: the quality of collected information, quality of elaborated analysis, especially the critical discussion of collected data, and quality of the given presentation. It is recommended that the presentation is conducted during a student group meeting, and the students should contribute to its evaluation.

Detailed contents:

It is recommended that the subject is completed in two steps:

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1. Collecting materials on the given subject with the aid of all available information sources: including books, textbooks, journals and the Internet. The collected material must be analysed and summarised in the form of a short report containing references to the literature sources used. This part should be conducted under the supervision of the advisor and its progress must be controlled during individual meetings. An important part of this stage is a critical analysis of the collected material and its relation to the knowledge gained during studies. It is required to use both domestic and international source materials.
2. Work presentation. Results presentation must be performed in front of a bigger audience during a student group seminar. Each of the students will be given 10-15 minutes of presentation time, followed with questions stated by the seminar participants. This stage is considered preparation to the upcoming thesis defense.

Additional remarks (by course staff):

The seminar should be prepared under the supervision of a scientific supervisor. It must follow the diploma thesis themes. The seminar should match the area of studies programme and specialisation.

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Sylabus

Course name:	**Master Diploma Thesis**
Course name in other language:	
Short name:	**MDT**
Course number:	**ML.ANW137**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Paweł Pyrzanowski**

ECTS:	**20**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Advanced**	weekly:	[0, 0, 0, **15,** 0,]
Form of grading:	**Exam**	by semester:	[0, 0, 0,**225,** 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**graduate studies, full time**	**3**
	Nuclear Power Engineering	**graduate studies, full time**	**4**
	Power engineering	**graduate studies, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**graduate studies, full time**	**3**
	Aerospace engineering	**graduate studies, full time**	**3**

Contents - short:

Synthesis of engineering knowledge acquired during first and second degree studies. Gaining the ability of solving the given problem and preparing the report.

Bibliography:

Books, textbooks, scientific journals, the Internet

Course results:

Gaining the ability: - to solve the research problem , - perform selection of relevant literature, - choosing research methods, - presentation of obtained results and its critical analysis.
Detailed specification depend on the topic of work.

Grading criteria:

The promoter and reviewer verify the realisation of task given to the student, they fill out the thesis assessment forms. With positive evaluation the student is permitted to diploma defence, the final grade is decided by the commission.

Detailed contents:

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Detailed contents depend on the topic and the nature of work (design-prototyping, computational, experimental).

Additional remarks (by course staff):

The scope of diploma work is terms to consultation between the student and his individual supervisor. The topic must be consistent with study programme and specialisation
The elaborated thesis report is evaluated. The student is permitted to attend the diploma exam (and the diploma defence) if he/she completed the required study programme and the other requirements specified in study regulations are fulfilled.

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Sylabus

Course name:	**Mathematical Modelling and Process Identification**
Course name in other language:	
Short name:	**MMPI**
Course number:	**ML.ANK486**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Janusz Lewandowski**

ECTS:	**4**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	weekly:	[	**2,**	**1,**	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[	**30,**	**15,**	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**

Contents - short:

Tasks and methods of modeling. Physical and mathematical models of objects and processes. Modeling steady and transient processes. Models analytical and approximate. Mathematical models of selected elements, processes and phenomena in the power machinery. Tasks, methods and algorithms for identification of models. Methods of solving mathematical models. Practical application examples - exercises.

Bibliography:

1. http://materialy.itc.pw.edu.pl/zmue/jlew/Mod_mat/
2. Materials supplied by lecturer

Course results:

Ability to formulate and solve simple mathematical models of power equipment and installations. Knowledge of mathematical modeling applications in power plant

Grading criteria:

Two tests during the semester. The final examination in the case of negative or unsatisfactory evaluations of tests.

Detailed contents:

The basic steps at the identification process are aimed: the define of the phenomenological model (equivalent scheme), the formulation of a mathematical model, model identification and processes simulation (solution of the mathematical model). The rules for creating of equivalent scheme; equivalent scheme for typical power machinery, equipment and installations. The formulation of a mathematical models: analytical and approximate. Models for steady state and transient processes. Basic equations developed mathematical models of the major components of power plant . Methods for models

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identification. Methods for solving models for transient processes and steady states. Applications of mathematical modeling in operation: optimization of load distribution, simulators.
The exercises developed a mathematical model of the recovery boiler (one-and two-pressure) steam turbine, a steam unit with a simplified model of the structure and drained the tank with gas.

Additional remarks (by course staff):

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Sylabus

Course name:	**NPP Operation and Maintenance**
Course name in other language:	
Short name:	**NUPOM**
Course number:	**ML.ANS676**
Course language:	**English**
Responsible for the course:	**dr inż. Grzegorz Niewiński**

ECTS:	**2**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
:		weekly:	[**2,**	0,	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[**30,**	0,	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**

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Sylabus

Course name:	**NPP Safety**
Course name in other language:	
Short name:	**NPPSAF**
Course number:	**ML.ANS675A**
Course language:	**English**
Responsible for the course:	**dr inż. Nikołaj Uzunow**

ECTS:	**4**	Number of hours:	[Lc, T, Lb, P, S,]
:		weekly:	[**2,** **1,** 0, **1,** 0,]
Form of grading:	**Continous assesment**	by semester:	[**30,** **15,** 0, **15,** 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**

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Sylabus

Course name:	**Neural Networks**
Course name in other language:	
Short name:	**NNET**
Course number:	**ML.ANK385**
Course language:	**English**
Responsible for the course:	**dr inż. Grzegorz Orzechowski**

ECTS:	**3**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[**2,** 0, 0, 0, 0,]
Form of grading:	**Continous assesment**	by semester:	[**30,** 0, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**
	Power engineering	**graduate studies, full time**	**2**

Contents - short:

Artificial neural networks – theory and application in process modeling

Bibliography:

1. Masters T., “Neural Networks”
2. Pham D.T., Liu X.,; Neural Networks for Identification, Prediction and Control, Springer Verlag, 1995
3. Kantardzic M., Data Mining, Wiley-IEEE 2002

Course results:

Basic knowledge of process modeling and computer systems (applications)

Grading criteria:

Midterm and final exam. Final grade based on achieved number of points

Detailed contents:

Theoretical fundamentals of neural networks.. Types and structures of ANN. Application of artificial neural networks in process modeling. Examples of NN modeling process in power installation – MPC type controllers with NN models, NN for sensor validation, forecasting using NN. Practical modeling using ANN. Advantages and constrains of NN application

Additional remarks (by course staff):

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Sylabus

Course name:	**Nuclear Fuels and Fuel Cycles**
Course name in other language:	**Paliwo jądrowe i cykle paliwowe**
Short name:	**NUFUC**
Course number:	**ML.ANS673**
Course language:	**English**
Responsible for the course:	**dr inż. Grzegorz Niewiński**

ECTS:	**2**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
:		weekly:	[	**2,**	0,	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[	**30,**	0,	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**

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Sylabus

Course name:	**Nuclear Reactor Modelling and Simulation**
Course name in other language:	**Modelowanie i symulacje reaktorów jądrowych**
Short name:	**NUMOD**
Course number:	**ML.ANS672**
Course language:	**English**
Responsible for the course:	**dr inż. Rafał Laskowski**

ECTS:	**6**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Advanced**	weekly:	[**2**, **1**, **2**, 0, 0,]
Form of grading:	**Exam**	by semester:	[**30**, **15**, **30**, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**

Contents - short:

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.

Bibliography:

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"

Course results:

The student has knowledge of the methods of mathematical modeling in nuclear reactors.
The student has the knowledge and skills in the use of comercial codes for nuclear calculations.
The student has abilities and skills in thermal-flow modeling.
The student has skills in the use of modern thermal-hydraulic codes for nuclear reactors.

Grading criteria:

Final test.
Mark from the own seminary.

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Mark from computer laboratory.

Detailed contents:

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 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.

Additional remarks (by course staff):

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Sylabus

Course name:	**Nuclear Reactor Physics**
Course name in other language:	**Fizyka reaktorów jądrowych**
Short name:	**NUREP**
Course number:	**ML.ANS666**
Course language:	**English**
Responsible for the course:	**dr inż. Nikołaj Uzunow**

ECTS:	6	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	weekly:	[**2,**	**1,**	**2,**	0,	0,]
Form of grading:	**Exam**	by semester:	[**30,**	**15,**	**30,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**

Contents - short:

Neutron-induced nuclear reactions. Nuclear fission. Neutron transport. Criticality. Homogenious reactor. Multiplication factor. Reactivity. Reactivity changes. Reactor kinetics. Reactor dynamics.
Released gas activity measurements. Neutron flux measurements. Reactor start-up. Control rod measurements. Reactor simulator. Hydraulic resistance measurements.

Bibliography:

E. E. Lewis, "Fundamentals of Nuclear Reactor Physics"
G. F. Hewitt, and J. G. Collier, "Introduction to Nuclear Power"
H. Anglart, "Nuclear Reactor Dynamics and Stability"
H. Tellier, "Cinetique des reacteur nucleaires"
M. Kiełkiewicz, "Teoria reaktorów jądrowych"

Course results:

The student acquires knowledge in the scope of physical processes taking place in nuclear reactors, and materials being used in nuclear technology.
He acquires knowledge and skills in the scope of neutron transport processes and solutions of simpler problems, connected with nuclear reactor physics.
He also acquires knowledge in the scope of requirements and principles, related to nuclear reactor design and operation.

Grading criteria:

During the semester: 2 tests; and 5 laboratory protocols.
During the session: oraz examination.
The final grade is a combination of the exam (50%), tests (25%), and laboratory protocols (25%).

Detailed contents:

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1. Neutron-matter interactions. Neutron-induced nuclear reactions. Microscopic cross-sections. Nuclear reactor materials.
2. Macroscopis cross-sections. Neutron flux. Nuclear fission - types, description, products, spectrum of prompt neutrons and gamma photons, delayed neutrons and gamma photons, energy balance. Fissile and fertile nuclides.
3. Neutron scattering - elastic and inelastic. Energy levels of nuclides. Radiation capture. Other reactions.
4. Neutron transport theory.
5. Approximation methods of neutron transport description. Neutron diffusion. Energy discretisation.
6. Criticality. Multiplication factor.
7. Reactor critical dimensions. Role of the reflector. Reactivity.
8. Reactivity changes induced by the control system. Types of absorbers and results of their application.
9. Reactivity changes induced by changes in the core isotopic content. Fissile nuclides burn-up and production. Xenon and samarium poisoning.
10. Temperature-induced reactivity changes. Temperature coefficients of reactivity.
11. Nuclear reactor kinetics. Role of the delayed neutrons. Perturbation theory.
12. Nuclear reactor dynamics.
- Calculations of densities, concentrations, masses, macroscopic cross-sections.
- Calculations of elastic scattering, mean logarithmic energy decrement, radiation capture, resonanse integral.
- Calculations of multiplication factor.
- Calculations of fuel burn-up and production, xenon and samarium poisoning.
- Measurements of radioactive gas releases from the MARIA reactor. Air sample activity measurements. Calculation of radioactive gases speed of release.
- Measurements of neutron flux in the MARIA reactor. Activity measurements. Calculations of thermal, epithermal, and fast neutron flux density.

Additional remarks (by course staff):

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Sylabus

Course name:	**Nuclear energy and international security**
Course name in other language:	
Short name:	**NENIS**
Course number:	**ML.ANS688A**
Course language:	**Polish**
Responsible for the course:	**dr Grzegorz Kostrzewa-Zorbas**

ECTS:	**3**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
:		weekly:	[	**2,**	0,	**1,**	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[	**30,**	0,	**15,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**

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Sylabus

Course name:	**Numerical Methods in Heat Transfer**
Course name in other language:	
Short name:	**NMHT**
Course number:	**ML.ANK347**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Jerzy Banaszek**

			Lc,	T,	Lb,	P,	S,
ECTS:	**3**	Number of hours:	Lc,	T,	Lb,	P,	S,
Course level:	**Intermediate**	weekly:	**2,**	0,	**1,**	0,	0,
Form of grading:	**Continous assesment**	by semester:	**30,**	0,	**15,**	0,	0,

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122), Heat Transfer 1 (ML.ANK423), Partial Differential Equations (ML.ANK481)

Contents - short:

Fundamental knowledge of contemporary computer simulation techniques in fluid mechanics and heat transfer (such as control volume method and finite element method) and training in application of these methods to engineering problems (with the use of selected commercial codes, such as Ansys Fluent and/or Fidap)

Bibliography:

1. C. Hirsch, „Numerical computation of internal and external flows", second edition, John Wiley & Sons, Chichester, 2007.
2. S.V. Patankar, „Numerical heat transfer and fluid flow", Mc Graw-Hill, 1980.
3. H.K. Versteeg and W. Malalasekera, „An introduction to computational fluid dynamics. The finite volume method", second edition, Pearson Prentice House, London, 2007.
4. O.C. Zienkiewicz, R.L. Taylor and P. Nithiarasu, „The Finite element method for fluid dynamics, sixth edition", Elsevier, Amsterdam, 2005.
5. R.W.Lewis and
6. Y. Yaluria and K.E. Torrance „Computational Heat Transfer", Hemisphere, 1986

Course results:

After completing the course a student:

• will be able to understand underlying assumptions, basic methodology and limitations of all consecutive stages of computer modelling of a real engineering problem;

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• will be familiarized with all details of FEM and CVFDM simulation of heat transfer and fluid flow problems, and, in particular, with major difficulties encounter in such modelling of both: a pure molecular diffusion (e.g. in composite materials) and convection (e.g. wiggles, cross-wind diffusion, numerical dispersion), as well as with special techniques of numerical errors elimination or reduction (e.g. up-winding, staggered grid approach, un-equal order FEM, grid refinement);
• will be able to use and modify, for his/her particular engineering problem to be solved (e.g. through the User Defined Functions), commercial codes applied for both: grid generation and calculations;
• will be able to correctly interpret obtained numerical results, in particular, to distinguish between potential numerical inaccuracies an specific features of the analysed physics.

Grading criteria:

An assessment consists of two parts: (1) a final theoretical test of the knowledge acquired during lectures; (2) a practical test in the lab.
A final grade comprises 60% of the theoretical test grade and 40% of the laboratory test evaluation.

Detailed contents:

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 a 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 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 ANSYS Gambit – step-by-step division of 2D complex domain into control-volumes, structural and non-structural grids, types of domain and boundary conditions, application of advanced functions in a local mesh refinement.
2. Introduction to ANSYS Fluent – mesh diagnostics, boundary and initial conditions, material properties, solver settings, graphical post processing, User Defined Files. 3. Examples of modelling with the code Fluent: 3D natural thermal and/or solutal convection, thermal radiation, convection in porous media, and/or heat transfer in a turbine blade.

Additional remarks (by course staff):

handouts will be provided.

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Sylabus

Course name:	**Partial Differential Equations**
Course name in other language:	
Short name:	**PDE**
Course number:	**ML.ANK481A**
Course language:	**English**
Responsible for the course:	**dr Paweł Wójcicki**

ECTS:	**4**	Number of hours:	[Lc, T, Lb, P, S,]
:		weekly:	[**2,** **1,** 0, 0, 0,]
Form of grading:	**Exam**	by semester:	[**30,** **15,** 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**1**
	Power engineering	**graduate studies, full time**	**1**
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**graduate studies, full time**	**1**

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Sylabus

Course name:	**Physics 2**
Course name in other language:	
Short name:	**PHYS2**
Course number:	**ML.ANK480**
Course language:	**English**
Responsible for the course:	**dr inż. Daniel Budaszewski**

ECTS:	**2**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	weekly:	[	**2,**	0,	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[	**30,**	0,	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**
	Power engineering	**graduate studies, full time**	**2**
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**graduate studies, full time**	**2**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**7**

Contents - short:

The student should have a good working knowledge of mathematics, which will be required in order to work problems. The course seeks to provide a reasonable blend of theory (concepts of physics) and problem-solving techniques based on theory. The lectures are primarily concerned with developing the concepts of physics and working through a few problems involving application of these concepts.
It is recommended that you keep up with the class on a steady basis and see us if there are things that you do not understand.

Bibliography:

The reading schedule will be given on the class and continually updated

Course results:

After completing his course the students will understand the basics of the relativity and the optics. This knowledge gives them possibility to project simple optics components and units.

Grading criteria:

The final written exam will be cumulative over all material covered during the semester. (grade: 100% exam)

Detailed contents:

Relativity
Time Dilatation

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Length Contraction
The Lorentz Transformation
Relativistic Energy and Momentum
Optics
Review of Electricity and Magnetism (Gauss' Law, Ampère's Law, Faraday's Law, Maxwell's Equations, The Wave Equation)
Plane Waves in Isotropic Media
Energy Flux (Energy Flux, Intensity)
Polarized Light (The Wave Equation as an Eigenvalue Problem, The Polarization Ellipse, Linear Polarization, Circular Polarization)
Fresnel Reflection (π polarization, σ Polarization, Total Internal Reflection (TIR))
Light Propagation in Uniaxial Media (The Dielectric Constant Tensor, Solution of Maxwell's Equation for the Propagating Eigenmodes, The Non-propagating Mode, The Ordinary Wave, The Extraordinary Wave)
Dispersion (Dissipation, Dispersion)
Interference
Diffraction (Single and Double Slit Diffraction, Young Experiment, Diffraction Grating, Holography)
Nonlinear Susceptibility
Gaussian Beams

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Date 06.03.2019

Sylabus

Course name:	**Project Management**
Course name in other language:	
Short name:	**PROJMAN**
Course number:	**ML.ANK445**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. Wojciech Bujalski**

			Lc	T	Lb	P	S
ECTS:	**2**	Number of hours:					
Course level:	**Intermediate**	weekly:	**2**	0	0	0	0
Form of grading:	**Continous assesment**	by semester:	**30**	0	0	0	0

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**3**
	Power engineering	**graduate studies, full time**	**3**

Contents - short:

Getting to know the basics of planning and preparation of investment and project management. Presentation of Project management techniques.

Bibliography:

The materials on the website http://materialy.itc.pw.edu.pl/zmue/bujalski/project_management/
PIM

Course results:

After completion of the course, students should know the basics of terminology and principles of project management. He should be able prepare your own project in accordance with the methodology of project management

Grading criteria:

Final qualifying test, and attendance

Detailed contents:

General principles of project management
Project Phases
Exercises for the preparation of your sample project
Risk management - the basics
General principles of organization of construction site
Basics of economic issues in project management

Additional remarks (by course staff):

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Date 06.03.2019

Sylabus

Course name:	**Statistical and Nonequilibrium Thermodynamics**
Course name in other language:	
Short name:	**SANT**
Course number:	**ML.ANS599A**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tomasz Wiśniewski**

ECTS:	**3**	Number of hours:	[Lc, T, Lb, P, S,]
:		weekly:	[**2,** 0, 0, 0, 0,]
Form of grading:	**Continous assesment**	by semester:	[**30,** 0, 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Nuclear Power Engineering**	**graduate studies, full time**	**2**
	Power engineering	**graduate studies, full time**	**2**