Warsaw University of Technology

Faculty of Power and Aeronautical Engineering

CATALOGUE OF COURSES

Undergraduate studies (B.Sc. degree)
Tok 2006

Warsaw 2018

FIELDS OF STUDIES AND SPECIALIZATIONS

The undergraduate studies last 7 semesters and conclude with the Bachelor 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

The program of B.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

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 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.

B.Sc. Programme						
Registration for semester	II	III	IV	V	VI	VII
Number of collected credits	22	44	68	98	130	170

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 undergraduate studies must not be longer than nine semesters. In case the student is granted the leave, duration of studies is prolonged accordingly.

Requirements for graduation

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

- Completion of all courses in the study program,
- 4-week internship (in industry)
- Collecting 210 ECTS points including the preparation of B.Sc. thesis
- Writing B.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

Power engineering	Semester 1
	Semester 2
	Semester 3
	Semester 4
	Semester 5
	Semester 6
	Semester 7

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 1

List of common courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANW101	Algebra and Geometry	0	3	0	0	0	4
2.	ML.ANW102	Calculus 1	2	3	0	0	0	7
3.	ML.ANW106	Computer Science 1	2	0	2	0	0	5
4.	ML.ANW105	Engineering Graphics	1	0	0	1	0	2
5.	ML.ANW104	Engineering Physics	1	2	0	0	0	3
6.	ML.ANW109	Environment Protection	2	0	0	0	0	2
7.	ML.ANJGA1	Foreign language 1	0	2	0	0	0	2
8.	ML.ANW71	Health and Safety Training	0	1	0	0	0	0
9.	ML.ANW72	Library Training	0	1	0	0	0	0
10.	ML.ANW107	Materials 1	2	0	0	0	0	2
11.	ML.ANW108	Mechanics 1	1	1	0	0	0	3
12.	ML.ANWF1	Physical Education and Sports 1	0	2	0	0	0	0
13.	ML.ANW103	The Wittgensteins Philosophy_Ethics	2	0	0	0	0	2

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 2

List of common courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANW90	Calculus 2	2	2	0	0	0	5
2.	ML.ANW114	Computer Science 2	1	0	1	0	0	2
3.	ML.ANW112	Economics	2	0	0	0	0	2
4.	ML.ANW113	Electric Circuits 1	2	1	0	0	0	3
5.	ML.ANW118	Engineering Graphics - CAD 1	0	0	0	2	0	2
6.	ML.ANJGA2	Foreign language 2	0	2	0	0	0	2
7.	ML.ANW115	Mechanics II	2	2	0	0	0	5
8.	ML.ANW117	Mechanics of Structures 1	2	1	0	0	0	4
9.	ML.ANWF2	Physical Education and Sports 2	0	2	0	0	0	0
10.	ML.ANW116	Thermodynamics 1	2	2	0	0	0	5

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 3

List of common courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANW123	Basics of Automation and Control 1	2	1	0	0	0	4
2.	ML.ANW91	Calculus 3	1	2	0	0	0	3
3.	ML.ANW122	Fluid Mechanics 1	2	1	0	0	0	4
4.	ML.ANJGA3	Foreign language 3	0	2	0	0	0	2
5.	ML.ANW124	Machine Design 1	1	1	0	0	0	3
6.	ML.ANWF3	Physical Education and Sports 3	0	2	0	0	0	0

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK317	Electric circuits 2	0	0	2	0	0	3
2.	ML.ANK423	Heat Transfer 1	1	1	0	0	0	3
3.	ML.ANK405	Theory of Heat Machines	2	1	0	0	0	3
4.	ML.ANK411	Thermodynamics 2 (lab)	0	0	2	0	0	3
5.	ML.ANK413	Thermodynamics 3	1	1	0	0	0	3

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 4

List of common courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANW135	Electronics 1	1	1	0	0	0	2
2.	ML.ANJGA4	Foreign language 4	0	2	0	0	0	2
3.	ML.NJAC1	Languages - C1_Exam (English)	0	0	0	0	0	0
4.	ML.ANW125	Machine Design 2	1	1	0	0	0	3
5.	ML.ANWF4	Physical Education and Sports 4	0	2	0	0	0	0

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK380	Combustion and Fuels	1	1	0	0	0	3
2.	ML.ANK333	Electric Machines 1	1	1	0	0	0	3
3.	ML.ANK381	Electric Power Systems	2	1	0	0	0	5
4.	ML.ANK316	Electronics 2 (lab)	0	0	1	0	0	1
5.	ML.ANK340	Fluid Mechanics 2	0	0	1	0	0	1
6.	ML.ANK341	Fluid Mechanics 3	1	1	0	0	0	2
7.	ML.ANK376	Fundamentals of Management	2	0	0	0	0	2
8.	ML.ANK424	Heat Transfer 2	0	0	1	0	0	1
9.	ML.ANK351	Measurements and Technique of Experiment	1	1	0	0	0	2
10.	ML.ANK406	Theory of Flow Machines	2	1	0	0	0	3

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 5

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK442	Electric Machines II (lab)	0	0	1	0	0	1
2.	ML.ANK329	Electric Power Systems 2 (lab)	0	0	2	0	0	3
3.	ML.ANK390	Energy Systems	1	1	0	0	0	3
4.	ML.ANK364	Fundamentals of Operation and Maintenance	2	1	0	0	0	5
5.	ML.ANK332	Marketing (ang)	2	0	0	0	0	2

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANS510	Chemistry of Water	2	0	0	0	0	2
2.	ML.ANS603	Energy Sources and Conversion	1	1	0	0	0	2
3.	ML.ANS549	Internal Combusion Engines	2	0	0	0	0	2
4.	ML.ANS539	Rotodynamic Pumps and Pumping Systems	0	2	0	0	0	2
5.	ML.ANS521	Steam Boilers	1	1	0	0	0	2
6.	ML.ANS577	Turbines	2	0	0	0	0	2

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 6

List of common courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANW127	Intermediate Engineering Project	0	0	0	4	0	6
2.	ML.ANW126	Physics 1	2	0	0	0	0	3

List of field of study courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK443	Energy management	1	1	0	0	0	2

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANS534	Advanced Renewable Energy Sources	2	1	0	0	0	3
2.	ML.ANS555	Control of Heat Processes	2	0	0	0	0	2
3.	ML.ECENG04	Elective Courses Engineering	0	0	0	0	0	4
4.	ML.ANS540	Heat Pumps	1	1	0	0	0	2
5.	ML.ANS524	Power Engineering Machines and Systems 1 (lab)	0	2	0	0	0	2
6.	ML.ANS516	RES - Solar Engineering 1	2	0	0	0	0	2
7.	ML.ANS566	Technologies of Environmental Protection	2	0	0	0	0	2
8.	ML.ANS550	Thermal Power Stations	2	0	0	0	0	2

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Field of Study Energetyka
Field of Specialization Power engineering
Semester 7

List of common courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANW128	Engineering Diploma Seminar	0	0	0	2	0	2
2.	ML.ANW136	Engineering Diploma Thesis	0	0	0	12	0	15

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ECENG03	Elective Courses Engineering	0	0	0	0	0	3
2.	ML.ANS625	Energy Market	2	0	0	0	0	3
3.	ML.ANS527	Energy Storage	2	0	0	0	0	2
4.	ML.ANS576	Gas Turbines and Gas-Steam Systems	2	0	0	0	0	3
5.	ML.ANS525	Power Engineering Machines and systems II (lab)	0	0	2	0	0	2
6.	ML.ANS517	RES - Solar Engineering 2 (Lab)	0	0	1	0	0	1

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Sylabus

Course name:	**Advanced Renewable Energy Sources**
Course name in other language:	
Short name:	**ARES**
Course number:	**ML.ANS534**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Roman Domański**

ECTS:	**3**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	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	**Power engineering**	**undergraduate, full time , graduate studies, full time**	**2, 6**

Recommended prerequisites:

Heat Transfer 1 (ML.ANK423), RES - Solar Engineering 1 (ML.ANS516), Thermodynamics 1 (ML.ANW116)

Contents - short:

Teaching evaluation of renewable energy. Evaluation of implementation possibilities for renewable energy, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of renewable energy storage. Presenting new and future renewable energy technologies.

Bibliography:

Materials for students placed on website

1. IEA: World Energy Outlook, OECD/IEA, 2006
2. Duffie J.A., Beckman W.A.: Solar Engineering of Thermal Processes, John Willey&Sons, 2006

Course results:

After passing the subject student will be able to analyze renewable energy resources and needs for storage systems. Understand relation between the renewable and fossil and nuclear energy conversion systems, understand the limits for renewables.

Grading criteria:

60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

Detailed contents:

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Basic terms related to energy conversion processes. World's energy resources (fossil fuel and nuclear) versus renewable energy sources. The basic parameters for energy storage. Energy conversion efficiency for selected processes and devices. Possibility of energy storage. Renewable sources; sun as an energy source, conversion of solar radiation energy (collectors and photovoltaic systems). Solar systems for heating and hot water production. Biomass and biofuels – in energy and transportation sector. Solar power plants. Solar energy for heating and hot water generation. Wind energy and wind power 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 conversion systems for heat and power generation. Place for renewable in world energy scenario. Prospective power generation technologies using the renewables. Typical solutions of waste utilisation used in power engineering. Rationalization of energy consumption, increase of energy conversion efficiencies. Renewables energy sources versus environment protection.

Additional remarks (by course staff):

Lecture based on Power Point presentations

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Sylabus

Course name:	**Algebra and Geometry**
Course name in other language:	**Algebra z geometrią**
Short name:	**ALG**
Course number:	**ML.ANW101**
Course language:	**English**
Responsible for the course:	**dr Ewa Lewińska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

to get students familiar with basic concepts of linear algebra and with some elements of 3-d analytic geometry; to introduce fundamental abstract definitions of linear spaces, algebraic bases, linear mappings and to reinterpret earlier material from this abstract point of view.

Bibliography:

Anton H., Rorres Ch.-Elementary Linear Algebra, John Wiley and Sons 2010,
also
Lay D.C.- Linear Algebra and its Applications, Addison-Wesley 2003,
Kolman B., Hill D.R.-Elementary Linear Algebra with Applications, Pearson/Prentice Hall 2008.

Course results:

After completing the course students will know basic concepts of linear algebra and 3-d analytic geometry .They will also see them in the deeper abstract setting of linear spaces and linear mappings. Thus they will be prepared for other mathematical courses where some algebraic background is required.

Grading criteria:

50% at a mid-semester class test, 50% at an exam,
if the class test is failed, then 100% at an exam.

Detailed contents:

1.Complex Numbers.

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Operations. Geometrical Representation. Polar Form and de Moivre's Theorem. Root Finding.
2.Polynomials.
Roots and their Multiplicity. The Fundamental Theorem of Algebra. Factorization of Complex Polynomials. Factorization of Real Polynomials.
3.Matrices and Determinants.
Matrix Operations and their Properties. Recursive Definition of a Determinant. Sarrus Method for an Evaluation of Determinants of Order 2 and 3. Laplace Expansion Theorem. Other Properties of Determinants. Cramer's Rule.
4.Inverse of a Matrix.
Definition and Properties. Classical Adjoint. Solving Matrix Equations with the Help of Inverses.
5.Systems of Linear Equations.
Matrix Representation. Elementary Operations on Equations in a System and Corresponding Elementary Row Operations on Rows in the Augmented Matrix of the System. Gauss Elimination Method for Systems with a Nonsingular Matrix.
Definition of a Rank of a Matrix and Operations which do not Change a Rank. The Kronecker-Capelli Theorem(the Consistency Theorem).
Gauss Elimination Method in a General Case. Homogeneous Systems.
6.Eigenvalues and Eigenvectors.
Definition. Characterisitc Polynomial. Definition of an Algebraic and a Geometric Multiplicity of an Eigenvalue. Theorem about Eigenvalues and Eigenvectors of a Real Matrix.
7.Elements of Analytic Geometry in Three Dimensions.
Vectors in the 3-d Cartesian Coordinate System. Scalar, Vector and Box Products. Area of a Parallelogram and Volume of a Parallelepiped. Angle between Vectors. Various Equations of Planes and Lines and Orthogonal Projections onto them.
8.Linear Spaces. Linear Operators.
Definition of a Linear Space and Examples. Linear Subspaces and Examples. Linear Combinations, Linear Independence and Linear Dependence of Vectors. Algebraic Basis and Dimension of a Linear Space. Examples.
Definition of a Linear Mapping, its Kernel and Image. General Linear Equations : a Relation between Solutions of Nonhomogeneous and Homogeneous Equations and Illustration of this Relation for Linear Algebraic Systems and Linear Differential Equations .
9.Inner Product Spaces.
Definition of an Inner Product. Orthogonality of Vectors. Gram-Schmidt Orthogonalization Procedure. Diagonalization of Matrices. Diagonalization of Real Symmetric Matrices.

Additional remarks (by course staff):

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Sylabus

Course name:	**Basics of Automation and Control 1**
Course name in other language:	
Short name:	**BAC1**
Course number:	**ML.ANW123**
Course language:	**English**
Responsible for the course:	**dr inż. Paweł Malczyk**

ECTS:	**4**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
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	**-**	**undergraduate, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**3**
Mechanical Engineering	**-**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**3**

Recommended prerequisites:

Calculus 1 (ML.ANW102), Calculus 2 (ML.ANW90)

Contents - short:

Basic introduction to the concept of Control Systems. Definition and interpretation of terms: CONTROL SYSTEM, FEEDBACK CONTROL, STABILITY of the system. Introduction to mathematical modelling - Laplace Transform as analysis and design tool for Control Systems. Transient and Frequency response analyses. Stability system analyses.

Bibliography:

[1] Ogata Katsuhiko: Modern Control Engineering, Prentice Hall;
[2] lecture notes/ materials provided by lecturer
[3] Zarys Dynamiki i automatyki układów, praca zbiorowa pod redakcją A.Olędzkiego, Wydawnictwo PW, Warszawa 1991 /position available vie WUT e-library/ - supporting references (in polish).

Course results:

The objective of the course is to gain the following abilities:
- ability to transform the functions using Laplace transform,
- ability to describe the control system in Laplace domain,
- ability to create and simplify the block diagrams of controled objects,
- ability to evaluate the typical system responses for standard inputs,
- ability to apply basic stability criteria,

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- ability to describe and analyse the control system in time and frequency domains.

Grading criteria:

100% continous assesment.
2 classworks during semester + individual activity and short tests assesment.

Detailed contents:

1) Basic introduction to the concept of Control Systems.
2) Definition and interpretation of terms: CONTROL SYSTEM, FEEDBACK CONTROL, STABILITY of the system.
3) Introduction and application of Laplace Transform as analysis and design tool for linear dynamical systems.
4) Transfer function definition.
5) Block diagram representation of physical systems.
6) Dynamic response analysis: transient response and performance indices.
7) Introduction of poles and zeros concept, dominant poles. Characterisic equation, steady state error, system types.
8) Basic principles of feedback control: PID controller.
9) Stability analyses, Routh-Hurwitz method.
10)Principles of frequency domain analysis; concept of frequency response, Bode plots, Nyquist plots and Nyquist stability.

Additional remarks (by course staff):

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Sylabus

Course name:	**Calculus 1**
Course name in other language:	
Short name:	**CALC1**
Course number:	**ML.ANW102**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Andrzej Fryszkowski**

ECTS:	**7**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	weekly:	[**2,**	**3,**	0,	0,	0,]
Form of grading:	**Exam**	by semester:	[**30,**	**45,**	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

1. to convey and reinforce the knowledge on real number sequences, functions of one variable, the constant e, one-variable differential and integral calculus, definite and improper integrals, and their application,
2. to acquire thorough understanding of basic concepts and computational processes, and to master skills of using them,
3. to acquire the skill of correct mathematical reasoning and inference.

Bibliography:

1. Thomas “Calculus”
2. Robert A. Adams, Calculus. A complete course
3. Thomas G. Finney: Calculus, ed. Addison-Wesley

Course results:

After completing his course the students will be able to:

1. establish the convergence of sequences and evaluate limits of basic types of sequences;
2. establish the limits of functions and known basic types of functions;
3. evaluate derivatives of elementary functions, know basic rules of differentiation and apply derivatives in evaluations approximate values of expressions, tangent lines, finding the limits of undetermined expressions, finding local extrema of a function and drawing it’s graph;
4. calculate the indefinite integrals of elementary functions;

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5. know basic properties of definite integrals (proper and improper), methods of evaluations and implement definite integrals in to evaluation computing areas of planar figures, arc length of the curves, surface areas, volumes of revolved solids;
6. know basic properties of functions of two and three variables;
7. evaluate partial derivatives of arbitrary order and write down the Taylor expansion;
8. find local extrema of functions of two and three variables;
9. examine local extrema of implicit functions.

Grading criteria:

50% continuous assesment based on laboratory work and tests, 50% written final exam

Detailed contents:

1. Real sequences . Definition of sequence limit - convergent and divergent sequences. Indeterminate forms. Squeezing theorem. The constant e.
2. Function domain and counterdomain. Inversion and composition of functions. Elementary functions - linear, quadratic and rational functions. Properties of the exponential and logarithmic functions. Even and odd functions. Periodic functions. Trigonometric and cyclometric functions and their properties.
3. Function limit at a given point and at infinity. Horizontal, vertical and oblique asymptotes. Function continuity at a point and in the interval. One-sided continuity. Properties of continuous functions.
4. Function increment. Definition of the derivative of a function at a given point and its geometric interpretation. Derivatives of some common functions. The derivative of a sum, a product and a quotient of functions. The derivative of a composition. Tangent and normal lines at a point to a curve f(x).
5. De l'Hospital's rule. Function differential. Higher order derivatives and differentials. Taylor and MacLaurin formulas - approximate values of expressions.
6. Function extrema, necessary and sufficient condition. Rolle's theorem. The Lagrange Mean Value theorem. And it’s implications.
7. Derivatives of higher order with the use to identify extrema. Inflection points. Concave and convex functions. Necessary and sufficient conditions for inflection points. Examining the function and plotting its graph.
8. Indefinite integral - definition; antiderivative; integral of some common functions; properties. Techniques of integration.
9. Properties of definite integrals. The Fundamental Theorem of Calculus. Integration by parts and by substitution for definite integrals.
10. Definite integrals: definition and geometrical interpretation. Improper integrals of the first and the second kind. Applications of integrals; computing areas of planar figures, arc length of the curves, surface areas, volumes of revolved solids.
11. Convergence of an R2 sequences. Functions of two variables. Heine’s definition for function limit.
12. Gradient of a function at a point. Higher order partial derivatives. Taylor formula with the second and higher order.
13. Differential. Computing approximate values of expressions. Local extrema and necessary condition for them. Sufficient condition for an extremum. Functions of three variables: partial and directional derivatives and differentials. Taylor formula with the second order differential.
14. Implicit functions of one variable. Implicit function derivatives of first and second order. Extrema of implicit functions.
15. Conditional extrema of the functions of two and three variables. Parametric representation of the two and three dimensional curves. Some common surfaces: sphere, cylinder, cone, paraboloid, hyperboloid. Planar regions in polar coordinates. Frenet trihedron.

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Sylabus

Course name:	**Calculus 2**
Course name in other language:	
Short name:	**CALC2**
Course number:	**ML.ANW90**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Andrzej Fryszkowski**

ECTS:	**5**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	weekly:	[**2,**	**2,**	0,	0,	0,]
Form of grading:	**Exam**	by semester:	[**30,**	**30,**	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Contents - short:

to convey and reinforce the knowledge on definite integrals (proper and improper) and their applications, series (numeric and functional), functions of many variables (sets, limits and continuity, multivariable calculus), ordinary differential equations, Frenet trihedron, line and surface integrals, Green, Stokes and Gauss Theorems.
2. to acquire thorough understanding of basic concepts and computational processes and to master skills of using them (labs) and to master the skill of correct mathematical reasoning and inference.

Bibliography:

1. Thomas “Calculus”
2. Robert A. Adams, Calculus. A complete course
3. Thomas G. Finney: Calculus, ed. Addison-Wesley

Course results:

After completing his course the students will be able to:
1. solve basic differential equations of 1st and higher order.
2. Implement differential equations to some practical problems in mechanics, biology etc.;
3. Evaluate double and triple integrals on bounded and unbounded regions.
4. Apply double and triple integrals in calculations of volume, area of surfaces, area of planar regions, moments of innertions and centers of the mass.
5. Know line integrals and basic applications of them.

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Grading criteria:

50% continuous assesment based on laboratory work and tests, 50% written final exam

Detailed contents:

1. First order ordinary differential equation. General and particular solutions. Initial value conditions. Existence and uniqueness. Separable equation and transformation a differential equat ion to that form. Linear equations of the first order. General solution.
2. Solving nonhomogenous linear differential equations by the method of integrating factor and the method of variation of a parameter. Linear equations of the higher order. General and particular solutions. Initial value problems. Linear equation of the second order transformable to equation of the first order.
3. Method of trial functions for nonhomogenous equation of the m-th order with constant coefficients.
4. Double integral on a rectangle; integrability theorem. Mean value and integral mean value theorem. Double integral and iterated integral. Double integral on a standard domain. The Fubini theorem.
5. Change of variable in a double integral. Region mapping: Jacobian determinant. Double integral in polar coordinates. Application of double integral to computation of areas and volumes of figures and solids.
6. Double integral application: surface area of a frustum. Triple integral on parallelepiped. Fubini theorem for triple integral on standard solids (standard 3D domains).
7. Changing of variables. Geometric application of a triple integral - volumes of solids, centers of mass.
8. Line integrals. Green Theorem. Potentials. Work of a vector field.

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Sylabus

Course name:	**Calculus 3**
Course name in other language:	
Short name:	**CALC3**
Course number:	**ML.ANW91**
Course language:	**English**
Responsible for the course:	**dr Iwona Wróbel**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**3**
Mechanical Engineering	**-**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**3**

Contents - short:

1. to convey and reinforce the knowledge on real number sequences, functions of one variable, the constant e, one-variable differential and integral calculus, definite and improper integrals, and their application,
2. to acquire thorough understanding of basic concepts and computational processes, and to master skills of using them,
3. to acquire the skill of correct mathematical reasoning and inference.

Bibliography:

1. Thomas “Calculus”
2. Robert A. Adams, Calculus. A complete course
3. Thomas G. Finney: Calculus, ed. Addison-Wesley

Course results:

After completing his course the students will be able to:

1. Evaluate surface integrals.
2. Implement and Gauss Theorems to vector field calculus.
3. Establish the convergence of number series.
4. Find radius and area of convergence of power series, expand the basic elementary functions into power series.
5. Apply power series in evaluation of number series.
6. Know trigonometric series and basic applications of them.

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Grading criteria:

50% continuous assesment based on laboratory work and tests, 50% written final exam

Detailed contents:

1. Non oriented surface integrals and their applications
2. Oriented surface integrals.
3. Stokes and Gauss Theorems. Elements of vector fields calculus.
4. Infinite real and complex series – convergence and divergence, necessary condition for convergence. Tests for convergence. Absolute and conditional convergence.
5. Cauchy's root test, d'Alembert ratio test. Integral test. Convergence of the Dirichlet series. Alternating series. Absolute and conditional convergence of a series.
6. Power series – real and complex. Radius and interval of convergence. Power series integration and differentiation. Taylor and Maclaurin expansions of functions. Applications of power series.
7. Trigonometric series. Formulas for coefficients. Dirichlet conditions. Sum of a trigonometric series. Applications

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Sylabus

Course name:	**Chemistry of Water**
Course name in other language:	
Short name:	**COW**
Course number:	**ML.ANS510**
Course language:	**English**
Responsible for the course:	**dr hab. Krzysztof Karaśkiewicz**

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	**Power engineering**	**undergraduate, full time**	**5**

Contents - short:

basic knowledge about water and steam in power engineering technologies

Course results:

basic knowledge about water and steam in power engineering technologies

Grading criteria:

Final test

Detailed contents:

Chemistry properties of water and steam. Water as row material for power engineering. Physical and chemical processes in water and steam cycles in power station. Water preparation methods in power engineering.

Additional remarks (by course staff):

All course info available on http://energetyka.itc.pw.edu.pl

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Sylabus

Course name:	**Combustion and Fuels**
Course name in other language:	
Short name:	**COMF**
Course number:	**ML.ANK380**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Rudolf Klemens**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122), Thermodynamics 1 (ML.ANW116)

Contents - short:

Lectures on: fuel properties; basic mechanisms of combustion and flame propagation in mixtures of different fuels with air; dynamics of explosion development and suppression; problems of environmental pollution

Bibliography:

1) J. Chomiak: "Combustion: A study in theory, fact and application", Gordon and Breach Sciennce Publisher, 1990;
2) J. H.S. Lee: " The detonation phenomenon" Cambridge University Press, 2008;
3) R. Wilk: " Low – emission combustion" Wydawnictwa Politechniki Śląskiej, Gliwice, 2002.
4) J. Jarosiński, B. Veyssiere: "Combustion Phenomena, Selected Mechanisms of Flame Formation, Propagation and Extinction", CRC Press, Taylor and Francis Group

Course results:

Completion of the course results in the knowledge in the domain of: fuel properties; mechanism of ignition and flame propagation; explosion development and suppression, environmental pollution

Grading criteria:

The subject is completed on the basis of the final written test

Detailed contents:

Basic properties of fuels and combustible mixtures; exploitation and processing of fossil fuels, bio-fuels, toxic properties of fuels and their combustion products, thermal and chain theory of self ignition; forced ignition; diffusion combustion-laminar and turbulent; kinetic combustion-laminar and turbulent; flame stabilization; mechanism of combustion of solid fuel particles and fuel droplets; combustion in technical

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facilities - burners and combustion chambers, transition from deflagration to detonation, detonation combustion; explosion parameters of combustible mixtures; passive and active methods of explosion suppression.

Additional remarks (by course staff):

As the subject is of an interdisciplinary character and is not based on a particular text book, students participation in lectures is highly recommended. The students absent from the lectures usually find it later difficult to comprehend courses in physical- chemical phenomena presented during the lectures and definitely attain poorer results at subject completion.

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Sylabus

Course name:	**Computer Science 1**
Course name in other language:	
Short name:	**CS1**
Course number:	**ML.ANW106**
Course language:	**English**
Responsible for the course:	**dr inż. Stanisław Gepner**

ECTS:	**5**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	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	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

Basic ability to write, compile and run programs in the C language

Bibliography:

1. Oualline, Steve, Practical C Programming, O Reilly, 1991

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 information related to operating systems and computer networks. Word-processing and spreadsheets used in typical engineering applications. Programming language C - variables and their types, arithmetical and logical operations, control statements, functions, tables and pointers, structures. Input and Output. Code examples. Basic algorithms (sorting), simple numerical methods. Practical programming skills.

Additional remarks (by course staff):

The laboratory groups can consist of at most 12 students

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Sylabus

Course name:	**Computer Science 2**
Course name in other language:	
Short name:	**CS2**
Course number:	**ML.ANW114**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Jacek Szumbarski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Recommended prerequisites:

Calculus 1 (ML.ANW102)

Contents - short:

Basic knowledge and practical skills in the area of numerical techniques applied to the problems like: post-processing of measurement data and numerical analysis of simple dynamical systems.

Bibliography:

1) Lecture notes provided by the course instructor.
2) Heinbockel J.H.: Numerical methods in Scientific Computing. Trafford Publishing, 2006.
3) Numerical Recipes in C++, 3rd Ed., Cambridge UP, 2007
4) C. Moler: Numerical computing with MATLAB. Freely downloadable from http://www.mathworks.com/moler/chapters.html.

Course results:

Basic theoretical knowledge in the elementary numerical methods such as polynomial and spline interpolation, polynomial approximation, root finding, numerical integration, solution of ordinary differential equations (Euler, Runge-Kutta methods)and linear algebraic systems (Gauss elimination and related methods)
Development of the programming skills in C language

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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:

1. Polynomial interpolation: Lagrange and Newton methods, Runge effect and Chebyshev nodes.
2. Least-squares approximation: formulation and geometrical interpretation, the method of normal equations, the method of orthogonal polynomials.
3. Numerical integration: the trapezoidal and Simpson methods, the Gauss-Legendre method.
4. Numerical solution of initial-value problems for ordinary differential equations: transformation to the standard form, the Euler method and convergence analysis, single-step higher-order methods, the standard RK4 method, problem of the time step adaptation.
5. Cubic spline interpolation: formulation, end-point conditions, 3-diagonal systems and the Thomas algorithm.
6. Method of Gauss Elimination: formulation, method with pivoting, LU factorization and its applications.

Additional remarks (by course staff):

The laboratory groups can consist of at most 12 students.

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Sylabus

Course name:	**Control of Heat Processes**
Course name in other language:	
Short name:	**CONTRHEAT**
Course number:	**ML.ANS555**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Janusz Lewandowski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**6**

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Sylabus

Course name:	**Economics**
Course name in other language:	
Short name:	**ECON**
Course number:	**ML.ANW112**
Course language:	**English**
Responsible for the course:	**prof. dr hab. Janusz Gudowski**

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	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Contents - short:

To learn fundamental economics

Bibliography:

1. P.A. Samuelson, W.D. Nordhaus, Introduction to economics (latest issue)

Course results:

After completing the course the students will be able to specify the rules of economic phenomenons

Grading criteria:

Test

Detailed contents:

Economics as the science. The sense of processes of production. The ideas of wealth and its sources.
The sense of value. The essence of economic growth.
Quantitative and qualitative aspects of economic growth. The level of life. The idea of development
Notions: market-supply-demand; elasticities measures; types of goods, the theory of consumer
Types of market; theory of competition; the state contribution to market economy
Genesis of contemporary macroeconcs. The conflict between demand and neoliberal approach
The essence of the main today's schools of economics
The main research interest in contemporary economics. Searching the new paradigm. Neoclassical, post-Keynes and institutional economics. Development economics. Ecologic approach in economics

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Additional remarks (by course staff):

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Sylabus

Course name:	**Elective Courses Engineering**
Course name in other language:	**Elective Courses Engineering**
Short name:	**ECENG**
Course number:	**ML.ECENG03**
Course language:	**English**
Responsible for the course:	**Brak Danych**

ECTS:	**3**	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	**Power engineering**	**undergraduate, full time**	**7**

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Sylabus

Course name:	**Elective Courses Engineering**
Course name in other language:	**Elective Courses Engineering**
Short name:	**ECENG**
Course number:	**ML.ECENG04**
Course language:	**English**
Responsible for the course:	**Brak Danych**

ECTS:	**4**	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	**Power engineering**	**undergraduate, full time**	**6**

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Sylabus

Course name:	**Electric Circuits 1**
Course name in other language:	
Short name:	**ELCIR1**
Course number:	**ML.ANW113**
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:	**Intermediate**	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	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Recommended prerequisites:

Calculus 1 (ML.ANW102), Calculus 2 (ML.ANW90), Computer Science 1 (ML.ANW106)

Contents - short:

To be able to use fundamental laws of linear electric circuits to solve electric DC and AC circuits.
Know how to analyse electric circuits containing independent and dependent sources using loop and nodal techniques.
Know how to analyse electric circuits using additional techniques e.g. superposition, source transformation, Thevenin's and Norton's equivalent circuits.
To get familiar with calculation of electric power and energy in DC and AC electric circuits.
To be able to analyse first- and second order transient circuits.
To understand variable-frequency performance of basic elements, resonant circuits and passive filters.

Bibliography:

1. Irwin J. D., Nelms R. M.: Basic Engineering Circuit Analysis, Willey, 9th edition.
Further Readings:
1. Griffiths D.J.: Introduction to Electrodynamics, Prentice Hall, 3rd edition.
2. Dorf R.C., Svoboda J.A.: Introduction to Electric Circuits, 7th edition.
3. Robbinson A.H., Miller W.C.: Circuit Analysis: Theory and Practice, Delmar Cengage Learning, 2003.
4. Svoboda J.A.: Worked Examples from the Electric Circuit Study Applets, Willey, 2006.

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5. Thomas R. E., Rosa A.J., Toussaint G.J.: The Analysis and Design of Linear Circuits, Willy, 2009, 6th edition.

Course results:

Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing electric circuits.
Ability to identify and formulate a problem related to electric circuits.
Ability to apply the fundamental laws of electric circuit to compute basic electric quantities (current, voltage, powers).
Ability to select a simple electrical component or system to meet desired engineering needs.

Grading criteria:

Two assessments + final exam

Detailed contents:

1. Basic concepts of electric field and magnetic field. Role of Electromagnetic Field Theory. Electromagnetic Field Quantities. Properties of Electrostatic Fields. Gauss's Law. Conservation Law. Electric Potential. Electric Fields for a System of Charges. Capacitance. Dielectrics. Electric Flux Density. Electric Potential for a System of Charges. Electrostatic Energy. Magnetic Force. Magnetostatics in Free Space. Magnetic Vector Potential. Biot-Savart Law. Faraday's Law of Induction. Time Harmonic Fields.
2. Basic Electric Circuit Concept. System of Units. Basic Quantities. Circuit Elements.
3. Analysis of Resistive Circuits. Element Constraints. Connection Constraints. Combined Constraints. Ohm's Law. Kirchhoff's Laws. Single Loop Circuits. Single-Node-Pair Circuits. Circuits with Series Parallel Combinations of Resistor. Wye-Delta Transformation. Circuit Reduction. Equivalent Circuits. Voltage and Current Division.. Circuits with Dependant Sources. Resistors for Electronics. Computer-Aided Circuit Analysis.
4. Loop and Nodal Techniques. Nodal analysis. Loop analysis.
5. Additional Techniques. Superposition. Network. Linearity Properties. Thevenin's and Norton's Theorems. Maximum Power Transfer.
6. Signal Waveforms. Step Waveform. Exponential Waveform. Sinusoidal Waveform. Composite Waveforms. Waveform Partial Descriptors.
7. Energy Storage Elements. Capacitors. Inductors. Capacitors and Inductors Combinations. Equivalent Capacitance and Inductance.
8. Analysis of First- and Second-Order Transient Circuits. First-Order Circuits. RC and RL Circuits. First-Order Circuit Step Response. Initial and Final Conditions. First-Order Circuit Sinusoidal Response. Second-Order Circuits. Series RLC Circuit. Parallel RLC Circuit. Second-Order Circuit Step Response. Other Second-Order Circuits.
9. AC Circuits Analysis Techniques. Sinusoids. Sinusoidal and Complex Forcing Function. Phasors. Phasor Relationship for Circuits Elements. Impedance. Admittance. Phasor Diagrams. Basic analysis Using Kirchhoff's Laws. Analysis Techniques.
10. Power Calculations in AC Circuits. Instantaneous Power. Average Power. Maximum Average Power Transfer. RMS Values. Power Factor. AC Power. Complex Power. Power Factor Correction. Single-Phase Three-Wire Circuits. Home Power. Poly-Phase Circuits. Resonant Circuits.
11. Analysis of Magnetically Coupled Networks. Mutual Inductance. Dot Convention. Energy Analysis. Ideal Transformer. Transformer Equivalent Circuits.
12. Analysis of Three-Phase Circuits. Three-Phase Circuits. Three-Phase Connections. Power Relationship. Power Factor Correction.

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13. Variable-Frequency Circuits. Variable-frequency-Response Analysis. Sinusoidal Frequency Analysis. Bode Plots. Resonant Circuits. Passive Filters.
14. Electrical Safety Considerations. Electric shock protection.

Additional remarks (by course staff):

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Sylabus

Course name:	**Electric Machines 1**
Course name in other language:	
Short name:	**EMACH**
Course number:	**ML.ANK333**
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:	[**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	**Power engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:

Electrical engineering (ML.ANW113A), Electronics 1 (ML.ANW135)

Contents - short:

Knowledge and understanding of construction and principles of operation of transformers and rotating electric machines employed in industry.
Knowledge on speed control techniques of rotating electrical machines.
Understanding the principles of electric energy generators used in power stations.
Mastering the application of power electronics in supply of electric machines.

Bibliography:

1. Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006.
Further Readings:
1. Bonal J.: Variable speed electric drives. Promethee. Schneider Electric. 1999.
2. Boldea I., Nasar S.A.: Electric drives, CRC Press, 1999.
3. Bose B: Power electronics and motor drives, Elsevier, 2006.
4. Chapman S.J.: Electric machinery fundamentals, John Wiley and Sons, Inc., 4th edition.
5. Chiasson J.: Modelling and high-performance control of electric machines, IEEE Series on Power Engineering, John Wiley and Sons, Inc., 2005.
6. De Doncker R. et al.: Advanced electrical drives analysis, modeling, control, Springer, 2011.
7. Hindmarsh J.: Electrical machines and their applications. Pergamon International Library, 1985.
8. Hindmarsh J.: Electrical machines and drives. Worked examples. Pergamon International Library, 1985.
9. Veltman A. et. al.: Fundamentals of electrical drives, Springer, 2007.

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Course results:

General knowledge on transformers and electric machines used in industry. Ability to select transformer or electric machine to specific industrial purpose. Understanding basic electric drives with power electronic supply.

Grading criteria:

Two assessments + final exam

Detailed contents:

1. Fundamentals. Electricity. Circuits and equations. One-phase circuits. Three-phase circuits. Electric powers. System of unites. Electromagnetism. Maxwell's equation. B-H curve. Faraday's law. Lorentz force. Hysteresis loop. Hysteresis loss. Eddy currents. Power flow in a mechanically coupled system. Heat and temperature.
2. Direct-current machines. Generators. Construction. Generator under load. Armature reaction. Commutation process. Commutating poles. Separately excited generator. No-load operation and saturation curve. Shunt generator. Compound generator. Differential compound generator. Load characteristics. Motors. Counter-electromotive force. Power and torque. Armature speed control. Field speed control. Shunt motor. Series motor. Compound motor. Reversing. Starting. Stopping. Dynamic braking. Plugging. Basics of variable speed control. Permanent magnet motors.
3. Transformers. Elementary transformer. Ideal transformer. Voltage ratio. Leakage. Reactance. Equivalent circuit. Construction. Transformer taps. Losses and transformer rating. No-load saturation curve. Cooling methods. Voltage regulation. Transformers in parallel. Three-phase transformers. Different connections. Characteristics. Phase transformation. Special transformers. Dual-voltage distribution transformer. Autotransformer. Voltage transformers. Current transformers. High-frequency transformers.
4. Three-phase induction motors. Construction. Principle of operation. Synchronous speed. Starting characteristics of a squirrel-cage motor. Motor under load. Slip. Characteristics of squirrel-cage induction motors. Active power flow. Torque versus speed curve. Wound-rotor motor. Linear induction motor. Equivalent circuit. Power relationship. Phasor diagram. Breakdown torque and speed. Calculation of the breakdown torque. Torque-speed curve and other characteristics. Induction generator. Tests to determine the equivalent circuit. Selection and application. Classification. Two-speed motors. Characteristics under various load conditions. Starting. Plugging. Braking with direct current. Abnormal conditions. Doubly-fed induction motor. Single-phase motors.
6. Synchronous machines. Synchronous generators. Construction. Exciters. No-load saturation curve. Equivalent circuit. Short-circuit ratio. Synchronous generator under load. Regulation curves. Synchronization. Synchronous generator on an infinite bus. Control of active power. Transient reactance. Power transfer between two sources. Efficiency, power. Synchronous motors. Construction. Starting. Power and torque. Reluctance torque. Losses and efficiency. Excitation and reactive power. Power factor. V-curves. Stopping. Synchronous compensator.
7. Basics of industrial motor control. Control devices. Contacts. Control diagrams. Starting methods. Inching and jogging. Reversing the direction of rotation. Plugging. Reduced-voltage starting. Primary resistance starting. Autotransformer starting. Other starting methods.
8. Electric drives. Fundamentals of electric drives. Typical torque-speed curves. Shape of the torque-speed curve. Current-speed curves. Braking.
9. Fundamental elements of power electronics. Diode. Transistor. Thyristor. Rectifiers. Filters. Power factor. Harmonic content. THD. Line-commutated inverter. AC static switch. Cycloconverter. Controllable converter. DC-to-DC Switching Converters. DC-to-DC switching converter. Four-quadrant DC-to-DC converter. Switching losses. DC-to-AC switching converters. AC-to-AC rectangular wave converter.

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DC-to-AC converter with pulse-width. modulation. DC-to-AC sine wave converter. DC-to-AC 3-phase converter.
10. Electronic control electric machines. DC machines. Four-quadrant drive. Six-pulse converter with freewheeling diode. DC-to-DC switching converter. Brushless DC motors. AC machines. Synchronous motor drive using current-source DC link. Drives with cycloconverter. Soft-starting. Self-commutated inverters. Current-source converter. Voltage-source converter. Chopper speed control and recovering power in wound-rotor induction motor.

Additional remarks (by course staff):

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Sylabus

Course name:	**Electric Machines II (lab)**
Course name in other language:	**Maszyny elektryczne 2 (laboratorium)**
Short name:	**EMACH2**
Course number:	**ML.ANK442**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tadeusz Skoczkowski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Electrical engineering (ML.ANW113A), Electric Machines 1 (ML.ANK333), Electronics 1 (ML.ANW135)

Contents - short:

To get familiar with practical aspects of construction and principles of operation of transformers and rotating electric machines employed in industry.
To understand practical aspects of measurement of parameters and characteristics of electric machines.
To understand methods of speed control techniques of rotating electrical machines.

Bibliography:

1. Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006.
Further Readings:
1. Bonal J.: Variable speed electric drives. Promethee. Schneider Electric. 1999.
2. Boldea I., Nasar S.A.: Electric drives, CRC Press, 1999.
3. Chiasson J.: Modeling and high-performance control of electric machines, IEEE Series on Power Engineering, A John Wiley and Sons, Inc., 2005.
4. De Doncker R. et al.: Advanced electrical drives analysis, modeling, control, Springer, 2011.
5. Hindmarsh J.: Electrical machines and their applications. Pergamon International Library, 1985.
6. Hindmarsh J.: Electrical machines and drives. Worked examples. Pergamon International Library, 1985.
7. Veltman A. et. al.: Fundamentals of electrical drives, Springer, 2007.

Course results:

To be able to prepare theoretically and practically laboratory experiments.
To be able to carry out basic laboratory experiments on electrical machines.
To be able present experiment results in a written report.
To be able to analyze possible causes of discrepancy between theory and practice.

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Grading criteria:

Tests after each laboratory unit

Detailed contents:

Experiment 1. Transformer Test
Construction of transformers. Rated data of one-phase and three-phase transformers. Measurement of insulation resistance and winding resistance. Polarity checks. Measurement of voltage ratio for different group of connections. Saturation presence. No-load test. Short-circuit test. Load characteristic. Calculation of per-unit transformer values. Transformers in parallel. Variable autotransformer test.
Experiment 2. DC Shunt Machine Test
Construction of dc machines. Rated date of different dc machines . Identification of terminals. Measurement of winding resistances and the contact (brush) resistance of the rotor. No-load characteristic. Load characteristics. Speed regulation characteristics. Field speed control. Starting characteristic. Braking. Tachometer and digital speed measurement.
Experiment 3. AC 3-phase AC Induction Ring Test
Construction of ac induction machines. Rated date of ac induction machines. Measurements of locked-rotor torque. No-load characteristics. Load characteristic. Speed regulation characteristics.
Experiment 4. Synchronous Machine Test
Construction of ac synchronous machines. Rated date of different synchronous machines. Different modes of operation: motor, generator, compensator. Starting methods of synchronous motor. No-load characteristic. V-curves characteristics. Regulation curves. Synchronisation of generator.
Experiment 5. Variable Speed Induction Motor Drive Test.
Methods of induction motor speed control. Induction motor supplied from voltage inverter. Load characteristic of induction motor with pump load. Valve control vs. variable speed control. Energy efficiency assessment.
Experiment 6. Variable Speed Industrial Drives Test.
Load characteristic of induction motor with fan load. Load characteristic of induction motor with compressor. Digital measurement equipment. Data loggers. Industrial computer system of data acquisition. Fault findings tips.

Additional remarks (by course staff):

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Sylabus

Course name:	**Electric Power Systems**
Course name in other language:	
Short name:	**EPS**
Course number:	**ML.ANK381**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tadeusz Skoczkowski**

ECTS:	**5**	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	**Power engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:

Electrical engineering (ML.ANW113A), Electronics 1 (ML.ANW135)

Contents - short:

To understand the conversion from primary energy sources to electric energy.
To understand the work of power generators in the power system.
To get familiar with the transmission and distribution networks and their basic components.
To understand the monitoring, co-ordination and control of electric power networks.
To understand the utilization of electric energy (industrial, commercial and residential loads).
To understand the principles of power system control (power, voltage, frequency).
To highlight future power system.

Bibliography:

1. Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006.
Further Readings:
1. Ackermann T. (editor): Wind Power in Power Systems, Wiley, 2005.
2. Crappa M. (ed.): Electric power system, Wiley, 2008.
3. Das J.C.: Transients in Electrical Systems Analysis, Recognition, and Mitigation, Mc Graw Hill, 2010.
4. Glover J.D., Sarma M.S., Overbye T.J.: Power systems, Cengage Learning, 2008.
5. Manwell J.F., McGowan J.G., Rogers A.L.: Wind energy explained, Wiley, 2009.
6. Schavemaker P., Sluis L.: Electrical power system essentials, Wiley, 2008.

Course results:

Ability to apply knowledge of basic electric circuit, power electronic and engineering to understand electric power networks.
Ability to understand the technologies of electric energy generation.
Ability to understand how electric energy is transmitted and distributed.
Ability to understand technical measures used to secure the reliable operation of electric power systems.

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Ability to understand electricity market operation with limitations due to technical constraints.

Grading criteria:

Two tests + final assessment

Detailed contents:

1. Generation of electrical energy. Demand of an electrical system. Location of the generating stations. Types of generating stations. Controlling the power balance between generator and load. Advantage of interconnected systems. Conditions during an outage. Hydropower generating stations. Pumped-storage installation. Thermal generating stations. Nuclear generating stations.
2. Transmission of electrical energy. Principal components of a power distribution system. Types of power lines. Standard voltages. Components of a HV transmission line. Construction of a line. Corona effect–radio interference. Lightning strokes. Lightning arresters on buildings. Lightning and transmission lines. Basic impulse insulation level (BIL). Ground wires. Tower grounding. Fundamental objectives of a transmission line. Equivalent circuit of a line. Typical impedance values. Simplifying the equivalent circuit. Underground Cable. Voltage regulation and power transmission capability of transmission lines. Resistive line Inductive line. Compensated inductive line. Inductive line connecting two. systems. Review of power transmission. Choosing the line voltage. Methods of increasing the power. capacity. Extra-high-voltage lines. Power exchange between power centers.
3. Distribution of electrical energy. Substations. Substation equipment. Circuit breakers. Air-break switches. Disconnecting switches. Grounding switches. Surge arresters. Current-limiting reactors. Grounding transformer. Example of a substation. Medium-voltage distribution. Low-voltage distribution. Protection of Medium-Voltage Distribution Systems. Coordination of the protective devices. Fused cutouts. Reclosers. Sectionalizers. Review of MV protection.
4. Low-voltage distribution. LV distribution system. Grounding electrical installations. Electric shock. Grounding of V and V/V systems. Equipment grounding. Ground-fault circuit breaker. Rapid conductor heating - I2t factor. Role of fuses. Electrical installation in buildings. Principal components of an electrical installation.
5. Direct-current transmission. Features of dc transmission. Basic dc transmission system. Voltage, current, and power relationships. Power fluctuations on a dc line. Typical rectifier and inverter characteristic. Power control. Effect of voltage fluctuations. Bipolar transmission line. Components of a dc transmission line. Inductors and harmonic filters on the dc side (pulse converter). Converter transformers. Reactive power source. Harmonic filters on the ac side. Thyristor converter station.
6. Transmission and distribution transmission power flow control. Basics of Power System Control. Active Power and Frequency Control. Voltage Control and Reactive Power. Control of Transported Power. Flexible AC Transmission Systems (FACTS). Thyristor-controlled series capacitor (TCSC). Vernier control. Static synchronous compensator. Eliminating the harmonics. Unified power flow controller (UPFC). Static frequency changer.
7. Distribution custom power products. Disturbances on distribution systems. PWM converters. Distribution system. Compensators and circuit analysis. Shunt compensator. Series compensator.
8. Harmonics. Harmonics and phasor diagrams. Effective value of a distorted wave. Crest factor and total harmonic distortion (THD). Harmonics and circuits. Displacement power factor and total power factor. Non-linear loads. Generating harmonics. Correcting the power factor. Generation of reactive power. Effect of Harmonics. Harmonic current in a capacitor. Harmonic currents in a conductor. Distorted voltage and flux in a coil. Harmonic currents in a 3-phase, 4-wire distribution system. Harmonics and resonance. Harmonic filters. Harmonics in the supply network. Transformers and the K factor. Harmonic Analysis. Procedure of analyzing a periodic wave.

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9. Future power systems. Renewable Energy. Decentralized or Distributed Generation. Power-electronic Interfaces. Energy Storage. Blackouts and Chaotic Phenomena.

Additional remarks (by course staff):

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Sylabus

Course name:	**Electric Power Systems 2 (lab)**
Course name in other language:	
Short name:	**EPSYS2**
Course number:	**ML.ANK329**
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,	**2,**	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[0,	0,	**30,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Electrical engineering (ML.ANW113A), Electric Power Systems (ML.ANK381), Electronics 1 (ML.ANW135)

Contents - short:

To gain knowledge on construction, operation and maintenance of transmission and distribution networks.
To get familiar with power network components and equipment.
To understand practical methods of power and energy measurement in power systems.
To understand reasons of faults and protection of electric power systems.
To get familiar with programmable logic controllers used in industry.
To obtain basic knowledge on utilization of electric energy and end-user requirements.
To gain knowledge on numerical modelling of electric drives and load matching in electric drives.
To gain practical knowledge on power factor correction.
To get familiar with electric installations and equipment of wind power station.
To get familiar with numerical modeling of power system (e.g. wind power station, small hydro power station).

Bibliography:

1. Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006
Further Readings:
1. Ackermann T. (editor): Wind Power in Power Systems, Wiley, 2005.
2. Crappa M. (ed.): Electric power system, Wiley, 2008.
3. Das J.C.: Transients in Electrical Systems Analysis, Recognition, and Mitigation, Mc Graw Hill, 2010.
4. Glover J.D., Sarma M.S., Overbye T.J.: Power systems, Cengage Learning, 2008.
5. Manwell J.F., McGowan J.G., Rogers A.L.: Wind energy explained, Wiley, 2009.
6. Schavemaker P., Sluis L.: Electrical power system essentials, Wiley, 2008.
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Course results:

Ability to understand practical issues concerning construction, operation and maintenance of transmission and distribution networks.
Ability to understand faults and methods of protection of electric power systems.
Possession of knowledge on practical methods of power factor correction.
Ability to understand methodology of load matching in electric drives.
Familiarity of methods of numerical modeling of electric loads and power systems (electric drives, wind power station, small hydro power station).

Grading criteria:

Tests after each laboratory unit.

Detailed contents:

Transmission and distribution networks. Section of Rated Voltage for Three-Phase AC Power Transmission. Network Structure. Substations. Open-Air Substations. Circuit Switching Gear. Substation Concepts. Single Bus System. Double Bus System. Polygon Bus System. Practical Analysis of Structure of Networks and Substations. Substation on Site Visit.
Power carriers. Conductor Material (Copper or Aluminum). Overhead Transmission Lines. Line Towers. Insulators. Bundled Conductors. Ground Wires. Shield Wires. Snow and Ice Deposits on Conductors. Transposition of Overheads Transmission Lines. Representation of Lines and Cables. Long Transmission Line. Medium-length Transmission Line. Short Transmission Line. Comparison of the Three Line Models. Underground Cables.
Power and energy measurement in power systems. Analogue Meters. Digital Meters. Data Acquisition. Harmonics Measurements. Power Management Control System. Practical Solutions.
Faults and protection of electric energy system. Transients during a Balanced Fault. Method of Symmetrical Components. Sequence Networks. Line-to-Ground Fault. Line-to-Line Fault. Balanced Three-Phase Fault. System Protection. Protective Relays. Transformer Protection. Transmission Line Protection. Impedance-Based Protection Principle. Computer Relaying. Numerical Examples.
Programmable logic controllers. Capacity of Industrial PLCS. Elements of a Control System. Examples of the Use of a PLC. Central Processing Unit (CPU). Programming Unit. I/O Modules. Structure of The Input Modules. Structure Of The Output Modules. Modular Construction of PLCS. Remote Inputs and Outputs. Conventional Control Circuits and PLC Circuits. Security Rule. Programming PLC. Programming Languages. Advantages of PLCS Over Relay Cabinets. Industrial application of PLCs. Planning the change. Getting to know PLCs. Linking the PLCs. Programming the PLCs. Transparent enterprise.
Utilization of electric energy. Types of Load. Mechanical Energy. Light. Heat. DC Electrical Energy. Chemical Energy. Classification of Grid Users. Residential Loads. Commercial and Industrial Loads. Electric Railways. Modern Light Sources and their Control Systems. Practical Investigation.
Numerical modelling of electric drives. Numerical Modeling of dc Drive. Numerical Modeling of ac Drive. Load matching in electric drives. Modes of Operation of Electrical Drives. Thermal Model of Electric Machine. Numerical Examples. Soft-start of an Induction Motor. Practical solutions.
Power factor correction. Correction of Power Factor of Induction Motor. Numerical Example.
Wind power station. Mechanical Components. Electrical Machinery. Supply Systems. Numerical Modeling of a Wind Power Statiion.
Numerical modeling of small hydro power station. Modeling of a Small Hydro Power Station.

Additional remarks (by course staff):

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Sylabus

Course name:	**Electric circuits 2**
Course name in other language:	
Short name:	**EC2**
Course number:	**ML.ANK317**
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:	**Intermediate**	weekly:	[0,	0,	**2,**	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[0,	0,	**30,**	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**3**

Recommended prerequisites:

Electrical engineering (ML.ANW113A), Electronics 1 (ML.ANW135)

Contents - short:

Getting familiar with basic measurement methods – measurements of electrical values.
Investigation of fundamental 3-phase circuits and electric shock protection networks.
Study the relationship of fundamental electric circuits laws.
Learning the various methods of calculating electric power and energy.
Study the accuracy of electrical measuring instruments.
Getting familiar with typical measurements methods in electrical machines.
Learning the fundamentals of practical aspects of electrical machines.

Bibliography:

1. Bird J.: Electrical Circuit Theory and Technology, Newnes, 2003.
2. Robbinson A.H., Miller W.C.: Circuit Analysis: Theory and Practice, Delmar Cengage Learning, 2003.
3. Irwin J.D., Nelms R.M.: Basic Engineering Circuit Analysis, Wiley, 9th edition, 2008.
3. Hindmarsh J.: Electrical machines and their applications. Pergamon International Library, 1985.
4. Hindmarsh J.: Electrical machines and drives. Worked examples. Pergamon International Library, 1985.
5. Veltman A. et. al.: Fundamentals of electrical drives, Springer, 2007.
6. Wildi T.: Electrical machines, drivers, and power systems, Pearson, 2006.

Course results:

Grading criteria:

Successfully completion of all the laboratory experiments

Detailed contents:

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1. Basic measurements in electric circuits (dc and ac). Voltage measurements. Current measurements. Methods of impedance measurement. Measurements with analog meters and digital multimeter. Analogue oscilloscope. Digital oscilloscope. Data loggers. Measurements of resistance and reactance. Practical illustrations of voltage divider and current divider. Verification of voltage and current relations in star and delta connected systems. Observation of the wave shape of an alternating (sinusoidal) supply on CRO and to measure its phase, frequency, time period and amplitude. Work and applications of instrument transformers. Basic troubleshooting in electrical circuits.
2. Studying of non-linear elements. Ferromagnetic core coil. Observation of the B-H loop of a ferromagnetic core material. Effects of magnetic permeability on inductance. Inductive reactance current control in an ac circuit. Bulbs and modern light sources. Power electronics devices. Rectifiers. Filters. Power quality. Harmonics.
3. Measurement of power and energy (in 1 phase and 3 phase circuits). Active and reactive power measurements with analog meters and digital multimeters. Power in 1 phase circuits. Power in 3 phase circuits. Balance circuits. Unbalance circuits. Electric energy measurement. Home and industrial solutions. Power factor correction measures.
4. Electric shock protection. Measures against electric shock.
5. Transformers (one-phase and three-phase). Construction. Parameters. Performance. Regulation. Open-circuit test. Load test. Parameters of equivalent circuit. Parallel operations of transformers. Use of a transformer for impedance matching.
6. Electric machines (induction, synchronous, dc). Construction. Parameters. Performance. Starting. Braking. Reversal. Power flow. Open-circuit test. Load test. Parameters of equivalent circuit. Power factor. Per-unit notation. Electromechanical performance. Speed-torque relationships. Typical duty cycles. Thermal problems. Motor overload protection. Fuses. Circuit brakes. Sizing motor overload protection.

Additional remarks (by course staff):

Person limit for one experiment is 3-4 students

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Sylabus

Course name:	**Electronics 1**
Course name in other language:	
Short name:	**ENICS1**
Course number:	**ML.ANW135**
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:	**Advanced**	weekly:	[**1,**	**1,**	0,	0,	0,]
Form of grading:	**Continous assesment**	by semester:	[**15,**	**15,**	0,	0,	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**4**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**4**
Mechanical Engineering	**-**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**4**

Recommended prerequisites:

Electrical engineering (ML.ANW113A), Engineering Physics (ML.ANW104)

Contents - short:

To obtain basic knowledge on analogue and digital electronic circuit.
To understand the principle of operation, construction and characteristics of basic semiconductor devices.
To learn the terminology of electronics.
To understand the functions performed by typical analogue and digital components and circuits.
To be able to analyse simple electronic circuit.
To get familiar with troubleshooting in electronic circuits.
To get familiar with manufacture’s specification sheets and application guidelines.

Bibliography:

1. Paynter R. T.: Introductory electronic devices and circuits, Person Prentice Hall, 7th edition.
2. Floyd T .L.: Digital Fundamentals, Person Prentice Hall, 9th edition.
Further Readings:
1. Irwin J. D., Nelms R. M.: Basic Engineering Circuit Analysis, Willey,8th edition.
2. Paynter R. T., Boydell B. J. T.: Electronics Technology Fundamentals Electron Flow Version and Conventional Flow Version, Person Prentice Hall, 2nd Edition.
3. EWB MultiSim Student Edition Lite v.10.
4. Buchala D.M.: Experiments in Digital Fundamentals, Person Prentice Hall, 2006.
5. Boydell B. J. T.: Experiments in Digital Fundamentals, Person Prentice Hall,2005.

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6. Mohan N., Undeland T.M. Robbins W.P.: Power Electronics, J. Wiley&Sons, Inc, 2003.

Course results:

Ability to understand fundamentals, abilities and limits of modern electronics.
Ability to recognise and understand basic electronic circuits.
Ability to apply knowledge of electric circuit to analyse basic electronics circuits.
Ability to use manufacture's documentation to select proper elements and circuits.
Ability to find faults in basic electronic circuits.

Grading criteria:

lesson quizzes +two tests + final assessment

Detailed contents:

ANALOGUE
1. Diodes. PN-Junction. Diode Models. Zener Diodes. Light-Emitting Diodes. Rectifiers. Filters. Special Application. Regulators. Clippers. Clampers. Voltage Multipliers. Displays. Varactors. Tunnel Diodes. Other Diodes.
2. Bipolar Junction Transistors. Bipolar Junction Transistors (BJTs). Construction and Operation. Transistor Current and Voltage Ratings. Characteristic Curves. DC Biasing. DC Load Line.
3. Unipolar Transistors. Field-Effect Transistors. Operation of JFETs. JFET Biasing Circuits. Common-Source Amplifier. Common-Drain Amplifier. Common-Gate Amplifier. MOSFETs. D-MOSFETs. E-MOSFETs. Dual-Gate MOSFETs. Power MOSFETs. Complementary MOSFET.
4. Amplifiers. Amplifier Properties. BJT Amplifier Configurations. Amplifier Classifications. Common-Emitter Amplifiers. AC Concepts. Roles of Capacitors in Amplifiers. Common-Emitter AC Equivalent Circuit. Amplifier Gain. Gain and Impedance Calculations. Swamped Amplifiers. h-Parameters. Other BJT Amplifiers. Emitter Follower (Common-Collector Amplifier). Darlington Emitter-Follower. Common-Base Amplifier. Power Amplifiers. AC Load Line. RC-Couple Class A Amplifiers. Transformer-Coupled Class A, Class B, Class AB Amplifiers. Frequency Response. Multistage Amplifiers.
5. Operational Amplifiers. Operation. Differential Amplifiers. Inverting and Non-inverting Amplifiers. Op-Amp Frequency Response. Negative Feedback. Comparators Integrators and Differentiators. Summing Amplifiers. Instrumentation Amplifiers. Other Op-Amp Circuits.
6. Tuned Amplifiers. Tuned Amplifier Characteristics. Active Filters. Low-Pass and High-Pass Filters. Band-Pass and Notch Filters. Active Filter Applications. Discrete Tuned Amplifiers. Class C Amplifiers.
7. Oscillators. Introduction Phase-Shift Oscillators. Wien-Bridge Oscillator. Colpitts Oscillator. Other LC Oscillators Crystal-Controlled Oscillators.
8. Solid-State Switching Circuits. Basic Switching Circuits. Schmitt Triggers.
9. Thyristor and Optoelectronics Devices. Thyristors. Diacs. Triacs. Photodetectors. Optoisolators. Optointerrupters.
10. Discrete and Integrated Voltage Regulators. Series Voltage Regulators. Shunt Voltage Regulators. Linear IC Voltage Regulators. Switching Regulators.
DIGITAL
1. Number Systems, Operations and Codes. Decimal and Binary Numbers. Number Conversion. Binary Arithmetic. Hexadecimal Numbers. Octal Numbers. Binary Coded Decimal. Digital Codes. Error Detection and Correction Codes.
2. Logic Gates. Inverter. AND Gate. OR Gate. NAND Gate. NOR Gate. Exclusive-OR and Exclusive-NOR.

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3. Boolean Algebra and Logic Simplification. Boolean Operations and Expressions. Laws and Rules of Boolean Algebra. DeMorgan's Theorem. Boolean Analysis of Logic Circuits. Simplification Using Boolean Algebra. Standard Forms of Boolean Expressions. Truth Tables. Kamaugh Map. Kamaugh Map SOP and POS Minimization.
4. Combinational. Basic Combinational Logic Circuits. Imp1ementing Combinational Logic. Universal Property of NAND and NOR Gates. Combinational Logic Using NAND and NOR Gates. Logic Circuit Operation with Pulse Waveform Inputs. Adders. Comparators. Decoders. Encoders.
5. Latches, Flip-Flops, and Timers. Latches. Edge-Triggered Flip-Flops. Flip-Flop Operating Characteristics Applications. 555 Timer.
6. Counters. Asynchronous Counter Operation. Synchronous Counter Operation. Up/Down Synchronous Counters. Cascaded Counters. Counter Decoding.
7. Shift Registers. Functions. Serial In/Serial Out Shift Registers. Serial In/Parallel Out Shift Registers. Parallel In/Serial Out Shift Registers. Parallel In/Parallel Out Shift Registers. Bidirectional Shift Registers. Shift Register Counters.
8. Memory and Storage. Basics of Semiconductor Memory. Random-Access Memories. Read-Only Memories. Programmable ROMs (PROMs and EPROMs). Flash Memories. Memory Expansion. Special Types of Memories. Magnetic and Optical Storage.
9. Digital Signal Processing. Converting Analog Signals to Digital. Analog-to-Digital Conversion Methods. Digital Signal Processor. Digital-to-Analog Conversion Method. Integrated Circuit Technologies.

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Sylabus

Course name:	**Electronics 2 (lab)**
Course name in other language:	
Short name:	**ENICS2**
Course number:	**ML.ANK316**
Course language:	**English**
Responsible for the course:	**dr inż. Jan Szymczyk**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**4**
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:

Electric Circuits 1 (ML.ANW113), Electric circuits 2 (ML.ANK317), Electronics 1 (ML.ANW135)

Contents - short:

The aim of this course is to develop and practice the skills learned in Electronics I, demonstrate measurement methods and electronic devices in practice.

Bibliography:

1. Paynter R. T.: Introductory electronic devices and circuits, Person Prentice Hall, 2005, 7/e.
2. Floyd T .L.: Digital Fundamentals, Person Prentice Hall, 2005, 9/e.
3. Irwin J. D., Nelms R. M.: Basic Engineering Circuit Analysis, Willey, 2005, 8th edition.
4. Paynter R. T., Boydell B. J. T.: Electronics Technology Fundamentals Electron Flow Version and Conventional Flow Version, Person Prentice Hall, 2005 Second Edition.
5. Laboratory tutorial.

Course results:

After completing this course students will be able to specify basic electronic parameters, its interpretation and meanings and implement methods of measurement of electronics circuits

Grading criteria:

short tests before and after each exercise

Detailed contents:

transistor amplifiers, operational amplifier, sine wave oscillators, voltage stabilizers (direct current), impulse circuits, digital circuits, analogue-digital converters and digital-analogue converters.

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Sylabus

Course name:	**Energy Market**
Course name in other language:	
Short name:	**ENERMAR**
Course number:	**ML.ANS625**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Konrad Świrski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**7**

Contents - short:

Knowledge about modern energy market and IT systems supporting electricity trading. Electricity market in Poland and Europe - energy pool, bilaterall contracts, balancing markets. Emission allowances and trading. TPA (Third Party Access)in Poland and Europe. Prices and tariffs on the market. Calculation of profits due to electricity supplier exchange.

Bibliography:

Full materials (updated annually) available on http://energetyka.itc.pw.edu.pl/pe

Course results:

Knowledge of modern regulation of electricity market. Information about market structure, types of contracts, volumes and prices on the market. Possibility of evaluation of profits due to TPA supplire contract for individual and industrial consumers.

Grading criteria:

Point scoring methodology (individual work during lectures and final internet test) according to regulation available on http://energetyka.itc.pw.edu.pl/re

Detailed contents:

Course introduce to the problem of electricity market (trading) in Poland and with some aspects in other European countries. Wide description of electricity market regulation and current status of trans action is presented. Additionally, the course presents IT systems supporting electricity trading and simulation of the process from the point of view of wholesale trading companies and generating units – units, power plants, power corporations. Simulation of energy trading (pool, balancing market) processes. Base course curriculum as below:

1. Power system in Poland and Europe - information about power system in Poland and Europe, installed capacity, demand, forecast of changes toward 2030, investment process (new power plants), regulations (current and introduced in 2015-2020) afecting power sector

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2. Electricity market fundamentals - the idea of liberalized electricity market, history of the markets, base regulations, wholesale and retailed market
3. Segments in electricity markets (volumes and prices)- detailed information about electricity market in Poland, how to trade electricity, historical data, how the market changed 2000-2010
4. Billateral contracts (and simulation) - detailed description of bilateral contracts segment - regulation, volumes and prices, computer simulation (and negotiation) of bilateral contract
5. Energty Pool (and simulation)- detailed description of electricity pool - regulation, volumes and prices, computer simulation of energy pool
6. Balancing market (with simulation) - detailed description of balancing market segment - regulation, volumes and prices, computer simulation
7. Electricity price for consumers - system of retaile market, price tariffs, demand of electricity
8. TPA in Poland and Europe - Third Party Access regulation (possibility of changing energy supplier) - regulation in Poland and Europe, procedures to change supplier, simulation of profits
9. Forecasting - electricity forecasting - techniques and computer software, practical simulation of electricity demand forecasting (using linear models and time series methods)
10. Emmission allowances and emission trading - european regulation regarding emission, impact of emission allowances on energy generation cost, new investment in energy sector fulfilling emission regulations
11. IT systems for electricity trading - computer system supporting electricity trading, overview of the systems at System Operator and other participants of electricity market - presentationa and simulation
12. Poland and Europe - comparison of electricity markets, electricity pools - Nordpool, IPX

Additional remarks (by course staff):

All course info available on http://energetyka.itc.pw.edu.pl/re

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Sylabus

Course name:	**Energy Sources and Conversion**
Course name in other language:	
Short name:	**ESAC**
Course number:	**ML.ANS603**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Roman Domański**

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	**Power engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Fizyka I (ML.ZNW135), Termodynamika (ML.ZNW116)

Contents - short:

Teaching evaluation of energy storage and resources. Evaluation of implementation possibilities for new energy storage technologies, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of energy storage. Presenting new and future energy storage technologies for different energy sources.

Bibliography:

Materials for students placed on website

1. Dincer I., Rosen M.A.: Thermal Energy Storage, John Wiley& Sons Ltd, England 2002
2. Kruger P.: Alternative Energy Resources, The Quest for Sustainable Energy, John Wiley & Sons, Inc.,2006
3. IEA: World Energy Outlook, OECD/IEA, 2006
4. Jezierski G.: Energia jądrowa wczoraj i dziś, WNT, Warsaw 2005

Course results:

After passing the subject student will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.

Grading criteria:

60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:

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Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

Detailed contents:

Basic terms related to energy conversion processes. World's energy resources (organic fossil fuels, nuclear fuels, renewable sources): documented and possible. Selected scenarios for world's energy development (IEA, WEC, DOE…). Threats related to energy conversion processes. Scenarios for Poland. Energy conversion matrix. Energy conversion efficiency for selected processes and devices. Issues of energy accumulation in various forms. Energy conversion from fossil fuels. CO2 capture and storage. Supercritical power plant. Possibility of energy storage. Environmental footprint of energy conversion processes: local and global. Greenhouse effect. Legal framework and standards for environmental protection. Renewable sources; sun as an energy source, conversion of solar radiation energy (collectors and photovoltaic systems). Biomass and biofuels. Wind power, energy of waters and oceans, OTEC. Geothermy – geothermal systems, prospective hot dry rock technologies. Geothermy in Poland. Nuclear reactions, nuclear fission and fusion, nuclear threats. BWR, PWR, HTGR nuclear reactors. Heat pumps, examples of application. Hydrogen as an energy carrier, hydrogen production and storage. Fuel cells in power industry and transportation. Energy conversion in lasers. Energy conversion in space. Prospective power generation technologies. Rationalization of energy consumption, increase of energy conversion efficiencies

Additional remarks (by course staff):

Lecture based on Power Point presentations

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Sylabus

Course name:	**Energy Storage**
Course name in other language:	
Short name:	**ESTO**
Course number:	**ML.ANS527**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Roman Domański**

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	**Power engineering**	**undergraduate, full time**	**7**

Recommended prerequisites:

Heat Transfer 1 (ML.ANK423), Termodynamika (ML.ZNW116)

Contents - short:

Teaching evaluation of energy storage and resources. Evaluation of implementation possibilities for new energy storage technologies, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of energy storage. Presenting new and future energy storage technologies for different energy sources.

Bibliography:

Materials for students placed on website

1. Dincer I., Rosen M.A.: Thermal Energy Storage, John Wiley& Sons Ltd, England 2002
2. Domański R.: Magazynowanie energii cieplnej, PWN, 1990
3. Jezierski G.: Energia jądrowa wczoraj i dziś, WNT, Warsaw 2005

Course results:

After passing the subject student will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.

Grading criteria:

60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

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Detailed contents:

Basic terms related to energy conversion processes. World's energy resources (organic fossil fuels, nuclear fuels, renewable sources). The basic parameters for energy storage. Energy conversion efficiency for selected processes and devices. Issues of energy accumulation in various forms. Possibility of energy storage. Thermal energy storage, (long and short term – heat storage tanks, ground storage, PCM storage), mechanical energy storage (flywheels). CAES energy storage systems for power plants, industry and air weapons. Hydrogen as an energy carrier, hydrogen production and storage. Fuel cells as energy storage and conversion system. Hydro storage power plant. Electrical energy storage (batteries, capacitors, super capacitors, electromagnetic systems, superconducting magnetic energy storage (SMES)). Examples of energy storage systems. Efficiency of energy storage in different forms. Increase of energy conversion efficiencies by introducing the energy storage.

Additional remarks (by course staff):

Lecture based on Power Point presentations

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Sylabus

Course name:	**Energy Systems**
Course name in other language:	
Short name:	**ENERSYS**
Course number:	**ML.ANK390**
Course language:	**English**
Responsible for the course:	**doc. dr inż. Paweł Skowroński**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**5**

Contents - short:

System-like feature of power industry. Creation and operation of power systems. Chosen energy system characteristic. Methods and goals of mathematical modeling of energy systems

Bibliography:

Materials provided by lecturer
Additional e.g:
1. Bejan A., Tsatsaronis G., Moran M., Thermal Design & Optimization, John Wiley&Sons Inc., New York/ Chichester/Brisbane/Toronto/Singapore, 1996

Course results:

Student is able to make an analysis and synthesis of simpler energy systems, and develop simplified mathematical models of the systems (steady state).
Student knows structure and rules of operation of domestic energy systems.

Grading criteria:

final test

Detailed contents:

Chosen topics of general system theory. Basic energy and technological processes. Features and structures of big energy systems.
Rules of energy systems creation/development.
Goals and methods (chosen) of mathematical modeling of energy systems. Examples of solution of simulation and optimization of energy systems.
Polish power system, Polish gas system, local municipal heating systems, chosen power stations – as electricity generation systems, and heat generation plant – structure, elements, internal relations, internal system constraints, load variability, development planning.

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Sylabus

Course name:	**Energy management**
Course name in other language:	
Short name:	**232**
Course number:	**ML.ANK443**
Course language:	**Polish**
Responsible for the course:	**doc. dr inż. Paweł Skowroński**

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	**Power engineering**	**undergraduate, full time**	**6**

Contents - short:

Basic rules and conditions of energy management – including technical, economical and legal factors; (related to Polish conditions)

Bibliography:

Materials provided by lecturer

Course results:

Student understands a role of energy in economy, basic aspects of energy supply and final use, and principles of energy markets and possible regulations on energy activities.

Grading criteria:

final test

Detailed contents:

Primary energy sources – abundance and availability. Review of processes of: energy generation, conversion, transmission, distribution, storage, and final use – economic and environmental aspects. Energy carriers. Conventional processes of energy use – space heating, transport, driver, lightening, energy use in households, energy use in chosen industrial processes - total energy consumption, power demand, daily and seasonal variability, load factors. Basic and peak energy sources. SSM and DSM. Energy costs. Cost structure In generation, distribution, and energy turn-over. Cost division in cogeneration.

Legal factors of energy management. EU Directives, Polish Energy Act, executory provisions. Energy market regulation. Energy prices and tariffs. Regulatory Authorities (Polish Energy Regulatory Office, URE)

Forecasting of domestic fuel and energy carriers demand and prices.

Economic conditions of construction and operation of energy generation systems. Investment profitability indices. Least cost planning method.

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Direct and cumulative energy consumption.
Energy saving – profitability and financing. Rational use of energy In industry and In households. Energy recuperation and waste energy utilization.

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Sylabus

Course name:	**Engineering Diploma Seminar**
Course name in other language:	
Short name:	**EDS**
Course number:	**ML.ANW128**
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	**-**	**undergraduate, full time**	**7**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**7**
Mechanical Engineering	**-**	**undergraduate, full time**	**7**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**7**

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:
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

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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 engineering diploma thesis themes. The seminar should match the area of studies programme and specialisation.

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Sylabus

Course name:	**Engineering Diploma Thesis**
Course name in other language:	
Short name:	**EDT**
Course number:	**ML.ANW136**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Paweł Pyrzanowski**

ECTS:	**15**	Number of hours:	[	Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	weekly:	[	0,	0,	0,	**12,**	0,]
Form of grading:	**Exam**	by semester:	[	0,	0,	0,	**180,**	0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**7**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**7**
Mechanical Engineering	**-**	**undergraduate, full time**	**7**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**7**

Contents - short:

Synthesis of engineering knowledge acquired during first 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 engineering problem, - perform selection of relevant literature, - choosing research methods, - presentation of obtained results and its critical analysis.

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:

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

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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.

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:	**Engineering Graphics**
Course name in other language:	
Short name:	**ENGRA**
Course number:	**ML.ANW105**
Course language:	**English**
Responsible for the course:	**dr inż. Witold Mirski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

Creating the orthogonal projection of spatial geometrical forms onto adequate plane of projection. Learning of the spatial imagination.

Bibliography:

1. George C. Beakley, Ernst G. Chilton – Introduction to Engineering Design and Graphics.

Course results:

Getting the skill of rational use of space.

Grading criteria:

Positive results of tests as well as home and class work.

Detailed contents:

Basic information about the axonometric projection. Introduction to the descriptive geometry using the Monge's method. Projection of such simple geometric elements as points, straight lines and planes. Their common elements. Spatial relationships between those elements. Auxiliary-view method. Projection of revolution. Projection of surfaces of basic geometric shapes: rectangular prisms, cylinders, cones and spheres (cross-sections and points of intersections, intersection lines. Creating of components of complex objects on the base of two-dimensional sketch using a Computer Aided Design three-dimensional system (3D-CAD).

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Additional remarks (by course staff):

Two teachers for group of 26÷32 students (tutorial). Term of registration according to the dean's information.

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Sylabus

Course name:	**Engineering Graphics - CAD 1**
Course name in other language:	
Short name:	**EGCAD1**
Course number:	**ML.ANW118**
Course language:	**English**
Responsible for the course:	**dr inż. Witold Mirski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Recommended prerequisites:

Engineering Graphics (ML.ANW105)

Contents - short:

Making views of machine’s element basing on the real object according to the rules of International Standards (ISO) and the technical drawing.

Bibliography:

1. George C. Beakley, Ernst G. Chilton – Introduction to Engineering Design and Graphics.
2. Cecil Jensen, Jay D. Helsel, Dennis R. Short – Engineering Drawing & Design.
3. International (ISO) and Polish Standards.

Course results:

Getting the skill of making the technical drawing of machine’s element according to the rules of International (ISO) and Polish Standards - drawing by hand and using the 2D-CAD system.

Grading criteria:

Positive results of tests as well as home and class work

Detailed contents:

Introduction to the technical drawing. Part view and axonometric projection of machine’s element basing on the real object. Modification of the technical drawing. Technical drawing of assemblies and parts with

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thread. Screw and keyed joints. Technical drawing of gears. Assembly drawing of machine's elements basing on the real object. Part views on the base of assembly drawing. Introduction to the 2D-CAD system. Making use of the computer library of 2D-CAD system.

Additional remarks (by course staff):

Group of 12 students for one teacher. Term of registration according to the information of dean of faculty.

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Sylabus

Course name:	**Engineering Physics**
Course name in other language:	
Short name:	**EPHYS**
Course number:	**ML.ANW104**
Course language:	**English**
Responsible for the course:	**dr inż. Nikołaj Uzunow**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

Recollection of the basic principles and laws of the fields of physics being most important regarding the programme of this Faculty: mechanics - mass, momentum, moment of momentum, and energy conservation laws in translatory and rotary motion; field theory - gravity field, electrostatic field, magnetic field; thermodynamics - intensive quantities, perfect gas, gas processes, extensive quantities, first law of thermodynamics, thermodynamic cycles, second law of thermodynamics; hydrodynamics - continuity law, Bernoulli equation.

Bibliography:

1. Halliday, D., Resnick, R., and Walker, J.: Fundamentals of Physics, John Wiley & Sons, Inc., 2001.
2. Young, H. D., and Freedman, R. A.: University Physics, Pearson Addison-Wesley, 2008.

Course results:

Better preparation for the much more profound and complex courses on mechanics, electrotechnics, thermodynamics, and fluid dynamics in the next semesters.

Grading criteria:

Two tests: I – conservation laws, field theory; II - thermodynamics, hydrodynamics.
Both tests have to be passed. The final grade is an average of the grades obtained on the tests.

Detailed contents:

Lectures and exercises:

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1. Basic physical quantities and SI measuring units; scalar and vector quantities; basic vector calculus.
2. Physical systems; fundamental interactions; modelling principles; Newton laws; curvilinear motion.
3. Momentum change law; momentum conservation law; moment of inertia; Steiner law; moment of momentum change law; moment of momentum conservation law. Engineering applications.
4. Kinetic energy in translatory and rotary motion; potential energy; conservative and dissipative forces; mechanical energy change law; mechanical energy conservation law. Engineering applications.
5. Gravity field: source quantity (mass), force, intensity (acceleration), flux, potential, energy. Engineering applications.
6. Electrostatic field: source quantity (electric charge), Coulomb force, intensity, flux, potential, energy. Engineering applications.
7. Magnetic field: source, Lorenz force, induction, intensity, Amper law, electrodynamic force. Engineering applications.
8. Intensive thermodynamic quantities; macroscopic (classical) and microscopic (statistical) approach; mass and molar approach; perfect gas model; Clapeyron equation; Dalton law. Engineering applications.
9. Gas processes; specific heat; extensive quantities; first law of thermodynamics. Engineering applications.
10. Process reversability; thermodynamic cycles; Carnot cycle; second law of thermodynamics. Engineering applications.
11. Hydrodynamics: compressibility; continuity law; Bernoulli equation. Engineering applications.

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Sylabus

Course name:	**Environment Protection**
Course name in other language:	
Short name:	**EPROT**
Course number:	**ML.ANW109**
Course language:	**English**
Responsible for the course:	**dr inż. Piotr Krawczyk**

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	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

Basic knowledge of the environment protection problems

Bibliography:

No relevant issues

Grading criteria:

The assessment is based on two tests, held in the middle and at the end of the semester. The tests consist of several questions to be answered. Students have to obtain positive grades on both tests. The final grade is calculated as an average from the two tests.

Detailed contents:

Objectives of the environment protection policy. National, European, and global environment protection legal system. Human health vs. technical and economical problems. Mechanisms and instruments of the environment protection policy. Air protection. Greenhouse gases, European Trading System. Water and soil protection. Waste utilisation. Protection against noise and vibration. Radiation protection.

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Sylabus

Course name:	**Fluid Mechanics 1**
Course name in other language:	
Short name:	**FLUMECH1**
Course number:	**ML.ANW122**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Jacek Szumbarski**

ECTS:	**4**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	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	**-**	**undergraduate, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**3**
Mechanical Engineering	**-**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**3**

Contents - short:

Basic concepts and theoretical constructs of the mechanics of continuum, summary of necessary mathematical tools.
Fluid statics: basic theory and engineering applications.
Fluid kinematics: description of fluid motion and deformation
Fluid dynamics: stress in fluids, equations of motion, energy equation, Bernoulli equation, calculation of dynamic reactions, etc.
Selected models of fluid flow: flow in pipes, boundary layer.
Elementary introduction to turbulent flows.

Bibliography:

1. Kundu P.K., Cohen I.M.: Fluid Mechanics. Elsevir Academic Press, 3rd Ed. (2004) or newer.
2. Aris R.: Vectors, tensors and the basic equations of Fluid Mechanics. Dover Publications Inc., 1989.
3. Krauze E.: Fluid mechanics. Springer, 2005 (available in electronic form in the main library of WUT)
4. Lecture notes provided by the instructor (PDF slides)

Course results:

Good knowledge of the fundamental concepts and principles of the Fluid Mechanics, skills in solving basic problems in fluid statics and dynamics of an ideal and viscous liquid.

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Grading criteria:

2 tests in the tutorial part + the final exam.

Detailed contents:

1. Fluid as a continuous medium
2. Elements of fluid statics: equilibrium equations and condition, manometers, fluid reaction on the solid walls, the Archimedes law.
3. Fluid kinematics: Lagrangian and Eulerian descriptions, vector field of the fluid velocity, trajectories of fluid elements and streamlines, the streamfunction, vorticity and related theorems, tensor description of the fluid deformation.
4. Principle of mass conservations and the continuity equation.
5. Dynamics of continuum: tensor description of stress in fluid, the linear momentum principle and general equation of motion, the principle of angular momentum and the symmetry of the stress tensor.
6. Viscous fluids: rheological model of the Newtonian fluid, Navier-Stokes Equation, problem of the boundary conditions, examples of analytical solutions.
7. Model of an ideal fluid: Euler equation, first integral of Bernoulli and Cauchy-Lagrange, some applications.
8. Integral form of the momentum principle and its application to determination of the reaction force exerted on immersed bodies. Aerodynamic coefficients.
9. Flow similitude.
10. Elements of hydraulics: motion of a viscous liquid in pipes, Bernoulli Equation with pressure-loss terms.
11. Introduction to the boundary layer theory: Prandtl’s equation, the layer thickness, The Blasius solution, integral von Karman equation, boundary layer separation.
12. Elementary introduction to the theory of turbulent flows: physical characteristics of a turbulent flow, the laminar-turbulent transition, averaging procedure and the Reynolds Equations, the closure problem.

Additional remarks (by course staff):

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Sylabus

Course name:	**Fluid Mechanics 2**
Course name in other language:	
Short name:	**FLUMECH2**
Course number:	**ML.ANK340**
Course language:	**English**
Responsible for the course:	**mgr inż. Konrad Gumowski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**4**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122)

Contents - short:

Familiarizing students with basic knowledge of the physics of fluids, and basic measurements techniques.

Bibliography:

1.Kundu P.K., Cohen I.M.: Fluid Mechanics. Elsevier Academic Press, 3rd Ed. (2004)
2.Frank M. White: Fluid Mechanics, 4rd Ed. (1999)

Course results:

After completing his course the students will be able to measure and specify: flow conditions, pressure gradients and aerodynamic forces.

Grading criteria:

Assesment method: e.g. 60% continuous assesment based on laboratory work, 40% exam
Practical work: e.g. Project/laboratory classes, where students will design and implement a simple measurements of flow conditions and parameters.

Detailed contents:

Measurement techniques for the flow-rate, velocity and pressure.
1) Thermo- and laser-anemometry.
2) Measurements of viscosity coefficient and hydraulic losses.
3) Flow visualisation techniques.
4) Pressure distribution and drag coefficient the on bluff bodies.

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5) Aerodynamics coefficients on lifting surfaces.

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Sylabus

Course name:	**Fluid Mechanics 3**
Course name in other language:	
Short name:	**FLUMECH3**
Course number:	**ML.ANK341**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Jacek Szumbarski**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Advanced**	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	**Power engineering**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**4**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122)

Contents - short:

To learn about essential concepts and theoretical methods of the compressible flow dynamics. To acquire practical skills in solving simple engineering problem in the one-and two-dimensional ideal gas dynamics.

Bibliography:

1. Kundu P.K., Cohen I.M.: Fluid Mechanics, 3rd Ed. (or newer). Elsevir Academic Press, 2004.
2. Liepmann H.W., Roshko A.: Elements of Gas Dynamics. Dover Publications, Inc., 2001.
3. Krauze E.: Fluid mechanics. Springer, 2005 (available in electronic form in the main library of WUT)

Course results:

After completing his course the students:
• should know the basic physical concepts and mathematical models of gas dynamics
• can calculate various gas parameters in isentropic flows
• can solve one-dimensional stationary flows with shock waves
• can determine various forms of the gas flow inside the Laval nozzle
• can solve simple one-dimensional gasodynamic problems with frictions or heat transfer
• can solve simple one-dimensional unsteady problems using the method of characteristics and Riemann invariants
• should know essentials about stationary two-dimensional gas flows

Grading criteria:

2 tests during the course, final exam.

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Detailed contents:

1. Energy equation: derivation, interpretation of terms, dissipation function.
2. First integral of the energy equation, Crocco equation.
3. Dynamics of small disturbances, acoustic approximation, speed of sound and the Mach number.
4. Isentropic and adiabatic gas flow: basic relations, stagnation and critical parameters, examples of application.
5. The normal shock wave
6. Stationary motion of an ideal gas in the duct with variable section. The Laval nozzle.
7. Stationary motion of the gas in the presence of heat transfer.
8. Stationary motion of the gas through the duct with friction.
9. One dimensional unsteady motion of a compressible fluid, method of characteristics and Riemann invariants, simple waves and emergence of shocks, examples of application.
10. Two-dimensional potential flow.
11. Two-dimensional and stationary motion of the gas, an oblique shock wave.

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Sylabus

Course name:	**Foreign language 1**
Course name in other language:	**Język obcy 1**
Short name:	**JGRANG1**
Course number:	**ML.ANJGA1**
Course language:	**Polish**
Responsible for the course:	**mgr Olga Pławska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

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Sylabus

Course name:	**Foreign language 2**
Course name in other language:	**Język obcy 2**
Short name:	**JGRANG2**
Course number:	**ML.ANJGA2**
Course language:	**Polish**
Responsible for the course:	**mgr Olga Pławska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

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Sylabus

Course name:	**Foreign language 3**
Course name in other language:	**Język obcy 3**
Short name:	**JGRANG3**
Course number:	**ML.ANJGA3**
Course language:	**Polish**
Responsible for the course:	**mgr Olga Pławska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**3**
Mechanical Engineering	**-**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**3**

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Sylabus

Course name:	**Foreign language 4**
Course name in other language:	**język obcy 4**
Short name:	**JGRANG4**
Course number:	**ML.ANJGA4**
Course language:	**Polish**
Responsible for the course:	**mgr Olga Pławska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**4**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**4**
Mechanical Engineering	**-**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**4**

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Sylabus

Course name:	**Fundamentals of Management**
Course name in other language:	
Short name:	**FOM**
Course number:	**ML.ANK376**
Course language:	**English**
Responsible for the course:	**dr Sylwia Michalska**

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	**Power engineering**	**undergraduate, full time**	**4**

Contents - short:

This course is a short presentation of the most important management theories and methods (like Taylorism, Fayolism etc). Students will also learn about groups - dynamic of groups, roles in groups, mechanisms of people's communication, team building. They learn about different communication methods, specially in he situation of conflict (mediation, negotiation etc). We will discuss about the factors of motivation, effectiveness.

Bibliography:

Recommended texts (reading):

Gary Hamel "The Future of Management" (with Bill Breen) (Harvard Business School Press, 10 September 2007
M. McKay, M. Davis, P. Fanning “Sztuka skutecznego porozumiewania się” GPW 2004
P. Hartley „Komunikacja w grupie” Zysk i s-ka 2000
T. Tyszka „Psychologiczne pułapki oceniania i podejmowania decyzji” GPW 1999
W. Stephan, C. Stephan, „Wywieranie wpływu przez grupy. Psychologia relacji” GPW 1999
P. Thompson ”Sposoby komunikacji interpersonalnej” Zysk i s-ka 1998

Course results:

After completing his course the students will be able to recognize relation in groups, will be conscious, how to (better) communicate and cooperate with other people, will be able to (better) organize his (and others) work, making rational decisions.

Grading criteria:

test - open and closed questions about most basic aspect of theories and problems presented during the course.

Detailed contents:

Contents (lecture’s programme):

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- What is management? - who can organize work of other people, what abilities we need, to work in groups.
- Why people cooperate? - dynamics of group, group roles, team building.
- Most important management theories - how the idea of management changed, why this change was necessary?
- Manager's functions - what are the duties and competences of manager?
- Manager's roles.
- Management of quality.
- Communication - how people communicate, problems with cultural differences.
- Manipulation - how can we avoid manipulation.
- Negotiations - positional, problematic, mediation - when, why and how?
- Effectiveness - what make people working good?

Additional remarks (by course staff):

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Sylabus

Course name:	**Fundamentals of Operation and Maintenance**
Course name in other language:	
Short name:	**FOAM**
Course number:	**ML.ANK364**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Konrad Świrski**

ECTS:	**5**	Number of hours:	[Lc, T, Lb, P, S,]
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	**Power engineering**	**undergraduate, full time**	**5**

Contents - short:

Knowledge about Fundamentals of machinery operations and operations standards. Diagnostic and performance monitoring systems. Fundamentals of operation in power

Bibliography:

Full materials available on http://energetyka.itc.pw.edu.pl/pe

Course results:

group work

Grading criteria:

Point scoring methodology (individual work during lectures and final web test) according to regulation available on http://energetyka.itc.pw.edu.pl/pe

Detailed contents:

Knowledge about Fundamentals of machinery operations and operations standards. Diagnostic and performance monitoring systems. IT systems supporting operation. Fundamentals of operation in power (with performance monitoring systems). Lectures supplemented with simulation and exercises utilizing industrial data

Additional remarks (by course staff):

All course info available on http://energetyka.itc.pw.edu.pl/pe

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Sylabus

Course name:	**Gas Turbines and Gas-Steam Systems**
Course name in other language:	
Short name:	**GASTUR**
Course number:	**ML.ANS576**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Andrzej Miller**

ECTS:	**3**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Advanced**	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	**Power engineering**	**undergraduate, full time**	**7**

Contents - short:

Advance knowledge of gas turbine and gas-steam system selection for power system analyzed

Course results:

Advance knowledge of gas turbine and gas-steam system selection for power system analyzed.

Grading criteria:

Final test

Detailed contents:

Gas turbine and gas-steam system in power engineering – state of the art and future perspectives. Also design principles, parameters and performance including off-design ones

Additional remarks (by course staff):

All course info available on http://energetyka.itc.pw.edu.pl

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Sylabus

Course name:	**Health and Safety Training**
Course name in other language:	**BHP**
Short name:	**HST**
Course number:	**ML.ANW71**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Paweł Pyrzanowski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

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Sylabus

Course name:	**Heat Pumps**
Course name in other language:	
Short name:	**HEATPUMP**
Course number:	**ML.ANS540**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Roman Domański**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**6**

Recommended prerequisites:

Termodynamika (ML.ZNW116)

Contents - short:

Teaching evaluation of energy resources. General information about heat pumping technology. Evaluation of implementation possibilities for new heat pump technologies, evaluation of environmental threats related to heat pumps and energy conversion processes, feasibility of individual technologies of heat pumps. Presenting new and future heat pump technologies for different energy sources.

Bibliography:

Materials for students placed on website

1. Cengel Y.A., Boles M. A.: Thermodynamics: An Engineering Approach, New York, 1994

Course results:

After passing the subject student will be able to analyze energy systems with heat pumps, understand needs for heat pump application, energy storage for all energy conversion processes, realize shortcomings of prospective heat pump technologies and limitations in their implementation today.

Grading criteria:

60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

Detailed contents:

Basic terms related to energy conversion processes in thermodynamic cycles. Efficiency of reverse thermodynamics cycle. Operation principle of a heat pump. General information about heat pumping technology. Types of heat pumps. Working fluids for heat pumps. Heat sources of heat pumps: air,

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ground, solid state. Earth as an energy source. Ground heat exchangers. Thermal energy storage (long and short term – ground storage, PCM storage). Heat pump application systems. Reduction of CO2 emissions
through the use of heat pump systems.
Increase of energy conversion efficiencies by introducing heat pumps and energy storage.

Additional remarks (by course staff):

Lecture based on Power Point presentations

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Sylabus

Course name:	**Heat Transfer 1**
Course name in other language:	
Short name:	**HETRA1**
Course number:	**ML.ANK423**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Piotr Furmański**

ECTS:	**3**	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	**Power engineering**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**5**

Recommended prerequisites:

Thermodynamics 1 (ML.ANW116)

Contents - short:

Knowledge of the basic and complex heat transfer modes and their mathematical description. Thermal properties of materials. Steady and transient heat conduction. Forced and natural heat convection. Heat convection with phase change - condensation and boiling. Fundamentals of radiative heat transfer.

Bibliography:

1) Cengel Y.A.: “Heat Transfer; A Practical Approach”, McGraw Hill
2) Materials for students placed on website

Course results:

Ability to solve simple problems in heat conduction, heat convection and thermal radiation.

Grading criteria:

2 tests, practical and theoretical exams, point system of evaluation

Detailed contents:

Lectures:
1. Basic and complex modes of heat transfer.
2. Heat conduction. Heat conduction through a thin-wal structures (fins). Thermal resistances.
3. Transient heat conduction.Characteristic features of heat conduction for limiting values of Biot and Fourier similarity numbers.
4. Heat convection. Convective heat transfer coefficient and ways of its determination. Similarity theory in heat transfer. Correlation equations.

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5. Forced convection in internal and external flows.
6. Natural convection in channels, open and closed spaces.
7. Heat transfer accompanying phase change. Characteristic features of heat transfer at condensation and boiling.
8. Fundamentals of thermal radiation and radiative heat transfer.

Tutorials:

1. Temperature and heat transfer calculations for simple geometries of solids for heat conduction in steady state.
2. Temperature and heat transfer calculations for simple geometries of solids for heat conduction in transient state.
3. Determination of the convective heat transfer coefficient, heat flux and temperature distribution for nonisothermal internal flow of fluids.
4. Determination of the convective heat transfer coefficient and heat flux for nonisothermal external flow of fluids.
5. Determination of the convective heat transfer coefficient, heat flux for natural convection in open and closed spaces.
6. Determination of the convective heat transfer coefficient, heat flux and an amount of the new phase formed for condensation and boiling.
7. Calculation of radiative heat transfer between grey and diffuse surfaces.

Additional remarks (by course staff):

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Sylabus

Course name:	**Heat Transfer 2**
Course name in other language:	
Short name:	**HETRA2**
Course number:	**ML.ANK424**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tomasz Wiśniewski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:
Heat Transfer 1 (ML.ANK423)

Contents - short:
Practical demonstration of measurement devices and methods for basic thermal properties of solids. Measurements of thermal conductivity, diffusivity, specific heat, convective heat transfer coefficients in natural and forced convection. Measurement of thermal contact resistance. Measurement of heat transfer coefficients in heat exchanger. Investigation of heat transfer in CPU radiator. Application of infrared thermography in heat transfer measurements.

Bibliography:
Cengel Y. A., Boles M.A.: Heat transfer. An engineering approach., Mc Graw Hill

Course results:
Student is able to measure properly basic thermal properties of solids with use of Poensgen apparatus, DSC calorimeter and regular regime methods. Student is able to measure convective heat transfer coefficients and thermal contact resistance between solids.

Grading criteria:
final test

Detailed contents:
Measurements of thermal properties of solids (thermal conductivity, diffusivity, specific heat with use of steady-state and transient heat transfer methods. Measurements of convective heat transfer coefficients in natural and forced convection. Measurement of thermal contact resistance. Investigation of heat exchanger. Investgation of heat transfer in CPU radiator. Application of infrared thermography in heat transfer measurements.

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Sylabus

Course name:	**Intermediate Engineering Project**
Course name in other language:	
Short name:	**IEPRO**
Course number:	**ML.ANW127**
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:	**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	**-**	**undergraduate, full time**	**6**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**6**
Mechanical Engineering	**-**	**undergraduate, full time**	**6**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**6**

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:	**Internal Combusion Engines**
Course name in other language:	
Short name:	**INTCOMENG**
Course number:	**ML.ANS549**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Andrzej Teodorczyk**

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	**Power engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Thermodynamics 1 (ML.ANW116)

Contents - short:

Funadamentals, operation and construction of Internal Combustion Engines. Calculations of basic engine parameters.

Bibliography:

1) R.Stone: Introduction to Internal Combustion Engines, MacMillan Press 1999
2) C.R.Fergusson, A.T.Kirkpatric: Internal Combustion Engines, John Wiley 2001

Course results:

Students will be able to calculate basic parameters of ICE

Grading criteria:

Test at the and of the course (50%); 2 homework assignments (50%).
Final mark on the basis of sum of points from the test and assigments.

Detailed contents:

History of ICE; Types of engines; Prospects for ICE; Thermodynamic principles; Combustion and fuels; Spark ignition engines; Compression ignition engines; Induction and exhaust processes; Two stroke engines; In-cylinder motion and turbulent combustion; Turbocharging; Mechanical design considerations; Calculation of engine cycles; Emissions

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Sylabus

Course name:	**Languages - C1_Exam (English)**
Course name in other language:	
Short name:	**EC1ANG**
Course number:	**ML.NJAC1**
Course language:	**English**
Responsible for the course:	**mgr Olga Pławska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**4**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**4**
Mechanical Engineering	**-**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**4**

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Sylabus

Course name:	**Library Training**
Course name in other language:	**Przysposobienie biblioteczne**
Short name:	**LIBTRA**
Course number:	**ML.ANW72**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Paweł Pyrzanowski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

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Sylabus

Course name:	**Machine Design 1**
Course name in other language:	
Short name:	**MDES1**
Course number:	**ML.ANW124**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Stanisław Bogdański**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**3**
Mechanical Engineering	**-**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**3**

Recommended prerequisites:

Algebra and Geometry (ML.ANW101), Calculus 1 (ML.ANW102), Calculus 2 (ML.ANW90), Computer Science 1 (ML.ANW106), Computer Science 2 (ML.ANW114), Engineering Graphics (ML.ANW105), Materials 1 (ML.ANW107), Mechanics 1 (ML.ANW108), Mechanics II (ML.ANW115), Mechanics of Structures 1 (ML.ANW117), Thermodynamics 1 (ML.ANW116)

Contents - short:

To gain an understanding of design philosophies and to learn how to incorporate into the process of design the earlier-studied principles of strength of materials, materials science, mechanics, etc. To learn the fundamentals of designing for static and fatigue loading with the use of simple machine elements (joints, fasteners, beams and shafts) as the examples

Bibliography:

1) Robert L.Norton. Machine Design – An Integrated Approach.4th edition, Prentice Hall 2010.
2) Robert L. Mott. Machine Elements in Mechanical Design. 4th edition,Prentice Hall 2006.
3) M.F.Spotts and T.E.Shoup. Design of Machine Elements.7th edition,Prentice Hall 1998.

Course results:

Understanding of design philosophies and ability to incorporate into the process of design the earlier-studied principles of strength of materials, materials science, mechanics, etc. Knowledge and ability to apply in practice the fundamentals of designing for static and fatigue loading with the use of simple

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machine elements (joints, screws and fasteners, preloaded bolts under static and dynamic loadings, beams and shafts) as the examples.

Grading criteria:

The basic points of regulations associated with grading are as follows:
1. Only the student who is registered for this course can complete it.
2. The presence at the lectures and tutorials of the course is obligatory and checked.
3. Basically, in order to complete the course one has to get positive grades from all three regular tests held during the course. However, the student who has got at least one positive grade from these tests has also a chance to complete the course by taking an additional test called "the improvement test".
4. "The improvement test" is organized once at the end of the semester. This test covers the whole material of the course.
5. In extraordinary cases the Head of the Fundamentals of Machine Design Department makes the decision concerning completing the course.
The final grade for the course is determined on the basis of the continuous assessment i.e. the results from the regular and/or the improvement tests.
see: http://itlims.meil.pw.edu.pl/zpk/dla_studentow/regulaminy/machine_design_1.pdf

Detailed contents:

Introduction to design: design process, problem formulation and calculation, experimental tests, the engineering model, factors of safety and design codes, patents and standards, safety regulations, limiting conditions, optimization and evaluation criteria.
Static failure theories - short reminder.
Fatigue failure theories:
Mechanisms of fatigue failure (crack initiation and propagation stages, fracture), fatigue failure models (fatigue regimes, the stress-life and the strain-live approaches, the LEFM approach), fatigue loads (rotating machinery loading, service equipment loading),
measuring fatigue failure criteria (fully reversed stresses, S-N curve, endurance limit, fatigue strength, combined mean and alternating stresses, Gerber line, Goodman line, fracture mechanics criteria, testing actual assemblies).
Estimating fatigue failure criteria [theoretical and corrected fatigue strength and endurance limit, correction factors (loading, size, surface, temperature, reliability, environment), estimated S-N curve].
Notches and stress concentrations (geometric and fatigue stress concentration factor, notch sensitivity).
Designing for high-cycle fatigue [designing for fully reversed and fluctuating stresses, creating the modified Goodman diagram, an augmented Goodman diagram, applying stress concentration effects with fluctuating stresses, determining the safety factor with fluctuating stresses (case 1 for independent variation of mean and alternating stresses, cases 2, 3 and 4 for constant: alternating stress, mean stress, ratio of alternating over mean stress)].
Modelling and calculations in selected areas of machine design:
Welded connections [fusion welding, fabrication by welding, types and forms of welds (butt, fillet, plug, transverse, longitudinal, skewed), stresses in welds (eccentrically loaded welds, weld centre of gravity and moment of inertia, direct and bending shear stresses)].
Riveted connections [typical applications, materials and types of rivets and methods of riveting, types of riveted joints (lap, single strap, butt), types of welded joints failure, stresses in rivets and riveted joints (shearing and bearing condition for rivets, plates and straps, tension in a plate and a strap, shearing of

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edge of plate/strap, condition for equal loading capacity of plate and straps, gravity centre of joint, direct and moment forces in joints with eccentric load)]. Cemented joints.
Screws and fasteners [standard thread forms and dimensions, power screws (square, acme, and buttress threads, typical applications, force and torque analysis, friction coefficient, self locking and back driving, efficiency, ball screws), stresses in threads (axial stress, shear stress, minimum nut length, torsional stress), types of screw fasteners (classification by intended use, by thread type, by head style), nuts and washers (lock nuts, lock washers, sems), manufacturing fasteners (thread cutting, thread rolling, head forming).
Preloaded fasteners (preloaded bolts under static loading, bolt and clamped material stiffness, material and bolts characteristic, joint constant, safety factor against separation and against yielding).
Preloaded fasteners under dynamic loading (mean and alternating stresses in a bolt, benefits of preload, determining fatigue safety factor for the bolt with the use of the Goodman diagram), determining the joint stiffness factor (confined and unconfined gaskets), controlling preload (torsional stress due to torquing of bolts), fasteners in shear (bolted and doweled eccentrically loaded joints)].

Additional remarks (by course staff):

Standard registration procedure is required. Handouts are distributed during the course. Additional materials (problems, supplements, etc) are displayed on the course website.

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Sylabus

Course name:	**Machine Design 2**
Course name in other language:	
Short name:	**MDES2**
Course number:	**ML.ANW125**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Stanisław Bogdański**

ECTS:	**3**	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	**-**	**undergraduate, full time**	**4**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**4**
Mechanical Engineering	**-**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**4**

Recommended prerequisites:

Computer methods in engineering analysis (ML.ANK370), Engineering Graphics - CAD 2 (ML.ANK431), Machine Design 1 (ML.ANW124), Manufacturing Technology 1 (ML.ANK399), Mechanics of Structures 2 (ML.ANK427)

Contents - short:

To present methods of analysis and design of various important machine elements and sub-assemblies as well as to explain their role and way of functioning in machines and systems. To make an introduction to surface failure phenomena and to the tooth gears, belt and chain drives.

Bibliography:

1) Robert L.Norton. Machine Design – An Integrated Approach.4th edition, Prentice Hall 2010.
2) Robert L. Mott. Machine Elements in Mechanical Design. 4th edition,Prentice Hall 2006.
3) M.F.Spotts and T.E.Shoup. Design of Machine Elements.7th edition,Prentice Hall 1998.

Course results:

Completing this course should result in the following effects:
In the topic of springs and flexible elements students are expected to gain knowledge about the theory and types of springs as well as flexible elements, their typical features and applications, ways of operation, materials used for them, methods of modelling and analysis. Spring modelling and analysis for constant and variable loads and consequently determining dimensions are illustrated on tutorials with the use of typical examples. Hence, students should gain skill to calculate springs and design them for static

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and dynamic loading conditions on their own. Designing flexible elements is illustrated on the example of cylindrical and block rubber cushioners.
Regarding surface failure, students are familiarised with the knowledge on main parameters of surface roughness geometry, theory of friction and wear, types of surface wear, theories of various types of concentrated contact, types and features of surface fatigue. Apart from theory, students are trained in determining the rate of abrasive wear and in calculating contact patch dimensions and contact stresses in contact couple members.

Grading criteria:

The basic points of regulations associated with grading are as follows:
1. Only the student who is registered for this course can complete it.
2. The presence at the lectures and tutorials of the course is obligatory and checked.
3. There are the two ways of completing the course:
a). The first way is by passing the exam, which is held during the examination session. The exam consists of two parts, theoretical (5 questions) and practical (3 problems). To pass the exam it is necessary to get positive grades from both parts.
b). The second way is by getting positive grades from all 3 tests held during the course. Moreover, the student who has got at least two positive grades from the tests has also a chance to complete the course by taking an additional test called "the improvement test".
4. "The improvement test" is organized once at the end of the semester. This test covers the whole material of the course.
5. In extraordinary cases the Head of the Fundamentals of Machine Design Department makes the decision about completing the course.
The final grade for the course is determined on the basis of the results of exam or the continuous assessment
i.e. the results from the regular and/or the improvement tests.
see: http://itlims.meil.pw.edu.pl/zpk/dla_studentow/regulaminy/machine_design_2.pdf

Detailed contents:

Springs and flexible elements: types and applications, materials used, modelling and analysis, spring index and rate, linear and non-linear spring characteristics, deflections and stresses, strength of wires used for springs, stress concentration factors, active number of coils, accumulated energy, spring ends, spring fixing and assembling, spring buckling, safety factors for springs, rubber and elastomeric cushioners, hysteresis of loading, dumping.
Surface failure: surface geometry, friction and wear, surface fatigue, spherical and cylindrical contact.
Machine sub-assemblies: sliding bearings-introduction to hydrodynamic lubrication theory, infinitely short and long bearing, load carrying capacity diagrams, design and materials used.
Rolling element bearings: types and classifications, selection- fatigue life, dynamic and static load rating, radial and combined loads, calculation procedures, bearing manufacturers catalogues, bearing mounting and sealing details, pairs of bearings, “O” and “X” bearing systems.
Shaft keys and couplings:-types of keys, stresses in key slots and stress concentration factors, calculation of keys, couplings classifications, types of rigid and compliant couplings, flexible couplings, torsional resonance of shaft and the role of torsionally flexible couplings, methods of avoiding the resonance
Clutches and brakes: selection and specification, materials;

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friction clutches and brakes-disk, cone clutches and brakes, multidisc clutches, uniform pressure and uniform wear approach, drum brakes and clutches, band clutches and brakes, dynamics of friction clutch engagement, model and real diagram of engagements, role of spring in clutch adjusting, heat generation and balance;
overrunning and safety clutches.
Tooth gears, belt and chain drives; basic schemes, features, calculations and selection.

Additional remarks (by course staff):

Standard registration procedure is required. Handouts are distributed during the course. Additional materials (problems, supplements, etc) are displayed on the course website

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Sylabus

Course name:	**Marketing (ang)**
Course name in other language:	
Short name:	**MKTANG**
Course number:	**ML.ANK332**
Course language:	**English**
Responsible for the course:	**mgr Justyna Ścibiorek**

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	**Power engineering**	**undergraduate, full time**	**5**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**7**

Contents - short:

Celem przedmiotu jest przedstawienie podstaw i założeń marketingu oraz nabycie praktycznych umiejętności w zakresie stosowania mechanizmów, technik i narzędzi marketingowych. Studenci będą mieli możliwość zapoznania się z praktycznym zastosowaniem narzędzi marketingowych dzięki analizie przykładów ich zastosowania w firmach międzynarodowych.

Bibliography:

1. Ph. Kotler; "Marketing"; 2003
2. Ph. Kotler; "Kotler on Marketing: How to Create, Win, and Dominate Markets"; 1999
3. D. Aaker; " Bulding strong brands"; 2009
4. Źródła internetowe

Course results:

Umiejętność różnicowania narzędzi marketingowych. Zapoznanie z praktycznym zastosowaniem narzędzi marketingowych.

Grading criteria:

Obecność na zajęciach.
Uzyskanie pozytywnej oceny ze wszystkich ćwiczeń.
Projekt końcowy

Detailed contents:

Wykłady:
1. Basic marketing rules and instruments - Zapoznanie z podstawowymi instrumentami marketingowymi oraz zasadami. wprowadzenie do teorii marketingu.

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2. Strategic planning - Planowanie strategiczne przedstawione jako element komplementarny z narzędziami marketingowymi. Zastosowanie planowania strategicznego w planowaniu działań marketingowych.
3. Analyses of customer's market and his decisions - Analiza rynku konsumeta oraz faktorów wpływających na decyzje podejmowane przez konsumentów.
4. Market segmentation - segmentacja rynku jako jeden z elementów marketingu. Przedstawienie zasad segmentacji rynku.
5. Competition strategies - Analiza konkurencji oraz strategie zdobywania rynku.
6. Brand and product strategy forming - Przedstawienie strategii kreowania wizerunku firmy, marki oraz nowego produktu na rynku.
7. Marketing Mix - Dokładne omówienie narzędzi marketingu mix z podziałem na narzędzia stosowane w firmach produkcyjnych ora uzługowych.
Ćwiczenia:
1. Analiza SWOT przedsiębiorstwa
2. Zastosowanie narzędzi marketingu mix w firmie Sanyo
3. Narzędzia marketingu mix - przykład restauracja
4. Wprowadzanie nowego produktu na rynek analiza przykładu z firmy Amway
5. Segmentacja rynku na przykładzie firmy Amway - studium przypadku
6. Analiza decyzji konsumentów na przykładzie firmy finansowej Zurich
7. Kreowanie wizerunku marki na rynku na przykładzie firmy Barclays - studium przypadku
8. Prezentacja projektów końcowych:
- Factors influencing the decision to purchase products by consumers in the selected shopping mall
- Creating corporate image - on the chosen example
- Promotion Tools (fairs, exhibitions) in the industrial market
- The role and functions of food packaging
- An image of a women In advertising
- Distribution of the product as a marketing tool for business

Additional remarks (by course staff):

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Sylabus

Course name:	**Materials 1**
Course name in other language:	
Short name:	**MATS1**
Course number:	**ML.ANW107**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Krzysztof Sikorski**

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	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

To gain fundamental engineering knowledge about various structures of engineering materials to be able to understand their mechanical properties

Bibliography:

1) Book 1: J.F. Shackelford, „Introduction to Material Science for Engineers”
2) Book 2: W. D. Callister Jr., “Materials Science and Engineering –An Introduction”
3) Documentation on http:// non
Further Readings:
- will be provided by lecturer

Course results:

After completing this course the students will have general knowledge about relations between the structure and mechanical properties of various engineering materials

Grading criteria:

100% assessment based on 4 tests
Practical work: non

Detailed contents:

Important mechanical properties of metals and polymers – definitions, measures and related most important tests. Background of material structure: crystal structures, defects and imperfections, polymer

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chains and polymerisation. Phase transformations and equilibrium diagrams. Heat treatment of ferrous metals, and aluminum and titanium alloys. Background of fiber reinforced composite materials. Corrosion and corrosion prevention.

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Sylabus

Course name:	**Measurements and Technique of Experiment**
Course name in other language:	
Short name:	**MTE**
Course number:	**ML.ANK351**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Janusz Narkiewicz**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**4**

Contents - short:

Basic terms of statistics illustrated by technical examples, foundamenetals of measurements data processing and analysis for static and time varying signals.

Bibliography:

DeGroot, Morris H., and Mark J. Schervish. Probability and Statistics. 3rd ed. Boston, MA: Addison-Wesley, 2002

Course results:

Understanding basic concepts of statistics. Ability to apply proper stochastic model for data processing and hypothesis testing.

Grading criteria:

Regular and control tests.

Detailed contents:

Measurement. Measurement errors. Linear sensors. Probability. Addition and multiplication theorems. Complementary probabilities. Conditional probability. Bayes Rule. Independence of events. Data parameters and presentation. Measures of dispersion. Variance. Standard deviation. Random variables. Probability distribution function. Expectation. Cumulative probability distribution function. Independent random variables. Discrete probability distributions: uniform, binomial, geometric, Poisson. Applications of discrete random variables distributions. Continuous random variables distributions: uniform, exponential, gamma Chi-squared, normal, Student. Standard normal distribution. Parameter estimation. Central Limit Theorem. Examples of application of CLT. Confidence intervals. Estimating the mean of a population. Statistical tolerance intervals. Hypothesis testing. Linear regression

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Sylabus

Course name:	**Mechanics 1**
Course name in other language:	
Short name:	**MECHS1**
Course number:	**ML.ANW108**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Elżbieta Jarzębowska**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

To learn theory and numerical problems in Statics

Bibliography:

1. Ferdinand P. Beer, E. Russell Johnston, Jr. (in last editions + three other co-authors): “Vector Mechanics for Engineers – STATICS”, McGraw-Hill, Inc., any edition, last one 2004.
2. R.C. Hibbeler: “Engineering Mechanics STATICS”, Pearson, any edition, last one 2004.
3. Any academic textbook (engineering course) on General Mechanics, part: Statics.
For solving of problems, in addition to the above textbooks:
1. Fogiel M. (editor): “The Mechanics Problem Solver. A Complete Solution Guide to Any Textbook”. Research and Education Association (REA), 1992.
2. Collection of problems in mechanics, in russian, and in polish as: J. Mieszczerski: “Zbiór zadań z mechaniki, PWN, many editions; solutions to this collection … in German (author Neuber H., VEB Verlag, Berlin 1962, 1963), and in Polish as: Romuald Romicki: “Rozwiązania zadań z mechaniki zbioru J. W. Mieszczerskiego”, PWN, many editions.

Course results:

After completing his course the students will be able to determine the loads of the statically determinate 3-D rigid constructions.

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Grading criteria:

3 written tests during semester

Detailed contents:

Fundamental concepts and principles of statics. Equilibrium of a particle: forces in a plane and in a space. Equilibrium of a rigid body in two and three dimensions: external and internal forces, reactions and constrains, equivalent system of forces, moment of a force about a point and about an axis, reduction of a system of loads to one force and one couple (wrench). Statically determinate and indeterminate systems. Dry friction. Geometry of masses: centre of mass (gravity), areal and mass moments of inertia.

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Sylabus

Course name:	**Mechanics II**
Course name in other language:	
Short name:	**MECHS2**
Course number:	**ML.ANW115**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Elżbieta Jarzębowska**

ECTS:	**5**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[**2,** **2,** 0, 0, 0,]
Form of grading:	**Exam**	by semester:	[**30,** **30,** 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Recommended prerequisites:

Algebra z geometrią (ML.NW101), Analiza I (ML.NW102)

Contents - short:

To learn theory and numerical problems of Kinematics and Dynamics

Bibliography:

1. Ferdinand P. Beer, E. Russell Johnston, Jr. (in last editions + three other co-authors): “Vector Mechanics for Engineers – DYNAMICS”, McGraw-Hill, Inc., any edition, last one 2004.
2. R.C. Hibbeler: “Engineering Mechanics DYNAMICS”, Pearson, any edition, last one 2004.
3. Any academic textbook (engineering course) on General Mechanics, parts: Kinematics and Dynamics.
For solving of problems, in addition to the above textbooks:
1. Collection of problems in mechanics, in russian, and in polish as: J. Mieszczerski: “Zbiór zadań z mechaniki”, PWN, many editions;solutions to this Collection … in German (author Neuber H., VEB Verlag, Berlin 1962, 1963), and in Polish as: Romuald Romicki: “Rozwiązania zadań z mechaniki zbioru J. W. Mieszczerskiego”, PWN, many editions.

Course results:

After completing his course the students will be able to analise the kinematics and dynamics of the translation, rotation about a fixed axis and planar motion of a rigid body.

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Grading criteria:

3 written tests during semester, final written examination

Detailed contents:

Kinematics (Geometry of motion): equations of motion of a particle in various reference frames. Motions of a rigid body: translation; rotation about a fixed axis; plane motion, including motion of a particle relative to a moving frame.

Dynamics (Kinetics): dynamic equations of motion of a particle in various reference frames. Theorems about the rate of change of linear momentum, angular momentum, and energy of a particle, system of particles and a rigid body. Dynamic equations of translation, rotation about a fixed axis, and plane motion of a rigid body. Dynamic reactions in rotation about a fixed axis.

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Sylabus

Course name:	**Mechanics of Structures 1**
Course name in other language:	
Short name:	**MOS1**
Course number:	**ML.ANW117**
Course language:	**English**
Responsible for the course:	**dr inż. Jakub Pawlicki**

ECTS:	**4**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	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	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Recommended prerequisites:

Mechanics 1 (ML.ANW108)

Contents - short:

To learn fundamentals of deformable bodies mechanics: stress, strain, material behavior as a introduction to structural analysis and design for static loads. Presenting concepts of statical structural analysis: equilibrium conditions, stress-strain relation (Hooke's law) and structure deformation. Develop knowledge for strength analysis of one-dimensional structures in basic load cases: tension-compression, torsion and bending.

Bibliography:

1) Roy Craig Jr. "Mechanics of Materials"
2) John Hearn "Mechanics of Structures"
3) Documentation on http://
Further Readings:
- will be provided by lecturer

Course results:

After completing his course the students will be able to specify and implement statical equilibrium based methods to solve simple stress – deformation analysis problems for one dimensional structures.

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Grading criteria:

tests, home works, examination

Detailed contents:

Introduction: material solid, concepts of mechanics of structures: equilibrium, deformation behavior models. Fundamentals: internal and external forces, stresses strains and displacements. Idealization of the material (elastic, plastic, elastic-plastic,, visco elastic, visco-plastic), idealization of the structure and idealization of the geometry of strains. General principles of structural analysis. Analysis of stresses and strains. General Hooke's low, plane stress and plane strain. Safety criteria: Huber-Mises criterion, maximum shear-stress criterion, concept of equivalent stress. Geometric properties of plane areas: moment of inertia, polar moment of inertia, product of inertia. One-dimensional problems of linear structures: tension and compression, torsion and bending of bars. Determination of stresses and displacements, safety evaluation.
Elastic buckling of columns.

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Sylabus

Course name:	**Physical Education and Sports 1**
Course name in other language:	
Short name:	**PES1**
Course number:	**ML.ANWF1**
Course language:	**English**
Responsible for the course:	**mgr Bożena Gronek**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

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Sylabus

Course name:	**Physical Education and Sports 2**
Course name in other language:	
Short name:	**PES2**
Course number:	**ML.ANWF2**
Course language:	**English**
Responsible for the course:	**mgr Bożena Gronek**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

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Sylabus

Course name:	**Physical Education and Sports 3**
Course name in other language:	
Short name:	**PES3**
Course number:	**ML.ANWF3**
Course language:	**English**
Responsible for the course:	**mgr Bożena Gronek**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**3**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**3**
Mechanical Engineering	**-**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**3**

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Sylabus

Course name:	**Physical Education and Sports 4**
Course name in other language:	
Short name:	**PES4**
Course number:	**ML.ANWF4**
Course language:	**English**
Responsible for the course:	**mgr Bożena Gronek**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**4**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**4**
Mechanical Engineering	**-**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**4**

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Sylabus

Course name:	**Physics 1**
Course name in other language:	
Short name:	**PHYS1**
Course number:	**ML.ANW126**
Course language:	**English**
Responsible for the course:	**dr inż. Cezariusz Jastrzębski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**6**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**6**
Mechanical Engineering	**-**	**undergraduate, full time**	**6**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**6**

Contents - short:

The objective of the subject is to acquaint students with elements of modern physics especially quantum mechanics and to present its recent history, importance in general word perception and particularly its importance in physics, chemistry, modern electronics and materials science. Another objective is to teach students the skills of defining correctly area of physics and nanoscience where classical approach fails and quantum mechanical approach is needed to understand the physical phenomena.
The scope covered by the subject is basis of quantum mechanics and its applications in atomics physics , chemistry and materials science . Basic level skills of quantum mechanical problems solving complete the task. .

Course results:

exam

Grading criteria:

To be decided later on the basis of availability of books, internet sources etc

Detailed contents:

Lecture 1
Fundamental assumptions of classical and quantum mechanics, where classical physics fails, blackbody radiation, Planck’s formula, de Broglie waves, optical spectra of light atoms, photoelectric effect.
Lecture 2

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Electron and photons waves and particles. Thomson cathode ray experiment, e/m calculation. Compton effect. Light and photon diffraction. Wave – particle duality solution, one and two slits electron diffraction. X-ray production and diffraction.
Lecture 3
Uncertainity principle, energy uncertainity, momentum uncertainity, Quantum states. Expectation values. Superposition of states. Probability, wave function and Copenhagen interpretation. Examples.
Lecture 4
Wave motion. Light and matter - Schr□dinger equation. General solution of Schr□dinger equation. Classical examples. Schr□dinger equation of a free particle. Particle in a finite and infinite potential well.
Lecture 5
Schr□dinger equation continued.. Properties of valid wave function. Time independent Schr□dinger equation. Stationary states..
Particle in a box. Potential barrier. Schr□dinger equation solutions, classical and quantum approach. Reflection and transmission of electron wave. Wave – particle duality solution, one and two slits electron diffraction.
Lecture 6
Harmonic oscillator-recall. Classical and quantum solution of harmonic oscillator. equation. Analogy with optics. Application in nuclear physics. Alpha particle decay. Structure of the atom. Thomson model of atom. Rutherford scattering experiment. Rutherford model of atom Successes and failures. Bohr model of atom. The correspondence principle. Limitations of the Bohr model.
Lecture 7
Schr□dinger equation in three dimensions. Spherical coordinates. Separable solution. Solution of Schr□dinger equation for hydrogen atom.
Lecture 8
Quantum numbers in spherical coordinates, principal quantum number, magnetic (azimuthal) quantum number, spin quantum number. Magnetic effects on atomic spectra –the Zeeman effect. Energy levels on electrons in atom. Optical spectra and selection rules. The role of spin.
Lecture 9
Atomic structure – many electron atoms. Electronic structure of many electron atoms. Building principle. The periodic table.
Lecture 10
Molecules. Molecular bonding and spectra. Molecular bonds; ionic bonds, covalent bonds, Van der Waals bonds, hydrogen bonds, metallic bonds. Molecular orbitals, orbitals overlap, bonding and antibonding orbital. Classification of molecular states. Vibrations of molecules. Rotational and vibrational states
Lecture 11
Quantum mechanics applications in solid state physics.
Fourier analysis of solid state physics of crystals. Bloch theory of electron in a periodic crystal lattice. Energy bands. Velocity of electron in Bloch formalism. Effective mass. “Free” Bloch electrons vs. tight binding.
Lecture 12
Crystal and amorphous solids. Dielectrics, semiconductors, metals. Fermi level. X-ray and neutron analysis of solids. Bragg formula. Electron diffraction in solid state physics. Surface analysis. RHEED.
Lecture 13
Quantum mechanics applications in modern optics. Blackbody and laser. Stimulated and spontaneous emission. Inversion of electron population. Three and four step laser model.. Examples of lasers; gas laser semiconductor laser, cascade laser.
Lecture 14

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Analogy between optics and solid state physics. Optical constants-recall, wave equation and Schr□dinger equation. Light in periodic structures. Photonic crystals. Energy gap in a crystal and in a photonic crystal.
Lecture 15
Entangled quantum states. Principles of quantum computing. Build a quantum computer, what it means. How to build it? Introduction to quantum cryptography.

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Sylabus

Course name:	**Power Engineering Machines and Systems 1 (lab)**
Course name in other language:	
Short name:	**PEMS1LAB**
Course number:	**ML.ANS524**
Course language:	**English**
Responsible for the course:	**dr inż. Jerzy Kuta**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**6**

Recommended prerequisites:

Heat Transfer 1 (ML.ANK423), Sensors and Measurements Systems (ML.ANS511)

Contents - short:

Improving the energy efficiency, different ways of power equipment regulating, Knowledge about locations of various types energy losses.
Learning how to research and development characteristics of the equipment used in power generation

Bibliography:

catalogues of power equipment

Course results:

After completion of course knowledge about the influence of the parameters of pumps, fans, compressors and how they control for energy efficiency. Knowledge about formation place of various kinds of energy losses.

Grading criteria:

participation in exercises, written reports

Detailed contents:

flow meters, parameters measurement, ways of regulating pumps, compressors, fans, turbines, heaters, turbines, combustion engines, heat exchangers.
1 The operation of heat exchangers substation
2 Measurement of thermal conductivity of insulation.
3 Disposition of heat
4 EC Zeran - preparation of water
5 Examination of the ejector
6 Examination of working conditions of pump

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7 Measurement of flow
8 Data Acquisition
9 Analysis of gases

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Sylabus

Course name:	**Power Engineering Machines and systems II (lab)**
Course name in other language:	
Short name:	**PEMS2LAB**
Course number:	**ML.ANS525**
Course language:	**English**
Responsible for the course:	**dr inż. Jerzy Kuta**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**7**

Contents - short:

Familiarization with measuring systems, their structure and components. Boiler heat balance method. Turbines. Nuclear radiation.

Grading criteria:

participation in exercises, written reports

Detailed contents:

boilers and steam generators, turbines, heat exchangers, regulation and control, thermal measurements water technology, nuclear technology, HVAC systems (Heating, Ventilation, Air Conditioning)

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Sylabus

Course name:	**RES - Solar Engineering 1**
Course name in other language:	
Short name:	**SOLENG1**
Course number:	**ML.ANS516**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. Dorota Chwieduk**

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	**Power engineering**	**undergraduate, full time**	**6**

Recommended prerequisites:

Fizyka (ML.DW001), Termodynamika (ML.ZNK414), Wymiana ciepła I (ML.NK423), Wymiana ciepła II (ML.NK424)

Contents - short:

To learn fundamentals of solar energy: sky and solar radiation models, measurements, methods of conversion: thermal and photovoltaic and active and passive use of solar energy. To learn about designing of the solar energy self sufficient buildings, solar heating active and passive systems and photovoltaics systems. To learn how to evaluate availability of solar radiation, irradiation on surfaces with different orientation and inclination, type and size of solar systems. To get known how to determine the characteristics of solar active systems including its storage ability and dimensioning of solar systems and their elements. To plan the building concept from the energy point of view. To learn how to estimate energy efficiency and economic efficiency of solar systems. Recognizing of basic and auxiliary elements of solar systems. Review of domestic and commercial application to learn on selection of solar system type according to type and scale of the application, and energy and economic efficiency.

Bibliography:

1. Anderson B.: Solar Energy: Fundamentals in Building Design, Total Environmental Action, Inc., Harrisville, New Hampshire, 1975
2. Anderson E. E: Fundamentals of solar energy conversion, Addison-Vesley Publ. Co., Reading, MA, 1982
3. Balcomb J.D. (ed.): Passive Solar Buildings, The MIT Press, Cambridge, Massachusetts, 1992
4. Chwieduk D., Bogdańska B.: Some recommendations for inclinations and orientations of building elements under solar radiation in Polish conditions, Renewable Energy Journal 29, 2004, 1569 - 1581
5. Duffie J.A., Beckman W.A, Klein S.A.: Solar Heating Design by the F-Chart Method, J. Wiley, Interscience Publication, 1978
6. Duffie J. A., Beckman W. A.: Solar Engineering of Thermal Processes, John Wiley & Sons, Inc., New York, 1991

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7. Gordon J.: Solar energy the state of the art., ISES position papers, UK 2001
8. Sayigh A.A.M. (ed.): Solar Energy Engineering, Academic Press, London, 1997
9. Schulz H., Chwieduk D. Wärme aus Sonne und Erde Energiesparende Heizungssysteme mit Erdwärmespeicher, Solarabsorber und Wärmepumpe. Okobuch Verlage, Staufen bei Freiburg, 1995
10. Twidell J., Weir T.: Renewable Energy Resources, E&FN SPON, London, University Press Cambridge,1996
11. Veziroglu T. N. (ed.): Solar energy and conservation, Pergamon Press, Oxford 1978
12. Weiss W., Bergmann I., Faninger G.: Solar heat Worldwide Markets and Contribution to the Energy Supply 2004, IEA Solar Heating & Cooling Programme, Austria 2006

Course results:

Students get fundamental knowledge on solar energy (radiation) and practical information on applied devices and systems, what includes theory on systems operation, performance and characteristics, and technical data on the system elements, modes of operation and integration into domestic and commercial heating/cooling and power (electric) systems. After completing his course the students will be able to specify all elements of different types of solar systems, to select the type of the solar conversion method and the installation according to the user needs. They will be prepared to design and evaluate solar systems depending on the expected working conditions. Students could propose and plan solar heating/ cooling system and its dimensioning and evaluate its performance.
Students would be able to evaluate energy and economic efficiency of solar collectors and whole systems and their environmental impact. They would be able to implement modern idea of solar passive systems into building architectural and energy concept. They could develop practical solution for low energy buildings.

Grading criteria:

100% continuous assessment based on tests and final closing test
Practical work:
Visit to low energy building equipped with solar systems

Detailed contents:

Fundamentals of solar radiation and solar energy conversion methods: solar thermal and photovoltaics. Availability and structure of solar radiation. Determination of solar irradiation on surfaces under consideration. Shading problems. Theoretical background for practical implementation of solar energy conversion, including fundamentals in optics and thermodynamics. Internal photovoltaic effect. Physics of materials used for PV cells. Creation of PV modules and panels. Different types of PV systems. BIPV modern options. Solar thermal conversion. Basic elements of solar thermal systems. Active and passive solution. Modes of solar system operation (domestic hot water, process heat, space heating and cooling and etc.) Working fluids. Short and long term storage. Energy performance of solar heating and cooling systems. Schematic operation modes. Methods of improvement of solar systems operation. Modelling of solar system operation. Domestic and commercial application. Primary energy reduction. Solar buildings; natural heating and cooling. Evaluation and planning of natural and construction shading elements. Passive systems. Operational issues. Daylighting, modern systems. Improvement of energy efficiency of installations under operation. Standards for solar systems.

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Sylabus

Course name:	**RES - Solar Engineering 2 (Lab)**
Course name in other language:	
Short name:	**SOLENG2LAB**
Course number:	**ML.ANS517**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. Dorota Chwieduk**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**7**

Recommended prerequisites:

Wymiana ciepła I (ML.NK423), Wymiana ciepła II (ML.NK424), Wymiana ciepła III (ML.NS590)

Contents - short:

To learn solar radiation measurement methods and test methods for solar collectors. To get experience in determination of energy performance of solar collectors - indoor conditions, under solar simulator. Review of optics and heat transfer phenomena and performance of different types of solar collectors. To measure flow and thermal parameters of solar systems during their operation. To learn how to determine energy performance of solar systems under operation and to predict characteristics of solar systems and compare them to select the best solar collector types ad modes of system operation for given conditions. To get experience in solar thermal application, including different modes of operation. To investigate thermal energy storage options (through specific heat and PCM – Phase Change Materials). To learn how to model energy balance of a solar system and calculate solar energy gains, useful solar energy input, energy stored and heating/cooling energy needs. To learn about planning renewable energy heating/ cooling systems coupled with solar systems, integration of different energy sources in one energy system. To learn about simulation in solar process design, including design of active systems and passive and hybrid systems. To estimate costs of investment and running cost to determine economics of systems.

Bibliography:

1. Duffie J. A., Beckman W. A.: Solar Engineering of Thermal Processes, John Wiley & Sons, Inc., New York, 1991
2. Schulz H., Chwieduk D. Wärme aus Sonne und Erde Energiesparende Heizungssysteme mit Erdwärmespeicher, Solarabsorber und Wärmepumpe. Okobuch Verlage, Staufen bei Freiburg, 1995
3. Twidell J., Weir T.: Renewable Energy Resources, E&FN SPON, London, University Press Cambridge,1996
4. Quaschning V.: Understanding Renewable Energy Systems. EarthScan, London, 2006

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Course results:

Students get practical knowledge on solar energy (radiation) measurements and testing of solar collectors and systems. They can evaluate effectiveness of operation of solar systems, energy performance and characteristics. They can select devices and equipment for solar active systems and integrate solar system into domestic and commercial heating/cooling systems. After completing this course the students will be able to select the solar system to be the most suitable to planned application, to energy heating/cooling needs and their distribution in time and climatic conditions. They will be able to calculate the solar energy fraction and auxiliary energy use for short time and throughout the year. They could specify all elements of solar systems, their type and size to assure their effective use. They could calculate the reduction in primary energy, greenhouses gas emission, and running costs. They can plan, design, and construct, test and control different types of solar systems. They can advise on improvement of energy efficiency and environment, and economic gains of heating/cooling systems. Students would be able to evaluate thermal energy use in buildings and to propose the upgrading of energy systems by applying solar energy. They would be able to develop solar passive solutions in buildings and implement modern energy effective methods into building concept during the design process and building/energy use.

Grading criteria:

100% continuous assessment based on theoretical, experimental and calculation tests (tasks).
Practical work: Measurements and tests of solar radiation, solar collectors and solar systems under solar simulator and outdoor conditions. Monitoring and control of solar system operation in real conditions, measurements of thermal and flow parameters. Simulation exercises of solar systems operations. Visit to other solar laboratories, solar active and passive systems in operation.

Detailed contents:

The Sun, solar radiation spectrum and solar energy components and irradiation on tilted surfaces. Measurements of solar radiation and solar radiation data, estimation methods for different receiving surfaces. Radiation characteristics of opaque and transparent materials. Absorptance and emittance, mechanism of selectivity. Reflectance and transmittance. Solar collector structure and materials used. Flat plate and vacuum solar collectors. Collector characterization. Measurement of solar collector performance. Collector tests: Efficiency, Incident Angle Modifier and Time Constant. Practical consideration. Solar collectors output. Energy storage in solar systems active and passive, short term and seasonal storage. Solar process loads: hot water, space heating and cooling, modeling and calculation. Solar active heating systems: modes of operation and control in practice. Concept of passive heating/cooling. Comfort criteria and heating/cooling loads. Costs and economic of passive systems.

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Sylabus

Course name:	**Rotodynamic Pumps and Pumping Systems**
Course name in other language:	
Short name:	**RPPS**
Course number:	**ML.ANS539**
Course language:	**English**
Responsible for the course:	**dr hab. Krzysztof Karaśkiewicz**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122), Fluid Mechanics 2 (ML.ANK340), Fluid Mechanics 3 (ML.ANK341)

Contents - short:

Principles of pump and hydraulic elevator operation. Characteristic parameters of pump and pumping systems. One dimensional flow theory of pumps Impact of impeller geometry on the pump performance. Impeller and volute design. Hydraulic thrust. Cavitation. General characteristics of pumps and pumping systems. Pump drivers and regulation. Selection and energy saving performance of pumps and pumping systems. Life Cycle Costs for pumps and pumping systems. Pumps standards and certificates

Bibliography:

1.) Pump Handbook - Igor J. Karassik, Joseph P. Messina, Paul Cooper, Charles C. Heald - McGraw-Hill
2.) Impeller Pumps - S. Lazarkiewicz, A.T. Troskolanski - Elsevier

Course results:

Get acquianted with different types of pumps and principle of their operation
Learn parameters of pumps and pumping systems
Learn one dimensional flow theory of pumps; Euler equation, impact of impeller geometry on pump operation parameters
Learn affinity laws for rotodynamic pumps
Ecquire basic design knowledge of pump impeller and other flow-through pump parts
Learn abut hydraulic forces acting on impeller and how to balance them
Learn about cavitation in pumps and cavitation characteristics of pump and pumping system
Get familiar with methods for regulating parameters of rotodynamic pumps
Learn pump selection and operation
Review pumps standards and certificates

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Grading criteria:

homework and examination

Detailed contents:

Classification of pumps and applications, pump types, special pump types
Basic principles of pump and hydraulic elevator operation.
Characteristic parameters of pump and pumping systems, specific work and head of pump and pumping system, general characteristics of pumping systems
One dimensional flow theory of pumps, velocity triangles, Euler Equation for infinite blade number, specific work and head, flow deflection caused by the blades, slip factor.
Dimensionless coefficients, similarity laws and specific speed
Power balance and efficiencies, disk friction losses, leakage losses through annular seals, power loss caused by the inter-stage seal, leakage loss of radial or diagonal seals, leakage losses in open impellers, mechanical losses
Impact of impeller geometry on the pump performance.
Impeller and volute design.
Hydraulic thrust. Flow phenomena in the impeller sidewall gaps.
Axial thrust, General procedure for calculating axial thrust, Unsteady axial thrust, Axial thrust balancing.
Radial thrust, Radial thrust balancing, Radial thrust prediction
Noise and Vibrations. Pressure pulsations, Generation of pressure pulsations, Noise generation in a fluid. Radiation of noise.
Overview of mechanical vibrations of centrifugal pumps. Forces in annular seals. Hydraulic impeller interaction. Bearing reaction forces. Eigen values and critical speeds. Rotor instabilities. Interactions between impeller and diffuser blades. Rotating stall
Cavitation. Growth and implosion of vapor bubbles in a flowing liquid. Cavitation in impeller or diffuser. Required NPSH, extent of cavitation, cavitation criteria. Scaling laws for cavitating flows. The suction specific speed. Experimental determination of the required NPSHR
Pump drivers and regulation.
Installation, Operation, and Maintenance
Life Cycle Costs for pumps and pumping systems.
Pumps standards and certificates.
Pump Testing

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Sylabus

Course name:	**Steam Boilers**
Course name in other language:	**Kotły parowe**
Short name:	**STB**
Course number:	**ML.ANS521**
Course language:	**English**
Responsible for the course:	**doc. dr inż. Wojciech Szwarc**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**5**

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Sylabus

Course name:	**Technologies of Environmental Protection**
Course name in other language:	
Short name:	**TEPROT**
Course number:	**ML.ANS566**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Krzysztof Badyda**

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	**Power engineering**	**undergraduate, full time**	**6**

Contents - short:

Knowledge about evaluation of main factors depending harmfully emissions from power generating installations, especially in the area of air protection. Knowledge of main technologies of environmental protection used in power generating industry.

Bibliography:

Materials for students placed on website

Course results:

After completing his course the students will be able to evaluate main factors depending harmfully emissions from power ganerating installations and will have knowledge about main technologies used to reduce dust, SOx, NOx, CO2 emissions

Grading criteria:

standard assessment methods: test and interview at the end of the semester, point system

Detailed contents:

Environment protection legal system and technical possibility of the requirements realization in power generating industry. Best Available Technologies (BAT). Overviev of used today and future technologies to reduce emissions of dust, SOx, NOx and CO2. Primary (pre-combustion) and secondary (post-combustion) environmental technologies in power engineering. Typical solutions of waste utilisation used in power engineering.
Exercises: calculation of the harmfully emissions for different plants, reduction technologies. Evaluation of the results.

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Sylabus

Course name:	**The Wittgensteins Philosophy_Ethics**
Course name in other language:	
Short name:	**WITT**
Course number:	**ML.ANW103**
Course language:	**English**
Responsible for the course:	**prof. dr hab. Marek Maciejczak**

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	**-**	**undergraduate, full time**	**1**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**1**
Mechanical Engineering	**-**	**undergraduate, full time**	**1**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**1**

Contents - short:

The course on philosophy it is an introduction to analytical philosophy. Its scope is critique of language. To understand how language works means to know better the nature of thoughts, i.e. mind. Wittgenstein's theory of linguistic meaning seems to be the eminent example of that current of thought. Besides of language, Wittgenstein's ideas on Mathematics, Ethics, Religion and Society are taken into account.

Bibliography:

1. Ray M., Wittgenstein: The Duty of Genius, London: Vintage, 1990.
2. Wittgenstein's Lectures, 1932-35, ed. by A. Ambrose, Blackwell 1979.
3. Wittgenstein: A Critical Reader, ed. by H. J. Glock, Blackwell 2001.
4. Baggnini J., Fosl P. S., A Compendium of philosophical Concepts and Methods, Oxford 2003

Course results:

After completing this course students should be able to work on their personal development by means of philosophical ideas.

Grading criteria:

There are 3 criteria: essay on chosen philosophical issues - presented and discussed in the class, presence on lectures nad taking part into discussion.

Detailed contents:

1. Introduction to philosophy

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2. Wittgenstein - person and life
3. Tracatus logico-philosophicus on language
4. Ethics in Tractatus
5. Wittgenstein's experiences during the First World War
6. The lecture on Ethics
7. Examples of etical problems
8. Anthropological method in philosophy
9. Language games, meaning as use
10. 11. Religious beliefs
12. Culture and value
12-15 Students essays and discussions

Additional remarks (by course staff):

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Sylabus

Course name:	**Theory of Flow Machines**
Course name in other language:	
Short name:	**TFM**
Course number:	**ML.ANK406**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Jarosław Milewski**

ECTS:	**3**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	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	**Power engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122), Fluid Mechanics 3 (ML.ANK341), Theory of Heat Machines (ML.ANK405), Thermodynamics 1 (ML.ANW116), Thermodynamics 3 (ML.ANK413)

Contents - short:

Theory – to use both thermodynamic and fluid flow mechanic laws. The theory of the turbomachinery stage. Group of stages. The performance characteristics of the stage and group of stages. Dimensional analysis utilization. Experimental investigations – rules of results application in project workflow.

Bibliography:

Miller A. Teoria Maszyn Przepływoych. Wydawnictwa Politechniki Warszawskiej. 1982

Course results:

The knowledge about the turbomachinery characteristic, utilization and developing. Background about turbine stage project workflow.

Grading criteria:

Project realization and test.

Detailed contents:

1. Introduction
2. Thermodynamic background
3. Fluid Flow Machines background
4. 1D theory of turbine stage
5. Typical turbine stages
6. 1D theory of compressor stage
7. Discussion of the 1D theory
8. Experimental investigation and theirs utilization in turbomachinery calculations

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9. 3D flow in axial turbomachinery stage
10. Turbomachinery losses

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Sylabus

Course name:	**Theory of Heat Machines**
Course name in other language:	
Short name:	**TEHMACH**
Course number:	**ML.ANK405**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. Wojciech Bujalski**

ECTS:	**3**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Intermediate**	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	**Power engineering**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**5**

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Sylabus

Course name:	**Thermal Power Stations**
Course name in other language:	
Short name:	**TPS**
Course number:	**ML.ANS550**
Course language:	**English**
Responsible for the course:	**dr inż. Adam Smyk**

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	**Power engineering**	**undergraduate, full time**	**6**

Contents - short:

Familiarizing students with thermal, thermal-electric, gas and nuclear power stations. Introduction to real fuel cycle and water management. Presentation of electric energy costs and heat production calculations.

Bibliography:

1. McGraw : Power Plant Egnineering, Hill Offices, New Dehli, 2008.
2. Breeze P.: Power Generator Technologies, Elsevier Newnews, 2005.
3. Sterman L.S., Tevlin S.A., Sharlow A.T.: Thermal and Nuclear Power Station, Mir Publisher, Moscov, 1986.
4. Modern Power Station Practice, Oxford, Pergamon Press,1992

Course results:

After completing this course students will be prepared to calculate the costs of energy production. They will be able to distinguish different types of power stations properly and evaluate their basic parameters: parameters of water, electric power, efficiency and specific fuel consumption. They will also know the methods of increasing the efficiency of such structures.

Grading criteria:

homework and final colloquium

Detailed contents:

Domestic and global energy and fuel resources. Local and worldwide requisition of electric energy and heat. Structure of primary energy sources. Power engineering and environment, TPS thermal cycle – structure and parameters. Conventional condensing power-stations (steam) and gas-steam power station, combined heat and power station (CHPS), nuclear power-stations. Fuel and water management at TPS. Costs of electric energy production at condensing power-stations. Investment and variable costs. Costs of heat production at combined heat and power station.

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Sylabus

Course name:	**Thermodynamics 1**
Course name in other language:	
Short name:	**THERM1**
Course number:	**ML.ANW116**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Piotr Furmański**

ECTS:	**5**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Intermediate**	weekly:	[**2,** **2,** 0, 0, 0,]
Form of grading:	**Exam**	by semester:	[**30,** **30,** 0, 0, 0,]

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**-**	**undergraduate, full time**	**2**
Lotnictwo i Kosmonautyka	**-**	**undergraduate, full time**	**2**
Mechanical Engineering	**-**	**undergraduate, full time**	**2**
Mechanika i Budowa Maszyn	**-**	**undergraduate, full time**	**2**

Recommended prerequisites:

Analiza I (ML.NW102)

Contents - short:

Knowledge of basic laws governing energy conversion. Ability to apply energy and entropy balances to analysis of different processes, in which simple substances take part. Ability to determine quality of different energy conversion processes. Knowledge of the fundamentals of thermodynamics applied to combustion processes.

Bibliography:

1) Y.A. Cengel, M.A. Boles: “Thermodynamics. An Engineering Appproach, McGraw Hill
2) Materials for students placed on website

Course results:

To solve problems in energy conversion in different applications using laws of thermodynamics

Grading criteria:

4 tests, practical and theoretical exams, point system

Detailed contents:

Lecture:

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1. Thermodynamic system and its properties, thermodynamic functions, irreversible and reversible transformations, microscopic and macroscopic energy, internal energy.
2. Energy interactions (work, heat, energy exchange accompanying mass flow). Enthalpy.
3. 1st Law of Thermodynamics for open system. Special cases (closed system, steady state, cycles). Thermal efficiency of engines and Coefficent of performance (COP) for refrigerators and heat pumps.
4. Entropy and its features. Balance of entropy for open systems. Entropy generation and 2nd Law of Thermodynamics. Carnot cycle.
5. Thermodynamic equilibrium and its types. Conditions for thermal, mechanical and phase equilibrium. Chemical potential.
6. Simple substance. Diagrams of state. Thermal expansion and isothermal compressibility. Thermodynamic functions for simple substances. Special cases of simple substances (incompressible substance, perfect gas).
7. Thermodynamic functions for incompressible substances and perfect gases. Specific heats of the perfect gases. Characteristic transformations of perfect gases (polytropic process,throttling).
8. Fundamentals of thermodynamics in combustion. Stoichiometric and nonstoichiometric reactions. Air excess ratio. Mass balance of reactants. Standard state. Thermal effects of combustion.
Tutorials:
1. Examples of thermodynamic analysis of processes based on the 1st Law of Thermodynamics.
2. Determination of a system state after transformations as well as amount and form of energy exchanged between the system and the surroundings.
3. Calculation of efficiency of different engine cycles and COP of refrigerators and heat pumps.
4. Examples of thermodynamic analysis based on the entropy balance.
5. Thermodynamic transformations in systems containing incompressible substances, vapours and perfect gases.
6.Determination of an amount of air needed for combustion, composition of combustion products and the maximum temperature of combustion.

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Sylabus

Course name:	**Thermodynamics 2 (lab)**
Course name in other language:	
Short name:	**T2LAB**
Course number:	**ML.ANK411**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Tomasz Wiśniewski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Energetyka	**Power engineering**	**undergraduate, full time**	**3**

Contents - short:

Practical demonstration of measurement devices and methods for basic thermodynamic parameters and properties. Measurement and calculation of energy balance components for typical technical devices (piston compressor, IC engine, air conditioner).

Bibliography:

Cengel Y. A., Boles M.A.: Thermodynamics. An engineering approach., Mc Graw Hill

Course results:

Student is able to measure properly temperature and pressure with use of different devices. Student is able to perform basic combustion gasses analysis and measure heating values of gaseous and solid fuels. Student can measure humid air properties. Student is able to make energy balance for piston compressor. IC engine and air conditioner.

Grading criteria:

Short tests after each exercise and final test

Detailed contents:

Thermometers and temperature measurements. Manometers and pressure measurements. Combustion gasses analysis. Orsat apparatus. Measurement of heating values for gaseous fuel. Measurement of higher heating value for coal. Measurements of humid air properties. Energy balance for piston compressor. Energy balance for compression ignition engine. Investigation of cooling cycle (air conditioner).

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Date 06.03.2019

Sylabus

Course name:	**Thermodynamics 3**
Course name in other language:	
Short name:	**THERM3**
Course number:	**ML.ANK413**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Piotr Furmański**

ECTS:	**3**	Number of hours:	[Lc,	T,	Lb,	P,	S,]
Course level:	**Advanced**	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	**Power engineering**	**undergraduate, full time**	**3**

Recommended prerequisites:

Thermodynamics 1 (ML.ANW116)

Contents - short:

Knowledge of the maximum (minimum) available work, basis of exergy analysis, determination of thermodynamic functions for multi-component systems including ideal mixtures. Thermodynamic transformation of moist gases. Thermodynamic equilibrium in multi-component systems,fundamentals of chemical thermodynamics and electrochemical reactions. Chemical equilibrium

Bibliography:

1) Cengel Y.A., Boles M.A.: “Thermodynamics. An Engineering Appproach”, McGraw Hill
2) Bejan A.: “Advanced Engineering Thermodynamics”, John Wiley & Sons
3) Materials for students placed on website

Course results:

After completing his course the students will be able to apply energy and exergy analysis to different processes in multi-component systems, to chemical and electrochemical reactions.

Grading criteria:

2 tests, practical and theoretical exams, point system of evaluation

Detailed contents:

Lecture:
1. Maximum available work. Exergy. Balance of exergy. Exergy losses. The Second Law Efficiency.
2. Thermodynamic functions for multi-component systems.
3. Real and ideal solutions. Partial properties. Graphical interpretation of partial properties for binary solutions.
4. Ideal mixtures. Mixtures of perfect gases. Moist gases.

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5. Thermodynamic equilibrium in multicomponent, multi-phase systems.
6. Chemical potential and fugacity. Gibbs rule.Henry's and Raoult's laws.
7. Chemically reacting systems.
8. The 3rd Law of Thermodynamics.
9. Thermodynamic analysis of electrochemical reactions.
10. Chemical equilibrium and fundamentals of chemical kinetics.

Tutorials:

1. Examples of exergy analysis of processes in simple and multi-component systems.
2. Transformation of the moist air.
3. Thermodynamic basis of separation of components in multi-component mixtures.
4. Examples of application of chemical thermodynamics to batteries and fuel cells.
5. Analysis of influence of temperature and pressure on equilibrium of chemically reacting systems.

Additional remarks (by course staff):

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Sylabus

Course name:	**Turbines**
Course name in other language:	**Turbiny gazowe**
Short name:	**TURBI**
Course number:	**ML.ANS577**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Jarosław Milewski**

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	**Power engineering**	**undergraduate, full time**	**5**