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 Lotnictwo i Kosmonautyka

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

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Field of Study Lotnictwo i Kosmonautyka
Field of Specialization Aerospace 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 Lotnictwo i Kosmonautyka
Field of Specialization Aerospace 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 Lotnictwo i Kosmonautyka
Field of Specialization Aerospace 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 specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK467	Aeronautical Systems 1	2	0	0	0	0	3
2.	ML.ANK431	Engineering Graphics - CAD 2	0	0	0	2	0	2
3.	ML.ANK466	Introduction to Aerospace	1	0	0	1	0	2
4.	ML.ANK399	Manufacturing Technology 1	2	0	0	0	0	2
5.	ML.ANK335	Materials in Aerospace Technology	2	0	0	0	0	3
6.	ML.ANK427	Mechanics of Structures 2	1	1	0	0	0	2

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Field of Study Lotnictwo i Kosmonautyka
Field of Specialization Aerospace 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 specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK473	Aerodynamics 1	2	0	0	0	0	2
2.	ML.ANK468	Astronautics	2	0	0	0	0	4
3.	ML.ANK316	Electronics 2 (lab)	0	0	1	0	0	1
4.	ML.ANK436	Integrated CAD/CAM/CAE Systems 1	0	0	2	0	0	2
5.	ML.ANK471	Integrated Laboratory (AE)	0	0	2	0	0	3
6.	ML.ANK400	Manufacturing Technology 2	0	0	2	0	0	2
7.	ML.ANK472	Mechanics of Flight 1	1	0	0	1	0	4
8.	ML.ANK433	Propulsion Systems 1	2	1	0	0	0	5

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Field of Study Lotnictwo i Kosmonautyka
Field of Specialization Aerospace engineering
Semester 5

List of specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK458	Aeronautical Systems 2	1	0	1	0	0	3
2.	ML.ANK307	Aircraft Design 1	2	0	0	1	0	4
3.	ML.ANS619	Aircraft Engine Design 1	2	0	0	0	0	3
4.	ML.ANK359	Chemistry of Combustion	1	1	0	0	0	3
5.	ML.ANK365	Machine Design 3	1	1	0	0	0	3
6.	ML.ANK457	Mechanics of Flight 2	1	0	0	1	0	3
7.	ML.ANS611	Risk and Reliability in Aviation	1	1	0	0	0	3
8.	ML.ANS609	Rotorcraft Aeromechanics	2	1	0	0	0	5
9.	ML.ANS630	Spacecraft Design	1	0	0	0	0	1

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Field of Study Lotnictwo i Kosmonautyka
Field of Specialization Aerospace 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 specialization courses:

No.	Course number	Course name	Lc	T	Lb	P	S	ECTS points
1.	ML.ANK308	Aircraft Design 2	1	0	0	2	0	4
2.	ML.ANS631	Aircraft Engine Design 2	0	0	0	2	0	2
3.	ML.ANK315	Aircraft Maintenance	2	0	0	0	0	2
4.	ML.ECENG02	Elective Courses Engineering	0	0	0	0	0	2
5.	ML.ANK342	Finite Element Method 1	2	0	1	0	0	4
6.	ML.ANK368	Machine Design 6	0	0	0	2	0	2
7.	ML.ANS614	Simulation of Aeronautical Systems	0	1	0	1	0	3
8.	ML.ANK401	Structure and Assebling of Airframe	2	0	0	0	0	2

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Field of Study Lotnictwo i Kosmonautyka
Field of Specialization Aerospace 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.ANS613	Aeronautical Regulations	1	0	0	0	0	1
2.	ML.ANS608	Aircraft Engines Maintenance	2	0	0	0	0	2
3.	ML.ANK348	Computational Fluid Dynamics	2	0	1	0	0	3
4.	ML.ANK479	Finite Element Method 2	1	0	1	0	0	2
5.	ML.ANS627	Simulators	1	1	0	0	0	2
6.	ML.ANK459	Vibrations and Aeroelasticity	1	1	0	0	0	3

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Sylabus

Course name:	**Aerodynamics 1**
Course name in other language:	
Short name:	**AEROA1**
Course number:	**ML.ANK473**
Course language:	**English**
Responsible for the course:	**dr inż. Jerzy Majewski**

ECTS:	**2**	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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**6**

Contents - short:

Good knowledge of the fundamental concepts and principles of the Aerodynamics of airplane.

Bibliography:

1) Bertin J.J., Smith M.L., Aerodynamics for Engineers, Printice Hall, 1989
2) Anderson Jr. J.D. - Fundamentals of Aerodynamics, McGraw-Hill International, 2006.
3) Kuethe A.M., Chow C-Y, Fundations of aerodynamics: bases of aerodynamic design, John Wiley and Sons, 1998.

Course results:

Grading criteria:

Detailed contents:

1. Elements of Gas Dynamics. Energy equation. Bernouli equation for compressible flow. Normal and oblique shock wave. Supersonic flow over convex corner (Prandtl-Mayer flow)
2. Potential flow. Conformal mapping. Kutta-Joukowski condition. Joukowski formula for lift. Pressure distribution and flow around wing section. Aerodynamics coefficients. Airfoil polar. Thin airfoil theory (Glauert's). High lift devices.
3. Wing of finite span. Induced velocity. Induced angle. Induced drag.
4. Influence of compressibility on aerodynamic characteristics. Prandtl-Glauert correction.
5. Transonic flow. Critical flow parameters. Critical Mach number. Drag divergence Mach number. Wave drag. Transonic buffeting.

Supersonic flow over airfoil. Wave drag in supersonic flow. Supersonic airfoil.

Additional remarks (by course staff):

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Sylabus

Course name:	**Aeronautical Regulations**
Course name in other language:	
Short name:	**AREG**
Course number:	**ML.ANS613**
Course language:	**English**
Responsible for the course:	**mgr Wiesław Jedynak**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**7**

Contents - short:

Knowledge regarding certification, rules of maintenance management as well as continued airworthiness of aircraft according to ICAO and EASA standards and regulations. Preparing of students as quality and continuing airworthiness managers

Bibliography:

1. Convention on International Civil Aviation, Signed at Chicago, 7 December 1944 Annex 6 (ICAO): Operation of Aircraft, Annex 8 (ICAO): Airworthiness of Aircraft COMMISSION REGULATION (EC) No 2042/2003 of 20 November 2003 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks.
2. COMMISSION REGULATION (EC) No 1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production.

Grading criteria:

Exam scores, home work

Detailed contents:

Regulatory Framework: role of International Civil Aviation Organisation, role of EASA, role of the Member States; relationship between Part-145, Part-66, Part-147 and Part-M; relationship with other Aviation Authorities. Part-66 — Certifying Staff — Maintenance: Detailed understanding of Part-66. Part-145 — Approved Maintenance Organizations: Detailed understanding of Part-145. JAR-OPS — Commercial Air Transportation: Air Operators Certificates, operators responsibilities, documents to be carried, aircraft placarding (markings); Aircraft Certification; General: certification rules: such as EACS 23/25/27/29, type certification; supplemental type certification, Part-21 Design/Production Organization Approvals. Documents: Certificate of Airworthiness, Certificate of Registration, Noise Certificate, Weight Schedule, Radio Station License and Approval. Part-M detailed understanding of Part-M; Applicable National and International Requirements for (if not superseded by EU requirements Maintenance Programs,

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Maintenance checks and inspections, Master Minimum Equipment Lists, Minimum Equipment List, Dispatch Deviation Lists, Airworthiness Directives, Service Bulletins, manufacturers service information; Modifications and repairs; Maintenance documentation: maintenance manuals, structural repair manual, illustrated parts catalogue, etc.; Continuing airworthiness: test flights, ETOPS, maintenance and dispatch requirements, All Weather Operations, Category 2/3 operations and minimum equipment requirements.

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Sylabus

Course name:	**Aeronautical Systems 1**
Course name in other language:	
Short name:	**ASYS1**
Course number:	**ML.ANK467**
Course language:	**English**
Responsible for the course:	**dr inż. Maciej Zasuwa**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**3**

Contents - short:

the presentation of basics of aeronautical systems: principles of operation and applications

Bibliography:

1) Grewal, Mohinder S., Global positioning systems, inertial navigation, and integration, 2001
2) Kayton M., Fried W.R., Avionic Navigation Systems, Second Edition, John Wiley, 1996,
3) Moir I., Seabridge A., Aircraft Systems; Longman Scientific & Technical, London, 1992
4) Moir I., Civil Avionics Systems, 2003
5) Pallet E.H.J., Aircraft Instrument Systems, IAP, 1993
6) Titterton, David H., Strapdown Inertial Navigation Technology, 1997

Course results:

After completing the course students will be familiar with principles of operation and applications of main aeronautical systems.

Grading criteria:

2 tests in semester in writing and final oral exam

Detailed contents:

Foundations of navigation. Magnetic compass and other magnetic sensors. Radio navigation background. Radio navigation systems: NDB, LORAN, DOPPLER, VOR, DME, TACAN. Landing augmentation systems: ILS and MLS. Collision Avoidance and ground proximity warning systems: TCAS, (E)GPWS. Satellite navigation GPS and its augmentation systems: DGPS, GNSS. Strapdown navigation: sensors and systems: IRS, IMU, INS. Air data systems. RNAV. Flight recorders: flight data and cockpit voice recorders. Radio communication transmitters and receivers, transponder. Cockpit layout.

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Sylabus

Course name:	**Aeronautical Systems 2**
Course name in other language:	
Short name:	**ASYS2**
Course number:	**ML.ANK458**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Janusz Narkiewicz**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Contents - short:

The presentation of basics of aeronautical systems: principles of operation and applications

Bibliography:

1) Grewal, Mohinder S., Global positioning systems, inertial navigation, and integration, 2001
2) Moir I., Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration, Third Edition, AIAA, 2008
3) Moir I., Seabridge A., Design and Development of Aircraft Systems: An Introduction, AIAA, 2004
4) Pallet E.H.J., Aircraft Instrument Systems, IAP, 1993
5) Spitzer, Cary R. Red., „The avionics handbook”, 2001
6) Stevens B., Lewis F., Aircraft Control and Simulation, Second Edition, John Wiley, 2003

Course results:

After completing the course the students will be familiar principles of operation and applications of selected aeronautical systems:.

Grading criteria:

60% continuous assessment based on laboratory work, 40% on theory presented during lectures. 1 test at the end of lectures, all laboratory exercises completed (report and test).
Practical work: Measurements, data acquisition and processing.

Detailed contents:

Lectures: Flight instruments. Cockpit design. Aeronautical pneumatic systems (pitot-static system, Air Data Computer, low speed measurement). Sensor integration in aeronautical systems.
Laboratory: The familiarization with principles of operation of elements of pneumatic and hydraulic, systems, magnetic and inertial sensors, IMU, electromagnetic actuations.

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Date 06.03.2019

Sylabus

Course name:	**Aircraft Design 1**
Course name in other language:	
Short name:	**ADES1**
Course number:	**ML.ANK307**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Cezary Galiński**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Aerodynamics 1 (ML.ANK473), Mechanics of Flight 1 (ML.ANK472)

Contents - short:

To learn about creating the airplane concept

Bibliography:

1) Book 1 Raymer, Daniel P. “Aircraft design”
2) Book 2 Corke, Thomas C. „Design of Aircraft”
3) Book 3 Roskam, Jan. „Airplane design”
4) Documentation on http://itlims.meil.pw.edu.pl/zsis/index.htm

Further Readings:

5) - Book 3 Roskam, Jan. „Airplane design”
6) Documentation on http://www.itlims.meil.pw.edu.pl/index.php?lang=1&id_page=238 - will be provided by lecturer

Course results:

After completing his course the students will be able to specify technical requirements, analyse costs and weights, create initial sketches of the airplane and modify design parameters to achieve desired flight performances.

Grading criteria:

50% continuous assesment based on the project work, 50% colloquium

Practical work:

Guided Project, where each students will design his own airplane

Detailed contents:

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Analyses of: trends, costs, mission, weight, thrust and wing loading. Fuselage and ergonomics. Wings and empennages. High lift devices and control surfaces. Landing gear. Propulsion integration. Loads and handling qualities.

Additional remarks (by course staff):

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Sylabus

Course name:	**Aircraft Design 2**
Course name in other language:	
Short name:	**ADES2**
Course number:	**ML.ANK308**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Cezary Galiński**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**

Recommended prerequisites:

Aerodynamics 1 (ML.ANK473), Aircraft Design 1 (ML.ANK307), Manufacturing Technology 1 (ML.ANK399), Materials in Aerospace Technology (ML.ANK335), Mechanics of Flight 1 (ML.ANK472), Mechanics of Flight 2 (ML.ANK457)

Contents - short:

To learn about developing the airplane concept

Bibliography:

1) Book 1 Niu, Chunyun. „Airframe structural design”
2) Book 2 Howe, Denis. „Aircraft loading and structural layout”
3) Documentation on http://itlims.meil.pw.edu.pl/zsis/index.htm

Further Readings:

1. Book 3 Megson, T. H. G. “Aircraft structures for engineering students”
2. will be provided by lecturer

Course results:

After completing his course the students will be able to manipulate with certain design parameters to achieve desired handling qualities, analyse loads and create the airframe concept.

Grading criteria:

50% continuous assesment based on project work, 50% colloquium

Practical work:

Guided Project, where each students will design his own airplane

Detailed contents:

Loads and handling qualities. Types of structures applicable in aircraft design. Wing and empennages components and their structures. Fuselage components and their structures. Simplified methods of

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strength calculations. Connections between fuselage, wing and empennages. Mechanical control systems.

Additional remarks (by course staff):

Students shall continue their projects from Aircraft Design 1

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Sylabus

Course name:	**Aircraft Engine Design 1**
Course name in other language:	
Short name:	**AEDES1**
Course number:	**ML.ANS619**
Course language:	**English**
Responsible for the course:	**dr inż. Maciej Chmielewski**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Lotnicze silniki turbinowe (ML.NS607), Zespoły napędowe I (ML.NK433)

Contents - short:

Acquainting students with construction, operation, and application of aircraft engines; the selection and rational designing and calculation techniques for parts and units of aircraft engines

Bibliography:

1) J. Mattingly „Aircraft Engine Design”
2) Serie Napędy Lotnicze Wydawnictw Komunikacji i Łączności
Further Readings:
- Mattingly “Elements of Propulsion”
- Flight International, Awiation Week and Space Technology

Course results:

After completing his course the students will be able to specify and implement methods of design of aircraft engines and its elements.

Grading criteria:

100 % The subject is completed on the basis of the final written tests

Detailed contents:

Turbine aviation engines: scope of using, design schemas, overview of units, aerothermodynamics calculations techniques. Short overview of basic design problems, overview basic responsibilities of control, diagnostic and monitoring unit.

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Sylabus

Course name:	**Aircraft Engine Design 2**
Course name in other language:	
Short name:	**AEDES2**
Course number:	**ML.ANS631**
Course language:	**English**
Responsible for the course:	**dr inż. Paweł Oleszczak**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**

Recommended prerequisites:
Aircraft Engine Design 1 (ML.ANS619)

Contents - short:
Practical training based on the course “Design of Aircraft Engines I”

Bibliography:
1) Mattingly “Aircraft Engine Design”
2) Documentation on http://
Further Readings:
- Mattingly “Elements of Propulsion”
- Will be provided by lecturer

Course results:
After completing his course the students will be able to specify and implement methods of design of aircraft engines and its elements

Grading criteria:
e.g. , 100% assesment of the project
Practical work: e.g., Project classes where students learn application of modern design tools in aircraft engine design

Detailed contents:
Guided, individual or group project of aircraft engines or its elements

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Sylabus

Course name:	**Aircraft Engines Maintenance**
Course name in other language:	
Short name:	**AEM**
Course number:	**ML.ANS608**
Course language:	**English**
Responsible for the course:	**dr inż. Mirosław Muszyński**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**7**

Contents - short:

To teach students about the basic principles of aircraft engines maintenance systems designing and implementing

Bibliography:

1) Boliński Benedykt, „Eksploatacja silników turbinowych”, Wydawnictwo Komunikacji i Łączności, Warszawa 1981
2) Rolls Royce plc. 1986. The jet engine. Birmingham, Renault Printing Co Ltd.
3) Documentation on http://
Further Readings:
- Krzysztof Buczko (s.d.), Maintenance and technical logistics, Warsaw, Polish Airlines LOT.
- will be provided by lecturer

Course results:

As a result of subject completion a student acquires knowledge in: basic aircraft engines maintenance systems, typical damages of aircraft engine parts and methods of engine testing.

Grading criteria:

The subject is completed on the basis of the final written tests – 100%

Detailed contents:

Aircraft engines maintenance systems, maintenance limits of aircraft engines, planning of aircraft engines overhauls, tasks of maintenance organizations, types of services, maintenance activities on an aircraft engines, ground testing of engine, typical damages of aircraft engine parts, methods of engine testing, the engine monitoring on the ground and in the flight, maintenance safety problems, maintenance documents and manufacture requirements

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Additional remarks (by course staff):

As the subject is of interdisciplinary character and is not based on a particular text book, students participation in lectures is highly recommended.

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Sylabus

Course name:	**Aircraft Maintenance**
Course name in other language:	
Short name:	**AIRM**
Course number:	**ML.ANK315**
Course language:	**English**
Responsible for the course:	**dr inż. Kamila Kustroń**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**

Contents - short:

Maintenance regulations. Dependences between design and maintenance philosophies from safety and cost-effectiveness point of view. Aircraft and airspace as elements in exploitations systems. Maintenance systems. Modeling of operation&maintenance process and effectiveness of exploitation system. Reliability, availability, durability, safety and security problems and their assessment . Maintenance of aging aircraft and novel aircraft. Reliability and maintenance characterization. Diagnostic methods: non destructive evaluation(NDE) and health monitoring (SHM, EHM, HUMS). Flight safety.

Bibliography:

Croes M, Watkns W., Delp F.: Aircraft Maintenance and Repair.
2010 maintemance Library, Publisher: Aircraft Technical Book Company. Edition 2010 (printable CD)
www.aviationtoday.com/am/, www.easa.eu.int/

Course results:

After completing this course the students will have skills to improve maintenance from safety and cost-effectiveness points of view

Grading criteria:

60% assessment of tutor marked assignment and 40% assessment of project (in presentation form)

Additional remarks (by course staff):

http://www.meil.pw.edu.pl/add/ADD/Teaching/Subjects/Aircraft-Maintenance

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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:	**Astronautics**
Course name in other language:	
Short name:	**ANAUT**
Course number:	**ML.ANK468**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Piotr Wolański**

ECTS:	**4**	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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:
Mechanika I (ML.NW108), Termodynamika (ML.ZNK414)

Contents - short:
Learn basics of rocket design, theory of space flights, types of satellites and spacecraft as well as with benefits from space exploration

Bibliography:
Written materials on the Department’s Web site.

Course results:
Calculation of simple orbit parameters, basic estimation of parameters of rockets, determining of features and requirements for space missions

Grading criteria:
Two written tests are necessary to pass to get the credit

Detailed contents:
Design and rocket’s flight; Types of rockers and their applications; Ciolkovski’s formula of space flight; Single and multistage rockets; contemporary rockets; Satellites and spacecrafts; Manned spacecrafts; Reentry problem; Exploration of planets; Benefits from space exploration; future direction of Space Exploration

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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 Combustion**
Course name in other language:	
Short name:	**CHOC**
Course number:	**ML.ANK359**
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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**6**

Recommended prerequisites:

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

Contents - short:

Lectures on: basic properties of fuels and combustible mixtures; mechanisms of combustion and flame propagation including thermal dissociation; methods of limitation of toxic combustion products emission in engines

Bibliography:

1) J. Chomiak ”Combustion: A study in theory, fact and application”, Gordon and Breach Science 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; high temperature combustion; low emission combustion.

Grading criteria:

The subject is completed on the basis of the written examination.

Detailed contents:

Basic properties of fuels and combustible mixtures; fundamentals of chemical kinetics; thermal and chain theory of self-ignition; diffusion combustion-laminar and turbulent; kinetic combustion-laminar

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and turbulent, kinetic-diffusion combustion-laminar and turbulent; flame stabilization; mechanism of fuel droplets combustion, thermal dissociation, transition from deflagration to detonation, detonation combustion; dynamics of explosion development and suppression; toxic properties of combustion products

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

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

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

Contents - short:

Knowledge about methods and tools of computational fluid dynamics

Bibliography:

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

Course results:

Grading criteria:

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

Detailed contents:

Basic models in fluid mechanics. Conservative versus non-conservative formulation. Basic discretisation methods for model equations (boundary and initial conditions, stability, CFL condition, Godunov barier). General algorithms for nonlinear problems (pseudo-time iterations, frozen coefficients, quasi-linearisation). Simulation of incompressible flows (stream-function vorticity formulation, projection method and artificial compressibility). Finite volume method for compressible flows. Flux-vector splitting technique. Modelling of shock-waves. Basic information on spectral methods.

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Additional remarks (by course staff):

The laboratory groups can consist of at most 12 students

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Sylabus

Course name:	**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:	**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.ECENG02**
Course language:	**English**
Responsible for the course:	**Brak Danych**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace 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:	**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:	**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 Graphics - CAD 2**
Course name in other language:	
Short name:	**EGCAD2**
Course number:	**ML.ANK431**
Course language:	**English**
Responsible for the course:	**dr inż. Witold Mirski**

ECTS:	**2**	Number of hours:	[Lc, T, Lb, P, S,]
Course level:	**Advanced**	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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**3**

Recommended prerequisites:

Engineering Graphics - CAD 1 (ML.ANW118)

Contents - short:

Creating the technical drawing of machine's element and assembly drawing by hands and using the 2D-CAD system. Introduction to the 3D-CAD system (Drafting Module). Making plain paper technical documentation basing on the given spatial model created by the use of 3D-CAD system.

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 assembly drawing and working drawing of machine's element with notation of fit and tolerance - drawing by hand and using the 2D-CAD system, according to the rules of International (ISO) and Polish Standards. Getting the skill of reading the assembly drawing. Base information about 3D-CAD system (Drafting Module).

Grading criteria:

Positive results of tests as well as home and class work

Detailed contents:

Technical drawing of machine's elements and assembly drawing created by hands and using the 2D-CAD system. Part view of assembly basing on the real object. Notation of fit and tolerance. Notation of heat treatment. Axonometric projection of joined machine's elements on the base of the assembly drawing.

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Introduction to making of plain paper documentation basing on the given spatial model created by the use of 3D-CAD system.

Additional remarks (by course staff):

One teacher for group of 12 students. Term of registration according to the dean’s information.

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

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

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

Recommended prerequisites:

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

Contents - short:

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

Bibliography:

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

Course results:

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

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Grading criteria:

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

Detailed contents:

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

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Sylabus

Course name:	**Finite Element Method 2**
Course name in other language:	
Short name:	**FEM2**
Course number:	**ML.ANK479**
Course language:	**English**
Responsible for the course:	**dr inż. Piotr Marek**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**7**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**7**

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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:	**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:	**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:	**Integrated CAD/CAM/CAE Systems 1**
Course name in other language:	
Short name:	**ICS1**
Course number:	**ML.ANK436**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Stanisław Bogdański**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**4**

Recommended prerequisites:

Engineering Graphics (ML.ANW105), Engineering Graphics - CAD 1 (ML.ANW118), Engineering Graphics - CAD 2 (ML.ANK431)

Contents - short:

Introduction to the most advanced Integrated CAD/CAM/CAE Systems and learning the basic functions of 2D and 3D modeling as well as the fundamentals of “Drafting”.

Bibliography:

Tutorials and manuals issued by Siemens UGS PLM Software available „on line” and distributed among students in electronic forms.

Course results:

After completing the course, student should gain the ability to use the systems NX Unigraphics and CATIA-Version 5 in the basic range. In particular she/he should be able:
-to create the 2D objects and using them for creating 3D objects;
-to utilise the 3D modelling tools for creating single machine components;
-to utilise the specialised modules of the system for creating simple assemblies;
-to create simple drafting drawings.

Grading criteria:

The final grade for the course is determined on the basis of the continuous assessment i.e. the results of the regular (usually two) and/or the improvement tests.
http://itlims.meil.pw.edu.pl/zpk/dla_studentow/regulaminy/integrated_cad_cam_cae_systems_1.pdf

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Detailed contents:

Introduction to the advanced contemporary CAD/CAM/CAE systems used in industry – typical structure, main modules, their roles and functions, strategy of use.
Practical applications of the systems in the following tasks:
• 2D modelling; points and curves on the plane, introduction to parametric sketcher,
• 3D modelling; creating separate objects (components) and building virtual models of machines and devices (assemblies),
• drafting; creating 2D engineering drawings (documentation) on the basis of 3D models.

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:	**Integrated Laboratory (AE)**
Course name in other language:	
Short name:	**INTEL**
Course number:	**ML.ANK471**
Course language:	**English**
Responsible for the course:	**mgr inż. Marek Tracz**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:

Fluid Mechanics 1 (ML.ANW122), Mechanics of Structures 1 (ML.ANW117), Thermodynamics 1 (ML.ANW116)

Contents - short:

Achieving of skill in leading experimental investigations in the field of aerodynamics, thermodynamics and mechanics of structures.

Bibliography:

1. Bijak-Żochowski M., Jaworski A., Krzesiński G., Zagrajek T.: Mechanika Materiałów i Konstrukcji, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2006.
2. Brzoska Z.: Wytrzymałość Materiałów, PWN, Warszawa, 1979.
3. M. Litwińczyk i in.: Ćwiczenia Laboratoryjne z Mechaniki Płynów, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa.
4. P.Bader, K. Błogowska: Laboratorium Termodynamiki, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2008.
5. R. Domański: Wymiana Ciepła Laboratorium Dydaktyczne, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 1996.

Course results:

Planning and leading experimental investigations.

Grading criteria:

On the base of report and short test reffered to each laboratory session.

Detailed contents:

- Aerodynamics Laboratory

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1) Velocity measurement with use of the thermoanemometer. Calibrating, measurement's rules, turbulence
parameter.
2) Velocity measurement with use of the accumulative Prandtl's and Pitot's pipes. Air industrial average velocity measurement devices. Applicability and accuracy of them.
3) Flow visualisation - compressible and uncompressible. Acquainting with characteristic points in the aerodynamic trace and on the model surface. Leading of appearance and shock (impact) wave shape visualisation.
4) The cylinder resistance measurement. Measurement of the pressure distribution on the cylinder surface and evaluation of its total resistance basing on the momentum conservation rule.
5) Weight measurements of aerodynamic coefficients. Loads measurements on a model with help of three-
component tensometric balance. Recounting of forces to coefficients, calculation of polar curve and the middle of the model pressure.
- Thermodynamics Laboratory.
1) Temperature measurements - thermodynamics temperature scale, calibration of temperature measurement
gauges.
2) Open system balance - combustion heat measurement.
3) Conversion of the air - air moisture investigation.
4) Measurement of insulators heat conductivity - plate device method in the steady state.
5) Searching of the heat diffiusivity.
- Mechanics of Structures Laboratory.
1) Torsion - determination of the revolution angle, the unit twisting angle and Kirchhoff modulus in the compact cross-section bars. Determination of strains and stresses in the thin walled close profile and the middle of transversal forces in the thin walled open profile.
2) Bending - verification of the superposition and Betti's rules with help of flexometer measuring beam deflection. Verification of the de Saint Venant rule by tensometrical method. Determination of the Young modulus. Investigation of the oblique bending.
3) Tensometer method (strain gauge)- wide application range. Determination of plane stress state. Stress concentration coefficient.
4) Buckling - Southwell's metod giving experimental value of critical forces. Advanced loading cases of invesigated bars.
5) Elastooptics - foundation of physical phenomenon, basic application of the elastooptics method. Determination of plane stress state. Stress concentration coefficient.

Additional remarks (by course staff):

Two six-person subgroups made from one laboratory group.

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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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Date 06.03.2019

Sylabus

Course name:	**Introduction to Aerospace**
Course name in other language:	
Short name:	**IAERO**
Course number:	**ML.ANK466**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. Tomasz Goetzendorf-Grabowski**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**3**

Contents - short:

Basic knowledge about history of avaiation
Knowledge of present problems of avaiation
Knowledge of basic terms on aeronautical technology

Bibliography:

1. Projects Guide: http://www.meil.pw.edu.pl/add/ADD/Teaching/Subjects/IntAero
2. Selected lectures in electronic form (web site above)
3. J.D. Andreson – Introduction to Flight, McGraw-Hill , 2004

Course results:

After subject is completed student should have the basic knowledge on:
• the history of aviation,
• present problems of aviation,
• basic terms on aeronautics and aircraft technology.

Grading criteria:

Three projects (including one in presentation form)

Additional remarks (by course staff):

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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:	**Machine Design 3**
Course name in other language:	
Short name:	**MDES3**
Course number:	**ML.ANK365**
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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**5**

Recommended prerequisites:

Engineering graphics - CAD 3 (ML.ANK432), Machine Design 2 (ML.ANW125), Manufacturing Technology 2 (ML.ANK400), Mechanics of structures 3 (ML.ANK428), Vibrations and Aeroelasticity (ML.ANK459)

Contents - short:

To supplement the material taken within MDI and MDII with the more advanced topics (listed in the course programme). To deepen the knowledge about designing for fatigue loading, designing to avoid surface failure and about tooth gears.

Bibliography:

1. Machine Design – An Integrated Approach, Second or Third edition, by Robert L.Norton, Prentice Hall 2000-2006.
2. Machine Elements in Mechanics and Design – Fourth Edition, by Robert L. Mott, Prentice Hall 2006.
3. Design of Machine Elements – seventh edition, by M.F.Spotts and T.E.Shoup, Prentice Hall 1998.

Course results:

Knowledge about (and skills in):
-types of lubrication, HL theory with the basic, simplified Reynolds' equation for eccentric journal bearing, solutions for “short” and “long” sliding bearings;
-types of contacts, EHL theory. Knowledge and skills in the usage of specific film thickness and its influence on fatigue life. Ability to determine minimum film thickness for cylindrical contact;
-knowledge and skills in reading and using the Weibull distribution for reliability of RE bearings;
-ability to calculate and select bearings for variable loading an non standard reliabilities;
-linear cumulative damage hypothesis, ability to use it for typical failure analyses.
-ability to distinguish the complex multi axial loading cases from the simple ones and to analyse them.

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-knowledge and skills in the field of dynamic contact stresses, S-N curve for surface fatigue, safety factor, designing to avoid surface fatigue failure.
-dynamic model of shaft with flexible coupling, critical speed and frequency. Ability to calculate and select the torsionally flexible coupling for power transmission system to avoid resonance.
-dynamic modelling of clutches for starting up, wear and endurance, energy balance and flow of heat. Ability to calculate and select friction disk and multidisc clutches for typical applications.
-knowledge about law of gearing, involute features, tooth loading, minimum number of teeth, technique of profile shifting. Skills in calculating parameters of spur and helical gears. Ability to determine the profile shifting coefficients to avoid undercutting and to adjust centre distances in two stage gear trains.
-skills in determining bearing reactions for spur and helical gears
-theory and design of bevel and worm gears. Ability to calculate the geometry of this type gears.
-the AGMA and ISO approaches in designing gears against tooth bending and surface fatigue failure. Ability to determine safety factors for bending and surface teeth loading.
-basic knowledge about chain and belt drives.

Grading criteria:

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.
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.
see: http://itlims.meil.pw.edu.pl/zpk/dla_studentow/regulaminy/machine_design_3.pdf

Detailed contents:

Lubrication of sliding and rolling element bearings. Probabilistic modelling of endurance of rolling bearing, selection of bearings and bearings systems for different levels of reliability. Cumulative damage hypothesis, variable loading of bearings. Designing for multi-axial stresses in fatigue, complex multi-axial stresses. Dynamic contact stresses, safety factor in surface failure, designing to avoid surface failure.
Dynamic model of shafts with flexible coupling, critical speed and frequency.
Dynamic modelling of disc clutches, wear and endurance, energy balance and flow of heat.
Tooth gear theory, law of gearing, involute features, spur and helical gearing, loading on spur and helical gears, interference and undercutting, minimum number of teeth, profile shifting, contact ratio. Bevel and worm gears types, design and calculations.

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Bearings reaction forces, bending and surface stresses in gears, AGMA* and ISO** approach and standards. Modelling of chain and belt drives, efficiency and endurance.
*AGMA – American Gear Manufacturers Association
**ISO – International Organisation for Standardisation

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 6**
Course name in other language:	
Short name:	**MDES6**
Course number:	**ML.ANK368**
Course language:	**English**
Responsible for the course:	**dr inż. Jacek Gadomski**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**6**

Recommended prerequisites:

Engineering Graphics - CAD 2 (ML.ANK431), Integrated CAD/CAM/CAE systems 2 (ML.ANK437), Machine Design 3 (ML.ANK365), Manufacturing Technology 1 (ML.ANK399), Materials in Aerospace Technology (ML.ANK335), Mechanics of structures 3 (ML.ANK428)

Contents - short:

The design of power transmission system (among other things aircraft subassembly) at a given technical assumption. Synthesis received knowledge in accordance with the valid standards.

Bibliography:

1. Mott R.L: Machine Elements in Mechanical Design, Pearson Education
2. Norton N.L.: Machine Design An Integrated Approach, Prentice Hall
3. Cecil Jensen, Jay D. Hensel, Dennis R. Short: Engineering Drawing & Design

Course results:

Skills of individual designing of power transmission system. Skills of making computations, draftings and using CAD systems.

Grading criteria:

Conditions of completion of the course
1. Submitting the project documentation before deadline determined at the beginning of the semester
2. Looking over evaluated project documentation in tutor’s presence
3. Positive final grade determined by tutor

Detailed contents:

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The design of power transmission system (among other things aircraft subassembly) e.g.: devices with gear or belt transmissions, part of aircraft control system or undercarriage retracting system. Among other things the design includes:
- the kinematics model
- selection of available materials
- choosing proper drive elements, couplings, bearings, joints, fasteners, seals etc.
- static and strength calculations
- the tolerance and fit analysis
- choice manufacturing technology

The project documentation is completed in the form of the engineering drawings – assembly and several components. Drawings documentation is prepared with the help of CAD system obligatory.

Additional remarks (by course staff):

max12 participants

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Sylabus

Course name:	**Manufacturing Technology 1**
Course name in other language:	
Short name:	**MTECH1**
Course number:	**ML.ANK399**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Joanna Radziejewska**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**3**

Contents - short:

The presentation of contemporary methods of manufacturing of machines elements, devices and the structure and their influence on properties of the product, analysis of produce ability of designed products

Bibliography:

1. Serope Kalpakjian – Manufacturing Engineering and Technology, Addison-Wesley Publishing Company, 1992
- http://www.cim.pw.edu.pl/lzp
Additional reading:
- Wit Grzesik – Advanced Machining Processes of Metallic Materials: Theory, Modelling and Application, Elsevier Science Ltd., 2008

Course results:

Ability of different goods manufacturing means selection and optimal product design in the productivity aspects. Ability of design simple basing manufacturing processes.

Grading criteria:

Short tests following every lecture and final test.
Individual work:
mainly preparing for the laboratory exercises

Detailed contents:

The technological process as the sequence of functional properties forming. Basic model of a production process. Process control and supervision
Properties of metals susceptible to plastic processing. The plastic state by principles and the possibility of a plastic deformation of metals. Properties of semi-finished products

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Shaping elements by rolling, forging or pressing, die forging, extrusion, drawing, Stamping, and others. Products obtained in the rolling plastic working process, and their properties.
Foundry as one of the basic technologies for the manufacturing of objects – castings from metals and their alloys. Classification of casting application. Main processes of castings production. Casting design productivity related to the processes and quality. Preparation of molds, cores, liquid metals added tools. Solidification, Casting production and their properties.
Types of machining processes (machine tools, machining accuracy), work-piece positioning, work-piece clamping, jigs and fixtures, dimensioning in machining operations, general rules for machining process planning, application of CNC machines and machining centers, some aspects of CNC programming, cellular manufacturing, flexible machining cells, programming of flexible robotized machining cells.
Cutting tools, Abrasive processes, grinding. Joining processes. General characteristics. Brazing, Standard symbols for wells. FW, FSW processes. Surface technology surface finishing. Coatings, surface treatments. Powder Metallurgy. Sinters forming, sintering sinters finishing. Cermets. Sinters properties, application and design.
The technological process as the sequence of functional properties forming. Basic model of a production process. Process control and supervision
Properties of metals susceptible to plastic processing. The plastic state by principles and the possibility of a plastic deformation of metals. Properties of semi-finished products
Shaping elements by rolling, forging or pressing, die forging, extrusion, drawing, Stamping, and others. Products obtained in the rolling plastic working process, and their properties.
Foundry as one of the basic technologies for the manufacturing of objects – castings from metals and their alloys. Classification of casting application. Main processes of castings production. Casting design productivity related to the processes and quality. Preparation of molds, cores, liquid metals added tools. Solidification, Casting production and their properties.
Types of machining processes (machine tools, machining accuracy), work-piece positioning, work-piece clamping, jigs and fixtures, dimensioning in machining operations, general rules for machining process planning, application of CNC machines and machining centers, some aspects of CNC programming, cellular manufacturing, flexible machining cells, programming of flexible robotized machining cells.
Cutting tools, Abrasive processes, grinding. Joining processes. General characteristics. Brazing, Standard symbols for wells. FW, FSW processes. Surface technology surface finishing. Coatings, surface treatments. Powder Metallurgy. Sinters forming, sintering sinters finishing. Cermets. Sinters properties, application and design.

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Sylabus

Course name:	**Manufacturing Technology 2**
Course name in other language:	
Short name:	**MTECH2**
Course number:	**ML.ANK400**
Course language:	**English**
Responsible for the course:	**dr hab. inż. Józef Zawora**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**4**

Contents - short:

Getting basic knowledge on the most used manufacturing processes and industrial measurement methods

Bibliography:

1) Selected English translation of an academic book “Obróbka Skrawaniem Ścierna i Erozyjna”(in Polish), L.Dąbrowski et al., OWPW, Warszawa 2007
2) Selected English translation of an academic book “Metrologia wielkości geometrycznych”(in Polish), B.Nowicki et al., OWPW, Warszawa 2007
3) Documentation on http://zowie.meil.pw.edu.pl
Further Readings:
1) “Manufacturing Engineering and Technology”, S. Kalpakjian, Prentice Hall 2006

Course results:

After completing this course the students will be able to render basic information on typical manufacturing processes, their applications and to measure the machined parts using various methods.

Grading criteria:

Checking students’ preliminary knowledge prior a lab class and a lab class mandatory report assessment.

Detailed contents:

Analysis of measurement errors, measurements of typical geometric features, machine parts shaping by plastic forming, bonding materials by welding, part programming for numerically controlled machine tools, abrasive machining for surface finish, metal cutting by turning and milling with cutting tool life investigation, electrochemical machining, electro-discharge machining.

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Additional remarks (by course staff):

For the quality of teaching, groups of less than 10 students are recommended

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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:	**Materials in Aerospace Technology**
Course name in other language:	
Short name:	**MATAERO**
Course number:	**ML.ANK335**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Piotr Czarnocki**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**3**

Contents - short:

Materials destined for aeronautical structures - strength, technological and usable properties. Foundations of lightness, and airworthiness analysis of the materials – selection criteria. Strength and technological properties of composites and structures properties design. Engineer's methods of composite structures strength evaluations.Application of advanced composite materials (ceramic-, metal, and nano-composites) in aerospace and automobile industry.

Bibliography:

1. B. Cantor, H. Sssender, P. Grant: "Aerospace Materials", Institute of Physics Publishing, Bristol and Philadelphia, 2001,
2. D. Gay, S.V. Hoa, S.W. Tsai: "Composite Materials: Design and Applications", CRC Press, 2003

Course results:

Acquiring skills in structural materials selection following strength, technological and usable factors, composite structures properties design, and engineers methods of their strength evaluations.

Grading criteria:

Based on tests results

Detailed contents:

1. Mutual stimulation of grows in aerospace engineering and materials engineering. Materials for aeronautical structures. Airworthiness of structural materials.
2. Influence of materials on aircraft aerodynamic performance.
3. Application of steel in aerospace structures. Carbon steel, alloy steel.
4. Structural materials based on aluminum, magnesium, cooper, nickel, cobalt or titanium.
5. Methods of machining and structure manufacturing. Processes of forming strength and durability properties.
6. Comparative analysis of properties of main structural materials.

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7. Lightness criteria of structural materials.
8. Examples of structural designs for different materials.
9. Application of wood in aeronautical structures. Airworthiness requirements. Isotropy as a joint feature of wood and composite structures. Joints of concentrated forces introductions and connection of wood structures.
10. Polymer composites – reinforced by fiber. Properties of components. Laminar and sandwich structures properties. Isotropy. Basic manufacturing processes. Joints of concentrated forces introductions and glue connections.
11. Polymer composites reinforced by powders. Main applications: gelcoat, glue & compensation layers, stuff for casting.
12. metallic composites – physical, strength, technological and maintenance properties. Application in aeronautical structures.
13. Prognostic and evaluation of mechanical properties.
14. Ageing of metallic and composite structures. Basics of corrosion and anticorrosive protection.
15. Grow-trends of composite materials – nanocomposites.

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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 Flight 1**
Course name in other language:	**Mechanika lotu**
Short name:	**MECHFL1**
Course number:	**ML.ANK472**
Course language:	**English**
Responsible for the course:	**dr inż. Zbigniew Paturski**

ECTS:	**4**	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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**

Contents - short:

Atmosphere properties. International Standard Atmosphere. Aerodynamic forces and moments, and aerodynamic characteristics of the airplane (sub- trans- and supersonic). Gliding (unpowered) flight. Aircraft propulsion: propellers and jets. Performances in powered flight: climb characteristics, ceiling, endurance and range. Take-off and landing of the airplane.

Bibliography:

1. Warren F. Philips: Mechanics of Flight, John Willey and Sons, 2004
2. Bernard Etkin, Lloyd D. Reid: Dynamics of Flight, John Willey and Sons, 1996
3. Jan Roskam: Airplane Flight Dynamic and Control, part I, DARCorporation, Lawrence, Kansas 1999

Course results:

After completing his course the students will be able to estimate basic aerodynamic characteristics and performances of the airplane

Grading criteria:

60% continuous assessment based on guided projects, 40% test work.
Practical work: five (6) projects covering covering aerodynamic characteristics of airplane and basic performance of the airplane.

Detailed contents:

Atmosphere properties. International Standard Atmosphere. Aerodynamic forces and moments, and aerodynamic characteristics of the airplane (sub- trans- and supersonic). Gliding (unpowered) flight. Aircraft propulsion: propellers and jets. Performances in powered flight: climb characteristics, ceiling, endurance and range. Take-off and landing of the airplane.

Additional remarks (by course staff):

!!!!!!!!! Błędna nazwa przedmiotu

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!!!!!!!!! Winno być (analogicznie jak dla kursu w jęz. polskim): Mechanics of Flight 1
!!!!!!!!! Tzw. 'treści ministerialne' nie są w jęz. przedmiotu (ang.)

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Sylabus

Course name:	**Mechanics of Flight 2**
Course name in other language:	
Short name:	**MECHFL2**
Course number:	**ML.ANK457**
Course language:	**English**
Responsible for the course:	**dr inż. Zbigniew Paturski**

ECTS:	**3**	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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:

Mechanics of Flight 1 (ML.ANK472)

Contents - short:

Longitudinal aerodynamic moments acting on the airplane. Longitudinal equilibrium, static stability and control of the airplane. Center of gravity location problem. Lateral forces and moments. Lateral equilibrium, static stability and control. Introduction into dynamics of flight: simple cases of steady and unsteady motion of the airplane. Basic natural modes of airplane (phygoid, short period, and Dutch-roll oscillations).

Bibliography:

1. Warren F. Philips: Mechanics of Flight, John Willey and Sons, 2004
2. Bernard Etkin, Lloyd D. Reid: Dynamics of Flight, John Willey and Sons, 1996
3. Jan Roskam: Airplane Flight Dynamic and Control, part I, DARCorporation, Lawrence, Kansas 1999

Course results:

After completing his course the students will be able to estimate basic motion properties of the airplane

Grading criteria:

60% continuous assessment based on guided projects, 40% test work.
Practical work: five (5) projects covering longitudinal stability and control, and simple cases of steady and unsteady motion of the airplane.

Detailed contents:

Longitudinal aerodynamic moments acting on the airplane. Longitudinal equilibrium, static stability and control of the airplane. Center of gravity location problem. Lateral forces and moments. Lateral equilibrium, static stability and control. Introduction into dynamics of flight: simple cases of steady and

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unsteady motion of the airplane. Basic natural modes of airplane (phygoid, short period, and Dutch-roll oscillations).

Additional remarks (by course staff):

!!!!!!!!!!!!! Błędna nazwa przedmiotu
!!!!!!!!!!!!! Winno być (analogicznie jak dla kursu w jęz. polskim) Mechanics of Flight 2
!!!!!!!!!!!!! Tzw. 'treści ministerialne' nie są w jęz. przedmiotu (ang.)

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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:	**Mechanics of Structures 2**
Course name in other language:	
Short name:	**MOS2**
Course number:	**ML.ANK427**
Course language:	**English**
Responsible for the course:	**dr inż. Jakub Pawlicki**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**3**
Mechanika i Budowa Maszyn	**Computer Aided Engineering_specjalność**	**undergraduate, full time**	**3**

Recommended prerequisites:
Mechanics of Structures 1 (ML.ANW117)

Contents - short:
Semi advanced knowledge for strength analysis of one-dimensional and two-dimensional structures.

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 this course students will be able to specify and implement analytical methods to solve basic and semi advanced static problems of determinate and indeterminate structures.

Grading criteria:
tests, home works, examination
Practical work:
Classes and home works where students will solve simple structure statics problems.

Detailed contents:

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Complex problem of bending of beams. Complex loading of bars. Bar structures: trusses and frames: statically determinate and indeterminate problems. Thermal stresses and assembly stresses. Membrane stresses in axisymmetric vessels and shells.

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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:	**Propulsion Systems 1**
Course name in other language:	
Short name:	**PSYS1**
Course number:	**ML.ANK433**
Course language:	**English**
Responsible for the course:	**dr inż. Paweł Oleszczak**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**4**

Recommended prerequisites:
Termodynamika I (ML.NW116P)

Contents - short:
Learning about basic kinds of aircraft propulsions. Skills in calculations of basic parameters of the aircraft engine cycle like thrust, efficiencies, fuel consumption.

Bibliography:
1) J. Mattingly „Elements of Propulsion”
2) G.C. Oates „Aerothermodynamics of Aircraft Engine Components”
3) R. Stone „Introduction to Internal Combustion Engines”
4) Documentation on http://materialy.itc.pw.edu.pl/zsl/Propulsion%20Systems%201/
Further reading:
- P. Dzierżanowski i in. „ Turbinowe silniki odrzutowe”
- P. Dzierżanowski i in. „Silniki odrzutowe”
- Will be provided by lecturer

Course results:
After completing his course the students will be able to calculate basic properties of aircraft propulsion.

Grading criteria:
Two test 50% each

Detailed contents:
History of the aircraft engines. Requirements for the aircraft engines. Efficiencies. Theoretical and real cycles of piston, turbine, ramjet and rocket engines. Air fuel mixture creation and combustion. Kinds of piston engines. Cooperation of a propeller with the engine. Performances of the engines. Elements

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of the turbine engines: intake, compressor, combustion chamber, turbine, nozzle, thrust reverser and afterburner. Calculation of the engine cycles. Ecological problems.

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Sylabus

Course name:	**Risk and Reliability in Aviation**
Course name in other language:	
Short name:	**RISKAV**
Course number:	**ML.ANS611**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Marek Matyjewski**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Contents - short:

Analysis methods and techniques in reliability. Human factors. Risk measures. Risk analysis.

Bibliography:

1. Patrick D.T. O'Connor: Practical Reliability Engineering. John Wiley & Sons, Ltd., 2008.
2. Efstratios Nikolaidis, Dan M. Ghiocel, Suren Singhal: Engineering Design Reliability Applications. Taylor & Francis Group, 2003.
Photocopies of slides from lecture or slides in pdf format.

Course results:

Knowledge of reliability methods. Making risk and reliability models. Application of risk analysis to problems in engineering.

Grading criteria:

Two part written examination (theory an problems). Passing of all three tests during semester exempts from the examination. Two positive marks admit to a catch up test.

Detailed contents:

Concept and kinds of risk. Causes and kinds of losses in the man-technology-environment system. Elements of probability theory: event, definitions of probability; random variable, probability density function, cumulative distribution function, moments; elements of statistics. Relationships between concepts of risk, reliability and hazard. Measures of losses, hazard, reliability and risk. Human reliability. Models of system reliability. Fault tree analysis. Event tree analysis. Pronciples and procedure of risk analysis. Probabilistic modelling of losses, hazards, reliability and risk. Quantitative methods of risk analysis and estimation. Tree methods in risk modelling. Human factor in risk analysis. Safety and safety factor.

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Sylabus

Course name:	**Rotorcraft Aeromechanics**
Course name in other language:	
Short name:	**RAMECH**
Course number:	**ML.ANS609**
Course language:	**English**
Responsible for the course:	**prof. dr hab. inż. Janusz Narkiewicz**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Contents - short:

Principles of vertical flight, modeling and calculation of basic performance of a single rotor helicopter.

Bibliography:

1) Done G., Balmford D.: „Bramwell's Helicopter Dynamics", 2001
2) Prouty R.W., „Helicopter Performance, Stability and Control", PWS Engineering Boston 1986
3) Documentation on http://zaiol.meil.pw.edu.pl
Further Readings:
Johnson W., „Helicopter Theory", Princeton University Press, 1980.
Will be provided by lecturer

Course results:

Ability to specify and implement simple models and methods for assessment of preliminary rotorcraft performance.

Grading criteria:

Three tests (75%) and one project (25%).
Practical work: During tutorials students will practice knowledge acquired on lectures.

Detailed contents:

Principles of vertical take-off and landing. Rotorcraft configurations and control. Main rotor hub and blades. Momentum theory. Strip theory. Airfoil unsteady loads. Uncoupled blade motions: flap, lag, pitch. Elastic blade modeling. Power systems. Tail rotor loads. Empennage loads. Trim and performance of single rotor helicopter. Autorotation. Ground and air resonance. Stability augmentation systems.Regulations for design, equipment and testing New design concepts.

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Sylabus

Course name:	**Simulation of Aeronautical Systems**
Course name in other language:	
Short name:	**SAS**
Course number:	**ML.ANS614**
Course language:	**English**
Responsible for the course:	**dr inż. Maciej Zasuwa**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**

Recommended prerequisites:

Aeronautical Systems 1 (ML.ANK467), Aeronautical Systems 2 (ML.ANK458)

Contents - short:

to acquire practical skills of creating simulation software, related to operation of selected on-board aircraft systems

Bibliography:

- general literature on programming theory
- general literature on programming in Matlab / Simulink
- books / manuals of selected aeronautical system

Further Readings:

- will be provided by lecturer

Course results:

After completing the course students will be able to use and create simulation tools in various fields of technology.

Grading criteria:

Final mark based on:

- test in writing
- assessment of students' projects

Detailed contents:

Introduction to programming in Matlab and Simulink software. The architecture of the simulation software. Mathematical models of selected aeronautical systems and components (sensors, controllers and actuators: electric motors, hydraulic and mechanical components, etc.). Introduction to real-time simulation, program optimization, verification and validation.

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Individual supervised project - simulation of selected aeronautical system or component.

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Sylabus

Course name:	**Simulators**
Course name in other language:	
Short name:	**SIMU**
Course number:	**ML.ANS627**
Course language:	**English**
Responsible for the course:	**dr inż. Maciej Zasuwa**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**7**

Recommended prerequisites:

Aeronautical Systems 1 (ML.ANK467), Aeronautical Systems 2 (ML.ANK458)

Contents - short:

to make students familiar with the base principles of simulators design in aeronautics and other fields of technology

Bibliography:

• none

Further Readings:

• will be provided by lecturer

Course results:

After completing the course students will be familiar with modern simulator technology, having background for design of simulators.

Grading criteria:

one final test

Detailed contents:

Definition of simulator and training devices. Simulator architectures and applications. Pilot training procedures. Human perception and proprioception. Influence of human physiology on simulator design: the role of human senses in flight control, sight physiology and hearing. Recording and analysis of training process. Simulation software: architecture and components, DIS, HLA, real-time computation. Mobile platform simulators: classification, control methods. Vision systems: image generation and display. Real-time computer graphics. Databases of terrain and 3D objects. Imitation and modeling of indicators

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in cockpit, flight control systems, force feedback systems. Simulation models of mobile platforms. Sound effects generation. Simulation sickness. Demonstration of available simulator.

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Sylabus

Course name:	**Spacecraft Design**
Course name in other language:	
Short name:	**SD**
Course number:	**ML.ANS630**
Course language:	**English**
Responsible for the course:	**dr inż. Arkadiusz Kobiera**

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

Field of Study:	Field of Specialization:	Study level:	Recommended semester:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**5**

Recommended prerequisites:
Astronautyka (ML.NK468)

Contents - short:
To learn about basic requirements and technologies used in design of spacecraft.

Bibliography:
1) D. Darling „The Complete Book of Spaceflight”,
2) P. Fortescue, J. Stark, G. Swinerd “Spacecraft Systems Engineering”,
3) Documentation on http://
Further Readings:
- Popular science books and journals
- Will be provided by lecturer

Course results:
Student should be able to describe requirements and proper technologies for specified types of space missions.

Grading criteria:
100 % final essay/project
Practical work: e.g., conceptual project of spacecraft

Detailed contents:
Specifics of space flight, basic subsystems of spacecrafts, artificial satellites, space probes, spacestations, maned spacecraft, spaceplanes

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Date 06.03.2019

Sylabus

Course name:	**Structure and Assebling of Airframe**
Course name in other language:	
Short name:	**STRA**
Course number:	**ML.ANK401**
Course language:	**English**
Responsible for the course:	**prof. nzw. dr hab. inż. Piotr Czarnocki**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**6**

Contents - short:

Manufacturing principles of selected airframe components - basics. Selected forming and joining methods. Airframe assembling methods. Design of fixtures and jigs. Finale airframe alignment.

Bibliography:

1. "Tooling for aircraft and missile manufacture", ed.F.W. Willson
2.Flake Campbell Jr, “Manufacturing Processes for Advanced Composites”

Course results:

Umiejętność, w podstawowym zakresie, projektowanie lotniczych wyrobów kompozytowych, projektowania oprzyrządowania produkcyjnego do ich wykonania. Znajomość technik wytwarzania i łączenia stosowanych w produkcji kompozytowych elementów płatowca. Umiejętność przeprowadzenia podstawowej analizy wytrzymałościowej struktury kompozytowej.
Basic knowledge concerning design of composite airframe parts, design of manufacturing processes and tooling. Basic knowledge about, joining methods applicable for composite structures. Ability to carry out basic stress analysis of composite airframe parts.

Grading criteria:

Final mark results from the project evaluation.

Detailed contents:

Principles of webs, bulkheads, spars and torsion boxes manufacturing. Selected methods used for forming metal parts of airframes: blanking, brake forming, stretch forming, rubber part forming, creep forming, chemical milling. Selected joining methods: riveting, adhesive bonding, friction stir welding. Tolerance requirements for an external geometry of airframe. Assembling methods. Flow charts Assembling fixtures and jigs. Fixing airframe parts. CMMs (mechanical docks). Traditional optic methods: use of autocollimators and transits. Optical docks. Mock-ups. types of mock-ups and their application for

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tooling and assembling of jigs and fixtures. Interchangeability of main airframe components. Application of mock-ups for jigs and fixture assembling.
Composite airframes. Manufacturing of composite airframe parts and joining – basics. Basics of curing process. Tooling for composite parts: mock-ups and moulds. Materials for moulds-curing temperature aspects.
Alignment of airframe main components and final check of geometry.

Additional remarks (by course staff):

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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:	**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:	**Vibrations and Aeroelasticity**
Course name in other language:	
Short name:	**VA**
Course number:	**ML.ANK459**
Course language:	**English**
Responsible for the course:	**dr inż. Franciszek Dul**

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:
Lotnictwo i Kosmonautyka	**Aerospace engineering**	**undergraduate, full time**	**7**

Contents - short:

Basic knowledge of vibrations phenomena. Basic knowledge of unsteady aerodynamics. Basic knowledge of aeroelastic phenomena. Basic competency in computational methods of vibrations and aeroelasticity.

Bibliography:

1) Osiński, J.; Teoria drgań, PWN, Warszawa, 1978
2) Bisplinghof, R.L., Ashley, H., Halfman, R.L.; Aeroelasticity, Addison-Wesley, Cambridge, Mass. 1955.
3) Dowell, E.H., Curtiss, H.C., Scanlan, R.H., Sisto, F.; A modern course in aeroelasticity, Sijthof & Noordhoff, Alpen aan den Rijn, 2004.
4) Documentation on http
Further Readings:
5) Wright, J., Cooper, J.E. Introduction to Aircraft Aeroelasticity and Loads, Wiley, 2007

Course results:

After completing his course student will have the basic knowledge of vibrations and aeroelasticity. He will be able to recognize various vibration and aeroelastic phenomena and implement adequate methods of analysis. He will be familiar with industrial methods of vibration and aeroelastic analysis.

Grading criteria:

Assessment based on classroom test.
Practical work:, Laboratory demonstration of forced vibrations and wing flutter.

Detailed contents:

Vibrations in physics and engineering. Models of vibration systems. Natural, free and forced vibrations. Resonance. Nonlinear, parametric, self-excited and stochastic vibrations. Vibrations of continuous systems and aerospace structures. Numerical determination of vibration modes. Ground vibration tests. Models of wing aerodynamics. Models of unsteady aerodynamics. Computational methods of unsteady

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aerodynamics. Aeroelastic phenomena in aviation. Critical velocity. Static and dynamics aeroelastic phenomena. Models of aeroelastic phenomena . Properties of flutter. Computational methods of flutter analysis. Methods of flutter suppression. Aeroelasticity of helicopters. Flutter tests. Aeroelasticity in aviation regulations. Modern aeroelastic analysis.