Faculty of Mechanical Engineering and Mechatronics

WEST POMERANIAN UNIVERSITY OF TECHNOLOGY
IN SZCZECIN, POLAND

THE OFFER FOR INTERNATIONAL STUDENTS
FOR THE YEAR 2023/2024
FIRST AND SECOND DEGREE

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
1	Advanced material technologies in hydrogen vehicle production	Alexander Balitskii	winter/summer	4	45
2	Alternative hydrogen fuels for transportation and energetic	Alexander Balitskii	winter/summer	3	30
3	Basics of control theory for linear systems	Andrzej Bodnar	winter/summer	5	60
4	Basics of Mechanical Engineering Technology	Janusz Cieloszyk	winter/summer	5	60
5	Basics of technology manufacturing molds and dies	Janusz Cieloszyk	winter/summer	5	60
6	Biomass energy	Anna Majchrzycka	winter/summer	3	30
7	Communicating in Science and Engineering	Janusz Typek	winter/summer	3	30
8	Computer simulation of machines and processes	Andrzej Bodnar	winter/summer	4	45
9	Corrosion protection	Paweł Figiel	winter/summer	5	60
10	Critical thinking	Janusz Typek	winter/summer	3	30
11	Dimensional analysis, scaling and modeling for engineers	Janusz Typek	winter/summer	3	30
12	Elastomeric materials	Anna Szymczyk	winter/summer	5	60
13	Electrical engineering	Andrzej Bodnar	winter/summer	5	60
14	Electric drives	Andrzej Bodnar	winter/summer	4	45
15	Electronics-devices, circuits and applications	Andrzej Bodnar	winter/summer	4	45
16	Elements of reliability	Andrzej Bodnar	winter/summer	3	45
17	Energy Storage	Aleksandra Borsukiewicz	winter/summer	3	30
18	Engineering Graphics	Jacek Zapłata	winter/summer	3	45
19	Fault detection and diagnosis in engineering systems	Andrzej Bodnar	winter/summer	4	45
20	Fluid mechanics	Kamil Urbanowicz	winter/summer	4	45
21	Functional materials	Janusz Typek	winter/summer	5	60
22	Heat transfer	Anna Majchrzycka	winter/summer	4	60
23	Industrial controls	Andrzej Bodnar	winter/summer	4	45
24	Introduction to mechatronics	Andrzej Bodnar	winter/summer	3	30
25	Introduction to polymer technology	Sandra Paszkiewicz	winter/summer	3	30
26	IT Technology in business	Bolesław Fabisiak	winter/summer	5	60
27	Manufacturing techniques	Małgorzata Garbiak	winter/summer	5	60
28	Measurements and industrial instrumentation	Andrzej Bodnar	winter/summer	4	45
29	Measurement Uncertainty: Methods and Applications	Janusz Typek	winter/summer	3	30

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
30	Metal and ceramic composites	Agnieszka Kochmańska	winter/summer	3	30
31	Metallic Materials	Małgorzata Garbiak	winter/summer	5	60
32	Metal machining	Janusz Cieloszyk	winter/summer	6	90
33	Modeling and Simulation of Manufacturing Systems	Andrzej Jardzioch	winter/summer	5	60
34	Modern materials for hydrogen and nuclear energetics	Alexander Balitskii	winter/summer	4	45
35	Modern processes in manufacturing	Janusz Cieloszyk	winter/summer	4	45
36	Modern welding	Adam Sajek	winter/summer	4	45
37	Monitoring of machine tools and machining processes	Andrzej Bodnar	winter/summer	4	45
38	Nanomaterials	Magdalena Kwiatkowska	winter/summer	3	30
39	Numerical methods in technical computing	Andrzej Bodnar	winter/summer	4	45
40	Physics of renewable energy sources	Janusz Typek	winter/summer	4	45
41	Polymer Processing	Magdalena Kwiatkowska	winter/summer	4	45
42	Power Generation Technologies	Aleksandra Borsukiewicz	winter/summer	4	45
43	Pumps, Fans and Compressors	Zbigniew Zapałowicz	winter/summer	3	45
44	Recycling	Sandra Paszkiewicz	winter/summer	2	15
45	Renewable energy sources	Aleksandra Borsukiewicz	winter/summer	4	45
46	Solar energy	Zbigniew Zapałowicz	winter/summer	4	60
47	Statistics	Marcin Chodźko	winter/summer	4	60
48	Steam and Gas Turbines	Zbigniew Zapałowicz	winter/summer	3	45
49	Surface engineering	Jolanta Baranowska	winter/summer	5	60
50	Sustainable materials	Anna Szymczyk	winter/summer	3	30
51	Thermodynamics	Anna Majchrzycka	winter/summer	4	60
52	Tools in machining processes	Janusz Cieloszyk	winter/summer	5	60

Course title	Advanced material technologies in hydrogen vehicle production		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Alexander Balitskii	**E-mail address to the person**	Aleksander.Balicki@zut.edu.pl
Course code (if applicable)	WIMiM-1-52	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	polish
Hours per week	3	**Hours per semester**	45
Objectives of the course	Basic properties of engineering materials used in the designed, construction of modern hydrogen vehicles. The concept of material structure and its relationship with the properties of materials in permanent operation in traditional fuels and in hydrogen. Metal materials, plastics, composites, used in hydrogen car construction and their main properties. Light weight and durable materials. Intelligent materials for self-renovation. Nanosteels, nanofilters, solar batteries. Fuel additives and solid hydrogen-containing solid, liquid, gaseous lubricants intended for operation in hydrogen and vacuum. Elements of nanotechnology that significantly increase the performance characteristics of existing and newly designed hydrogen cars. Classification of modern structural materials. Characteristics of materials properties - their influence and role in design; the concepts of anisotropy, advanced electroslag remelting steel technology, welded joints, residual stresses. Structural design problems with regard to fatigue strength and impact, deformation and cracking of metals under the influence of hydrogen.		
Entry requirements	Fundamentals of thermodynamics, fundamentals of physics and chemistry recommended.		
Course contents	The objective of the course is to give the student knowledge on modern materials for “green” technologies in hydrogen vehicle building, properties of hydrogen resistant materials. Getting to know the theoretical basis of the properties of engineering materials used in the construction of modern hydrogen vehicles. Getting to know the theoretical foundations regarding the possibility of using modern metals, plastics, composites used in hydrogen vehicle technology. Getting to know the theoretical basis of the application of the so-called intelligent and renewable materials and nanotechnology elements in hydrogen vehicle technology. Getting to know the theoretical foundations regarding the possibility of using modern additives for conventional and unconventional fuels as well as solid lubricants intended for operation in hydrogen and vacuum. Upon successful completion of this course the student also has knowledge on modern materials for “green” hydrogen energetics ang future energy production: student is able to solve practical problems concerned with new generation of energy technologies (hydrogen buffer) for improved environmental performance and develop a system solution stabilizing the operation of electricity distribution networks. The assumption is to explain the differences in the selection of materials and the design of structures, including super alloys and nanocomposites. The aim of the course is to prepare students for literary studies, diagnosis and assessment problems, identifying and analyzing the observed phenomena, especially those with which the graduate will have to deal with making in practice, drawing the right conclusions, actively using the knowledge acquired during the studies and using it in application to practice or theoretical inference, conducting a logical course of arguments, independently solve specific diagnostic or design tasks, use clear and precise language		
Assessment methods	Informative lecture with audio-visual resources. End – of – term presentation. Material prepared by the students to discuss selected topics presented at lectures and their activity during the lecture. Written test.		
Recommended readings	1. Merkisz J., Pielcha I.,, Alternative vehicle drives, Publishing House of the Poznań University of Technology, Poznań University of Technology, Poznań, 2006 2. Sam Zhang, Dongliang Zhao, Aerospace Materials Handbook. Series in Advances in Materials Science and Engineering, CRC Press.-Taylor & Francis Group., New York., 2012		
Knowledge	The student has knowledge of the basics of modern materials engineering related to the specificity of hydrogen vehicle technology, basic possibilities of using various types of modern, intelligent and renewable materials and elements of nanotechnology in the field of hydrogen transport, modern environmentally friendly additives for hydrogen containing fuels and solid lubricants in the area of vehicle operation transportation.		
Skills	The student has skills in the basics of modern material engineering related to the specificity of vehicle technology, basic possibilities of using various types of modern, intelligent and renewable materials and elements of nanotechnology in the field of transport, - modern environmentally friendly additives for fuels and solid lubricants in the area of vehicle operation transportation.		
Other social competences	Students can effectively work in a team.		

Course title	Alternative hydrogen fuels for transportation and energetic		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Alexander Balitskii	**E-mail address to the person**	Aleksander.Balicki@zut.edu.pl
Course code (if applicable)	WIMiM-1-51	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The objective of the course is to give the student knowledge on alternative hydrogen fuels for transportation, energy industry, methods of “green” hydrogen production, properties of hydrogen resistant materials, environmental pollution . Upon successful completion of this course the student has knowledge on hydrogen fuels for transportation, energy production. Student is able to solve practical problems concerned with application of hydrogen fuels, hydrogen resistant materials in modern vehicle, energy technologies for improved environmental performance.		
Entry requirements	Basics of physics		
Course contents	Introduction to energy storage devices (ESDs) for the transport, energy sector. Classification of batteries for the private and public transport, installation of hydrogen buffer with intention of utilizing hydrogen. Nickel metal hydride (NiMH) batteries for the transport. Lithium-ion (Li-ion) batteries for the transport. Hydrogen and fuel cells for the transport and energy sector. Current hydrogen distribution methods. Fuel cells for the transport. Hydrogen and fuel cell challenges. Electrochemical capacitors (ECs). Current status of low-carbon vehicle technologies. Conventional internal combustion engine (ICE) vehicles. Advantages of HEV (hybrid vehicle). Battery electric vehicles (BEVs). Future developments of fuel cell electric vehicles (FCEVs). Proton exchange membrane (PEM) fuel cell stack. Hydrogen as fuel for fuel cell hybrids. Example of hybrid battery FCEV. Future developments and comparisons with BEVs. Technical prospects barriers. Durability and degradation of structural materials in hydrogen. Energy and power density of hydrogen as fuel. Explosions and improving the safety of hydrogen-powered vehicles tanks (pressure vessels).		
Assessment methods	Informative lecture with audio-visual resources. End – of – term presentation. Material prepared by the students to discuss selected topics presented at lectures and their activity during the lecture. Written test.		
Recommended readings	1. Richard Folkson, Alternative fuels and advanced vehicle technologies for improved environmental performance, Published by Woodhead Ltd. (Publishing Series in Energy), 2014 2. Brian Somerday, Petros Sofronis, Russell Jones, Effects of Hydrogen on Materials, Published by ASM International, Materials Park, Ohio (Printed in the USA), 2009 3. Pollet B.G., I.Staffell, J.L.Shang, V.Molkov, Fuel-cell (hydrogen) electric hybrid vehicles.- In: Alternative fuels and advanced vehicle technologies for impropved environmental performance, Published by Woodhead Ltd. (Publishing Series in Energy), 2011 4. Richard P.Gangloff and Brian P. Somerday, Gaseous hydrogen embrittlement of materials in energy technologies, Published by Woodhead Ltd., 2012		
Knowledge	Students knows the basic materials used in the construction of hydrogen vehicles, hydrogen turbines, knows their properties, and knows the principles of their selection in the elements and functional parts of transport end energetic devices with zero carbon emission.		
Skills	Can assess the suitability of materials for the construction of hydrogen vehicle, hydrogen buffer and make the right choice according to known criteria.Students knows the basic materials used in the construction of hydrogen vehicles, energetic installations, knows their properties, and knows the principles of their selection in the elements and functional parts of hydrogen vehicle and energetic parts, resistant to hydrogen embrittlement. Can assess the suitability of materials for the construction of a hydrogen vehicle, hydrogen buffer and make the right choice according to known criteria.		
Other social competences	Students can effectively work in a team.		

Course title	Basics of control theory for linear systems		
Level of course	first and second cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-03	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The lecture gives basic knowledge on linear control systems theory. Student has basic knowledge about elements of linear control systems – their description and characteristics, knows methods used for the system analysis and its quality assessmen, knows basic rules of linear control system design. Exercises and laboratory help students to apply and deepen their knowledge on solving practical problems. Student is able to carry out analysis of a linear control system, can interpret transfer functions and frequency characteristics, find stability margins and tune controllers. Student can work effectively in a group.		
Entry requirements	Basics of physics, differentiation, integration.		
Course contents	Determination of an equivalent transfer function of a complex control system. Finding system response to impulse and step. Finding steady-state system response to harmonic excitation. Determination of control error. Using stability criteria for assessing limits of stability. Calculation of stability margins. Choosing controler settings. Determination of transfer functions and different characteristics of real systems. Finding response to a given signal. Checking stability conditions. Simulation of control system with the help of Matlab - Simulink. Mathematical models. Closed loop systems. System transfer function. Block diagrams. Pulse and step response. Frequency response and frequency bandwidth. Characteristics of basic elements and elementary control systems. Static errors and disturbance propagation. Stability criteria. Roots on s-plane. Performance specification. Basics of linear control system design; PID controller. MIMO systems. State variables. Controllability and observability. Dynamical observers. Robustness. Dealing with nonlinearities.		
Assessment methods	Lecture, laboratory and workshop. Observation of students work and cooperation in the group (laboratories Two term-time written tests. Laboratory reports. Written exam. Observation of students work and cooperation in the group (laboratories).		
Recommended readings	1. Clarence W. de Silva, Modeling and control of engineering systems., CRC Press/Taylor & Francis Group., Boca Raton, 2009		
Knowledge	Student has basic knowledge on linear control systems theory, on the description and characteristics of basic elements of control systems. Knows methods used for the system analysis, testing and its quality assessment. Knows basic rules of linear control system design.		
Skills	Students can apply their knowledge when solving practical problems on control - analysis, simulation, testing and design of simple systems.		
Other social competences	Students can effectively work in a team.		

Course title	Basics of Mechanical Engineering Technology		
Level of course	first and second cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Janusz Cieloszyk	**E-mail address to the person**	Janusz.Cieloszyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-05	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The engineering project course requires students to define, plan, and complete a mechanical engineering technology project and then to report on their work. This project may involve design, selection, test, process development, and feasibility study or problem analysis in a mechanical engineering technology context. Proposals for other types of mechanical engineering projects may be considered.		
Entry requirements	metal machining		
Course contents	Analysis of selected methods to setup and fixings of machine parts Experimental verification of deviations setup and fixings of machine parts Research effort Standardization of time selected technological operations Produce complex job: 1. Sketch the production drawing of the part. Part should include shaping, milling, drilling, taping, boring, slotting, surface grinding, etc. 2. Outline the processes. Prepare process plan for the part. 3. Prepare workshop layout and route sheet. 4. Produce the part, Calculate/select, set, observe and record the cutting parameters for each process. 5. List the cutting tools you have used. Also state specifications of each. 6 List the work holding devices you have used. Also state specifications of each. Classification of Manufacturing Process: Importance and perspective of machining process, Schematic.Representation of machining system, Different types of motions to generate different shapes. Manufacturing Technology, manufacturing process of typical products, process planning. Technological data base. Positioning and clamping, clamping devices. Tolerances,. Economics and cycle times. Work flow and flexible manufacturing. Integrated design and manufacturing. Knowledge of an advanced CAD/CAM package and an understanding of the principles and techniques of computer-driven manufacturing systems during typical part products. CNC Machines: Configuration, co-ordinate systems, machine referencing, tool changing. CNC Programming: ISO standards, Manual Data Input, Conversational, Computer-Aided Part Programming. Introduction to CAD/CAM. Write based programs for component: turning, milling parts manufacture on a CNC milling machine		
Assessment methods	Lectures, reading assignments, projects, discussions, video presentations, multimedia presentations, and web content Student attendance and participation in class sessions play a vital role in successful course completion. Students will be expected to complete written tests, projects, and homework assignments as specified by the teacher		
Recommended readings	1. Balic J.:, Contribution to Integrated Manufacturing, Vienna, 1999, Vienna, 1999 2. F. C. Jelen and J. H. Black, McGraw Hill Int., Cost and Optimization Engineering,, McGraw Hill Int., 2011 3. Grzesik W., Advanced Machining Processes of Metallic Materials,, Elsevier, 2008 4. Shaw M. C.,, Metal Cutting Principles,, Oxford Univ. Press., Oxford, 1996 5. Modern Metal Cutting,, AB Sandvik Coromant 1994, Sandviken, Sweden, 1994		
Knowledge	Upon successful completion of this course, the student will be competent to perform the following: • Understand various terminologies associated with the technological process • Recognize major types of technological process • Designing technological processes of simple parts, e.g. a shaft, body or disc parts • Prepare and read the documntation of the technological process of the selected part		
Skills	Designs the manufacturing processes for typical parts, eg roller, wheel, gear, body, disc Evaluate the technology of the element's construction		
Other social competences	It will assess the relationship between the costs and features of any parts and the technology for their production. He will apply and evaluate pre-requisite technological processes for the manufacture of any products in the machine industry. Understand the importance and conditioning of technology process in creating any products in the machine industry.		

Course title	Basics of technology manufacturing molds and dies		
Level of course	first and second cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Janusz Cieloszyk	**E-mail address to the person**	Janusz.Cieloszyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-04	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The course requires students to define, plan, and complete a mechanical engineering technology of modles an dies and then to report on their work. This project may involve design, selection, test, process development, and feasibility study or problem analysis in a machining of modles an dies context.		
Entry requirements	metal machining, basis of mechanical engineering technology		
Course contents	EDM machining in the manufacture of molds and dies Machining tools for EDM molds and dies Milling processes in machining of molds and dies Finishing processes in machining of parts of molds and dies Generating a machining program selected part of molds or dies Methods for machining of corners & cavities in machining molds and dies Control and measuring selected part of mold or die Produce complex job: 1. Sketch the production drawing of the die or mould. Part should include shaping, milling, drilling, taping, boring, slotting, surface grinding, etc. 2. Outline the processes. Prepare process plan for the die or mould. 3. Prepare workshop layout and route sheet. 4. Produce the the die or mould. Calculate/select, set, observe and record the cutting parameters for each process. 5. List the cutting tools you have used. Also state specifications of each. 6 List the work holding devices you have used. Also state specifications of each. Manufacturing Technology, manufacturing process of die and mould products, process planning. Technological data base. Positioning and clamping, clamping devices. Tolerances, Classification of Manufacturing Process: Importance and perspective of machining process of die and mould products, Schematic.Representation of machining system, Different types of motions to generate different shapes. Manufacturing Technology, manufacturing process of die and mould, process planning. Technological data base. Positioning and clamping, clamping devices. Tolerances,. Economics and cycle times. Work flow and flexible manufacturing. Integrated design and manufacturing. Knowledge of an advanced CAD/CAM package and an understanding of the principles and techniques of computer-driven manufacturing systems during typical die and mould products. CNC Machines: Configuration, co-ordinate systems, machine referencing, tool changing. CNC Programming: ISO standards, Manual Data Input, Conversational, Computer-Aided Part Programming. Introduction to CAD/CAM. Write based programs for component of die and mould: turning, milling parts manufacture on a CNC milling machine		
Assessment methods	Lectures, reading assignments, projects, discussions, video presentations, multimedia presentations, and web content Student attendance and participation in class sessions play a vital role in successful course completion. Students will be expected to complete written tests, projects, and homework assignments as specified by the teacher		
Recommended readings	1. Application Guide, Application Guide :Die & Mould Making,, Sandvik Cormoant, Sandvik Cormoant, 2005 2. High speed machining and conventional die and mould machining, Sandvik Cormoant, Sandviken, 2005 3. Y. Koren,, Computer Control of Manufacturing Systems, McGraw-Hill, 2011 4. F. W. Wilson,, Numerical Control in Manufacturing, McGraw-Hill Book Company New York., 2011		
Knowledge	Upon successful completion of this course, the student will be competent to perform the following: • Understand various terminologies associated with the manufacturing process of die and mould, process planning. • Recognize major types of manufacturing process of die and mould, process planning. • Design the technological process of die and mould, process planning.		
Skills	Designs the manufacturing processes for typical molds and die Uses methods of machining and assembly, conditions for their implementation in the case of typical molds and dies Selects elements of the MTHW system (machine tool, holder, tool, object) for transitions, operations in various manufacturing methods od molds and dies		
Other social competences	It will assess the relationship between the costs and features of any die and mould products, and the techniques for their production. He will apply and evaluate pre-requisite technological processes for the manufacture of any of die and mould products. Understand the importance and conditioning of manufacturing techniques in the process of creating any die and mould.		

Course title	Biomass energy		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Anna Majchrzycka	**E-mail address to the person**	Anna.Majchrzycka@zut.edu.pl
Course code (if applicable)	WIMiM-1-06	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	On successfull completion of this module the students should be able to : define biomass and biomass characteristics,explain methods of biomass conversion (gasification, pyrolysis, anaerobic digestion),explain methods of production of liquid and solid biofuels, explain principles of operation of biomass conversion installations,calculations concerning problems of biomass combustion,understand production of biopower (combine heat and power production) explain principles of operation of biomass combustion and co-firing installations.		
Entry requirements	Fundamentals of mathematics, physics, chemistry recommended		
Course contents	Biomass and its characteristics. Different methods of biomass conversion Biopower (industrial combustion of biomass, co-firing, CHP systems)		
Assessment methods	Lecture ,PPT presentation Written examination		
Recommended readings	1. Côté, Wilfred A- Biomass utilization, ed.Wilfred A. Côté ; North Atlantic Treaty Organization. Scientific, 1983 2. Higman Chris; van der Burgt Maarten, Gasification, Elsevier, 2003 3. Klass Donald L, Fuels from biomass and wastes Donald L. Klass, George H. Emert,1981, Donald L. Klass, George H. Emert, 1981 4. Overend, R.P.- Fundamentals of thermochemical biomass conversion ,, ed. R.P.Overend, T.A. Milne, L.K. Mudg, 1985		
Knowledge	Student has knowledge on: biomass and its properties, methods of biomass conversion (gasification, pyrolysis, anaerobic digestion), methods of liquid, gaseous and solid biofuels production, principles of operation of biomass conversion installations,calculations of biomass combustion, production of biopower (combine heat and power production), principles of operation of biomass combustion and co-firing installations.		
Skills	On successfull completion of this module the students should be able to use methods of thermochemical conversion of biomass. and solve the practical problems in the field of bio-energy production.		
Other social competences	Student is aware of the importance and understanding of the effects and results of engineering activities of biomass conversion.		

Course title	Communicating in Science and Engineering		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Janusz Typek	**E-mail address to the person**	Janusz.Typek@zut.edu.pl
Course code (if applicable)	WIMiM-1-09	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The course will teach how to use English to carry out everyday activities at university, such as understanding English language science books, how to write a lab report, emails, how to prepare a presentation. The student will have the ability to write lab report and prepare presentation. The student will be able to work in a group in preparation of project work.		
Entry requirements	Basics of English teached as a foreign language in the first and second year of university study.		
Course contents	A review of basic notions in mathematics, physics and chemistry. Reading mathematical expressions. English used in presenting characteristics of materials (metals, ceramics, polymers, composites, advanced materials). Preparing lab reports. Preparing and delivering seminar and presentation. Writing a research paper. English for scientific correspondence and socializing. Final test. Presentation of project work.		
Assessment methods	Lecture Discussion Seminar Final test Project work Continuous assessment		
Recommended readings	1. Iris Eisenbach, English for Materials Science and Engineering, Vieweg+Teubner Verlag | Springer Fachmedien, Wiesbaden, 2011 2. Heather Silyn-Roberts, Writing for Science and Engineering, Butterworth-Heinemann, 2002		
Knowledge	The student will have the knowlegde to use English to carry out everyday activities at university, such as understanding English language science books, will known how to prepare lab reports, how to prepare a scientific presentation		
Skills	Student will be able to write lab report and prepare presentation on a given scientific subject.		
Other social competences	Will be able to work in a group to prepare presentation or project work		

Course title	Computer simulation of machines and processes		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-10	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives basic knowledge on methods of description, modeling and simulation of mechanical and mechatronic systems as well as production processes. Laboratory exercises enable to apply selected methods of the theory in practice. Upon successful completion of this course the student should be able to prepare data, build models and carry out computer simulations of mechatronic systems and typical production processes, can analyze and interpret results. Student can effectively cooperate in a team.		
Entry requirements	Basic knowledge on differential equations recommended.		
Course contents	Modeling of systems with friction, with heat sources and heat transfer, electromagnetic actuators, electric motors and drives, hydraulic systems. Application of MATLAB tools for control system simulation. Simulation of production processes using Em-Plant. Introduction to computer simulation – areas of application, basic problems, advantages. Main stages of computer simulation. Physical and mathematical models of simple dynamic systems. Model simplification, linearization, scale effect. Simulation constants and variables, inputs and outputs. Process description, system design, prediction of behavior in different conditions. Modeling of mechanical structures – modal analysis, eigenvalues and vibration modes. Modeling of systems with friction, systems with heat sources and heat transfer, actuators, electromagnetic actuators, electric motors and drives, hydraulic systems. Simulation accuracy and stability.		
Assessment methods	Lecture and laboratory. One written test. Laboratory reports. Observation of students's work in the team.		
Recommended readings	1. Giurgiutiu V., Lyshevski S.E., Micromechatronics, Modeling, analysis and design with MATLAB, CRC Press, Boca Raton, London, New York, 2009, 2 2. Clearence W.S.:, Modelling and control of engineering systems., CRC Press, Boca Raton, 2009		
Knowledge	Students have basic knowledge on methods of description, modeling and simulation of mechanical and mechatronic systems as well as production processes.		
Skills	Upon successful completion of this course the student should be able to prepare data and models and carry out computer simulations of mechatronic systems and typical production processes.		
Other social competences	Students can effectively work in a team.		

Course title	Corrosion protection		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paweł Figiel	**E-mail address to the person**	Pawel.Figiel@zut.edu.pl
Course code (if applicable)	WIMiM-1-11	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Making students knowledge and understanding about corrosion phenomenon in order to appreciation of the main reason of the destruction and erosion of the constructions and in order to aware using of the methods in corrosion protection; skills in materials selection for application to work in difficult conditions, and selection of corrosion protection methods.		
Entry requirements	Knowledge about general chemistry, physics and materials science. Basic knowledge of the chemical composition, structure, materials and physicochemical changes.		
Course contents	Galvanic cell-polarization phenomenon. High temperature corrosion. Pitting corrosion. Potentiodynamic curves - corrosion properties test of steels and alloys. Salt spary test - SST. Galvanic corrosion – welding joint. Electrochemical etching. Corrosion principles. Forms of corrosion. Corrosion testing. Metods of corrosion prevention and protection. Materials selection: metals and alloys, metal purification, non-metallic materials. Alteration of environment: changing medium, inhibitors. Design: wall thickness, design rules. Cathodic and anodic protection: protective currents, anode selection, prevention of stray-current effects. Coatings: metallic, other inorganic and organic. Economic considerations. Corrosion control standards. Pollution control.		
Assessment methods	Informative lecture with audiovisual aids, ie. educational movies, computer presentations . Experimental tests in laboratory. Laboratory: On the basis of student reports grade is received . Lecture. After completion of the reports the student proceeds to pass a written exam and receive a passing grade.		
Recommended readings	1. M.G.Fontana, N.D. Greene, Corrosion Engineering, Ed.McGraw-Hill Book Company, USA, 1978 2. Alec Groysman, Corrosion for everybody, Springer, Dordrecht, London, Heidelberg, New York,, 2010 3. Ph.Marcus, F.Mansfeld, Analytical Methods in Corrosion Science and Engineering, CRC Taylor & Francis Group, 2006		
Knowledge	Student has knowledge and understanding about corrosion phenomenon in order to appreciation of the main reason of the destruction and erosion of the constructions and in order to aware using of the methods in corrosion protection.		
Skills	Student has skills in materials selection for application to work in difficult conditions, prevention uring design of the constructions, and selection of corrosion protection methods.		
Other social competences	Student has awareness of environmental and economical impacts of corrosion.		

Course title	Critical thinking		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Janusz Typek	**E-mail address to the person**	Janusz.Typek@zut.edu.pl
Course code (if applicable)	WIMiM-1-12	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	To increase the ability to reason well and to improve the analytical skills. Students will be able to use elementary methods of building strong arguments. Student will be able to understand the essential principles involved in the practice of reasoned decision making. Student will be able to work in agroup and engage in discussion.		
Entry requirements	No prerequisites required.		
Course contents	Reasoning from evidence: Fallacies and logic; Truth, knowledge and belief; Identifying flaws in the argument Inductive and deductive reasoning Evaluating sources of evidence Scientific method and critical reasoning		
Assessment methods	Lecture Discussion Presentation Oral presentation Essay Continuous assessment		
Recommended readings	1. T. Bowell and G. Kemp, Critical thinking: A concise guide, Routledge, 2005 2. S. Cottrell, Critical thinking skills, Palgrave Ma cmillan, 2005		
Knowledge	The student will be able to: recognise the arguments of specialist authors; locate arguments in key texts; recognise the difference between critical analysis and other kinds of writing (e.g. description).		
Skills	The student will be able to: engage with the arguments used by both experts and their peers; produce better critical analytical writing of their own for marked assignments.		
Other social competences	Student will be able to work in a group and be involved in discussion.		

Course title	Dimensional analysis, scaling and modeling for engineers		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Janusz Typek	**E-mail address to the person**	Janusz.Typek@zut.edu.pl
Course code (if applicable)	WIMiM-1-13	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	polish
Hours per week	2	**Hours per semester**	30
Objectives of the course	To gain knowledgeabout dimensional analysis, scaling and modelling. To be able to use dimensional analysis, scalling and modelling in engineering applications. To be able to work in a group.		
Entry requirements	General knowledge of physics and mathematics.		
Course contents	Basic and derived units of measurements. Scales of units and conversion between different systems of units. Dimensions and dimensional consistency of equations. Dimensionless quantities, equations and relationships. Buckingham's Pi Theorem. Forming dimensionless relationships, writing governing equations in terms of dimensionless variables. Similarity and model testing Use of Dimensional Analysis to design experiments and present experimental data. Projects and final test		
Assessment methods	Lecture Discussion Seminar Final test Continuoes assessment Project work		
Recommended readings	1. T. Szirtes, Dimensional analysis and modelling, Elsevier, 2007 2. J. Kunes, Similarity and modelling in science and engineering, Springer, 2012		
Knowledge	The student will have the knowlegde about dimensional analysis and modelling in simple experimental situations		
Skills	Student will be able to apply the obtained knowledge in simple experimental situations and use it in simple modelling.		
Other social competences	Student will be able to work in a group to prepare presentation or project work.		

Course title	Elastomeric materials		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Anna Szymczyk	**E-mail address to the person**	Anna.Szymczyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-37	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student will acquire knowledge about chemistry, technology and processing of rubber and TPE. Student will be able to compare the chemical structure, properties, compounding, processes and applications of the main types of rubber TPE. Reference is made to the place of TPEs relative to vulcanised rubber and thermoplastics and the future potential for these materials. Developing the ability of the study and analyses of received results and estimating of uncertainty in measurement in the application for conducted laboratory tests. Developing the ability of applying of selected knowledge from the lectures for solving problems in practice.		
Entry requirements	There is no specific entry requirement for these course.		
Course contents	Training in rubber compounding, establishing of curing parameters, processing and testing of rubber. Visit in rubber company. Synthesis of polyester thermoplastic elastomer. Injection moulding processes training for polyester TPE. Testing of hardness and mechanical properties of polyester TPE. Elastomers: definition, type of elastomer materials and their application, rubber elasticity: stress-strain relationships, elongation and compression set. Rubber compound: polymer, cursing system, fillers, plasticizers, antioxidants. Type of rubbers. Rubber vulcanization: chemistry and technology. Rubber processing. Rubber for food application. Thermoplastic elastomers (TPE): Types of thermoplastic elastomers. TPE-S, TPE-O, TPE-A, TPE-E, TPE-U, TPE-V. Applications of TPE. Processing methods applicable to TPE. Recycling of TPE. Bio-based thermoplastic elasomers. Elastomeric nanocomposites.		
Assessment methods	Informative lecture with audio-visual resources Laboratory training Test Material prepared by the students to discuss selected topics presented at lectures and their activity during the lecture. On the basis of elaborated laboratory reports the student receives a final grade.		
Recommended readings	1. Mark J.E., Erman B., Erlich F.R.,, The Science and Technology of Rubber, Elsevier, Amsterdam 2005, Elsevier, Amsterdam, 2005 2. Holden G., Kilcherdorf H.R., Quirk R.P.,, Thermoplastic Elastomers, 3rd Ed, Hanser Publishers, Munich, 2004 3. Sabu T., Ranimol S., Rubber Nanocomposites: Preparation, Properties and Applications, John Wiley & Sons, Canada, 2010		
Knowledge	Student will aquire knowladge about chemistry, technolgy and processing of rubber.		
Skills	As a result of the course the student will be able to solve the problems regarding applications and processing of rubber and thermoplastic elastomers.		
Other social competences	The student wiill have proven ability to use knowledge, skills and personal competences in the field of rubber materials.		

Course title	Electrical engineering		
Level of course	first and second cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-14	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student has knowledge on DC and AC network analysis and testing, know priciples of working of electric machines Students should be able to solve typical problems connected with calculation of currents and power ain DC and AC networks, apply basic laws in electricity and magnetism, select and use measuring instruments. Students can effectively cooperate in a team.		
Entry requirements	Finished course on physics recommended.		
Course contents	Charging of circuits with capacitors - voltage, charge. Simple DC nets and application of basic network theorems and solving methods. Equivalent Thevenin and Norton sources. Sinusoidal and phasor representation of voltage and current in a single phase AC circuit. AC network analysis with the help of complex numbers. Equivalent resistance, T-Y connections, voltage and current dividers. Combination of R, L and C in series and parallel. Resonance. Power calculations in AC circuits: instantaneous power, power factor, apparent power, reactive power, power triangle, power factor. Three-phase AC nets: line and phase voltage/current relationship for star and delta connections. Balanced three phase voltages and unbalanced impedances. Power losses and voltage drops in tansmission lines and cables. Analysis of two-terminal two-port and multi-port circuits. DC and AC network examination. Connecting circuits according to a schematic and performing measurements: measurements in AC/DC circuits current, RLC resonance, mutual- and self- inductance, hysteresis in magnetic circuits, transformer, transient states in DC circuits. Basic electrical quantities and their units. Electric field. Capacitor. Potential and potential difference, electromotive force, current and resistance. Basic network theorems. Equivalent Thevenin and Norton sources. Step response. Sinusoidal and phasor representation of voltage and current. Single phase AC circuit. Circuit analysis in DC and AC steady-state. Network analysis with the help of complex numbers. Equivalent resistance, T-Y connections, voltage and current dividers. Combination of R, L and C in series and parallel. Resonance. Power relations in AC circuits: instantaneous power, power factor, apparent power, reactive power, power triangle, complex power. Power factor correction. Magnetic field. Lenz' Law. Coupled circuits. Transformer: principle of operation and construction of single-phase transformer, phasor diagram and equivalent circuits, losses, efficiency and voltage regulation, nonlinearity. Three-phase AC circuits: line and phase voltage/current relationship for star and delta connections. Balanced three phase voltages and unbalanced impedances. Transmission lines: parameters, steady-state performance of overhead transmission lines and cables, voltage drops. Analysis of two-terminal two-port and multi-port circuits. Measurements in DC and AC circuits.		
Assessment methods	Lecture, exercises and laboratory Written exam and laboratory reports. Two term-time tests. Observation of student's work in a team.		
Recommended readings	1. Del Toro V., Principle of Electrical Engineering, PHI, 2018 2. Nagrath I. J., Basic Electrical Engineering, Tata Mc Graw Hill., 2001		
Knowledge	Students have basic knowledge on DC and AC network analysis and testing.		
Skills	Students can test and analyze DC and AC networks.		
Other social competences	Studants can cooperate in teams.		

Course title	Electric drives		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-15	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The course gives basic knowledge on drives equipped with electrical motors (motors and their control systems – rules of functioning and technical solutions, selection of the motor and the drive controller). Students get practical experience in drive modelling, basic design calculations and measurements. Students can effectively work in a team.		
Entry requirements	Physics recommended. Finished courses on “electrical engineering” and “fundamentals of control systems”.		
Course contents	Servo-drive testing. Drive efficiency and power losses. Testing positioning accuracy. Tool path errors. Stepping motors. Electric drives – basic characteristics, rated values. Fundamental information on DC, AC and stepping motors – types, construction, static and dynamic characteristics, heating, limitations, speed control, acceleration and braking. Servo-drives – structure, transfer functions, dynamic response, control quality, static and dynamic errors. Power units, drive control units – thyrystor controller, PWM converter, vector control, drive safety. Position and displacement measuring systems – encoder, resolver, inductosyn, laser systems. Linear drives – motors, features, technological problems.		
Assessment methods	Lecture and laboratory. Oral exam, test and laboratory reports. Observation of student's work.		
Recommended readings	1. Harter J., Electromechanics. Principles, concepts and devices, Prentice Hall, 2001 2. Rashid M.H., Power electronics, Pearson Ed. – Prentice Hall, London, 2004 3. Paul Krause, Oleg Wasynczuk, Scott D. Sudhoff, Analysis of Electric Machinary and Drive Systems, Wiley Interscience, 2002		
Knowledge	Students have knowledge on working principles, characteristics and properties of drives equipped with electrical motors and their control systems – rules of functioning and technical solutions, motor and controller selection.		
Skills	Students can use information about drive load and elestrical motor data for the motor and controller selection, can carry out simple measurements in the drive, can recognize typical failures.		
Other social competences	Students can cooperate in a team.		

Course title	Electronics-devices, circuits and applications		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-16	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	polish
Hours per week	3	**Hours per semester**	45
Objectives of the course	The course gives basic knowledge on characteristics of electronic elements and their applications (power supplies, amplifiers, generators, logical systems and measuring instruments electronics). Student can analyze simple electronic circuits, can assess properties of electronic devices, can carry out measurements. Student can effectively work in a group.		
Entry requirements	Finished course on physics recommended.		
Course contents	Power supply. Operational amplifier. Function generator. Logical system. ADC. Measuring instruments electronics. Power supplies. Electronic devices used (diodes, thyristors, triacs, transistors, LEDs), voltage and current stabilizers and converters. Examples of IC stabilizers, circuitry of stabilizers and converters. Amplifiers. Transistor as an amplifier, operational amplifiers, instrumentation amplifiers, field effect transistors, power amplifiers, PWM, active filters. Examples of application in measuring instruments and control devices. Generators. Sine and function generators, clock pulse generators, PLL. Applications in radio transmitters and receivers. Electronic switching. Logical gates, flip-flops, time dependent switching, analogue timers. Applications of timing IC's. Digital systems. Registers, counters, adders, ALUs, data storage devices. ADCs and DACs. Basic types, conversion speed and errors. Quantisation noise, aliasing, leakage. Example of an ADC datasheet. Influence of temperature. Heat generation in electronic devices, heat sinks, working point stabilization, thermal noise reduction. Example of a heat-sink calculation.		
Assessment methods	Lecture and laboratory. One written test and laboratory reports. Observation of student's work in a team.		
Recommended readings	1. Forrest M. Mims III, Getting started in electronics, Master Publ. Inc., 2003 2. Bishop O., Electronics. Circuits and systems, Elsevier, Amsterdam, 2011		
Knowledge	Students have knowledge on characteristics of electronic elements and their applications (power supplies, amplifiers, generators, logical systems and measuring instruments electronics).		
Skills	Students understand role of electronic elements in electronic circuits (power supplies, amplifiers, generators, logical systems and measuring instruments electronics), can carry out basic measurements in the circuit and detect main faults.		
Other social competences	Students can cooperate in a team.		

Course title	Elements of reliability		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-17	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives basic theoretical knowledge on methods of description, assessment and testing of reliability and life of components and whole technical systems. Laboratory exercises teach students selected ways of application of the theory in practice. Upon successful completion of this course the student can assess the reliability of simple technical systems. Student can effectively work in a team.		
Entry requirements	Probability theory and statistics recommended.		
Course contents	Calculation of reliability of simple systems in MatLab and Excel. Reliability tuning. Calculation and plotting reliability functions of reparable and redundant CFR systems. Empirical measures of reliability. Reliability and risk functions. Distributions in modeling of life. Serial, parallel and complex systems; the triangle-star transformation. Models of failure. Constant failure rate systems. MTTF. Examples of the reliability assessment. Dispensing reliability between components, system reliability improvement and its costs. Life testing. Reliability data bases. Remarks on reliability of electronic systems and reliability of machine tools and machining processes.		
Assessment methods	Lecture and klaboratory. One written test and laboratory reports. Observation of student's work.		
Recommended readings	1. Grosh D.L., A Primer of Reliability Theory., Wiley, New York, 1989		
Knowledge	Students have theoretical knowledge on methods of description, assessment and testing of reliability and life of components and whole technical systems.		
Skills	Students can apply theoretical knowledge in practce. Upon successful completion of this course the student will know how to assess and increase life and reliability and how to tune reliabilities of elements of technical systems.		
Other social competences	Students are able to cooperate effectively in a team.		

Course title	Energy Storage		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Aleksandra Borsukiewicz	**E-mail address to the person**	Aleksandra.Borsukiewicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-15-Z	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The lecture gives fundamental knowledge about energy storage in large and small-scale energy systems.		
Entry requirements	Physics - level of first degree technical studies, Chemistry - level of first degree technical studies, Mathematics - level of first degree technical studies, Thermodynamics - level of first degree technical studies,		
Course contents	Introduction - why we have to storage energy? Thermal energy storage: sensible heat, latent heat (inorganic and organic phase change materials), reversible chemical reactions; sorption system for cold storage. Mechanical energy storage: energy storage in pressurized gas, potential energy storage using gravity, hydroelectric power (pumped storage technology), kinetic energy storage (flywheel storage technology); Electrochemical energy storage (battery storage technologies); Hydrogen (production and storage); Energy storage from medium to large scale applications. Short and long - term storage. Energy use and storage in vehicles.		
Assessment methods	An informative and problem-oriented lecture Writing control work		
Recommended readings	1. Edited by Luisa F. Cabeza, Advances in Thermal Energy Storage Systems, Woodhead Publishing Series in Energy: Number 66, Elsevier, 2015, Woodhead Publishing Series in Energy: Number 66 2. A.G. Ter-Gazarian, Energy Storage for Power Systems, The Institution of Engineering and Technology, London, United Kingdom, 2011 3. Edited by Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems H a n d b o o k, CRC Press Taylor & Francis Group, 2011		
Knowledge	Student has knowledge about energy storage methods and technologies		
Skills	After successful completing of this course the student should be able to use theoretical knowledge about energy storage methods, in order to estimate the potentials of known technologies and select the most advantageous one.		
Other social competences	Student is aware of importance of energy storage, and understands the effects and possiblilities of energy storage methods.		

Course title	Engineering Graphics		
Level of course	first and second cycle		
Teaching method	project / lecture		
Person responsible for the course	Jacek Zapłata	**E-mail address to the person**	Jacek.Zaplata@zut.edu.pl
Course code (if applicable)	WIMiM-1-52	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The participating students gain knowledge in subject of engineering graphics. The participating students gain ability to create technical drawings. The participating students practice teamwork.		
Entry requirements	The course does not require any previous knowledge. The common knowledge of geometry and trigonometry would be helpful.		
Course contents	Orthographic sketching: first angle projection Pictorial sketching: isometric projection Creating technical drawings of 5 elements (as the students' skills grow - the difficulty of elements increases). Practicing the abilities of drawing: views, sectional views, dimensions, threads. Principles of projection: first angle projection, third angle projection, isometric projection, oblique projection Lines and lettering Types of drawings (component, assembly, detail drawings, graphs) Views, auxiliary views, sectional views Principles of dimensioning and tolerances Intersection of surfaces Presenting threads and welds		
Assessment methods	Lecture, Tutorial, Self-study Regular checking-up of students technical drawings Written end-of-term test		
Recommended readings	1. Thomas E. French, Carles J. Vierck, The fundamentals of engineering drawings & graphic technology, McGraw-Hill Book Company 2. Colin H. Simmons, Dennis E. Maguire, N. Phelps, Manual of Engineering Drawing, Elsevier 3. K. Venkata Reddy, Textbook of Engineering Drawing, BS Publications 4. David A. Madsen, David P. Madsen, Engineering Drawing and design, Delmar Cengage Learning		
Knowledge	Student has knowledge allowing to read and create technical drawings.		
Skills	Student can read technical drawings. Student can make technical drawings of mechanical parts of medium difficulty.		
Other social competences	Student is able to cooperate in team.		

Course title	Fault detection and diagnosis in engineering systems		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-18	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	polish
Hours per week	3	**Hours per semester**	45
Objectives of the course	The course gives basic knowledge on methods used in engineering systems for fault detection and placement. Examples show how diagnostic methods can be used in different machines and processes. Laboratory helps students to get basic experience in application of knowledge obtained during lectures and studying of literature. Students understand methods and are able to identify, formulate, and solve problems connected with diagnosing faults in engineering systems. Students can use various diagnostic techniques and modern instrumentation. Student can effectively work in a team.		
Entry requirements	Basic course on measurements recommended.		
Course contents	Signal processing for finding symptoms of faults. Spectral and cepstral analysis. Finding symptoms hidden in noise. Computerised monitoring system. Failures in drives. Fault detection through modal analysis. Applications of thermography. Evaluation of machine health, reliability, prognosis. Failure diagnostics techniques. Symptoms and their choice. Application of vibration and experimental modal analysis, Fourier and time-frequency transformations, signature analysis, model supported diagnostics. Modulation, sidebands, envelope, cepstrum. Diagnostic experiment planning and preparation, signal processing. Failures in rotating machines and control systems. A/D conversion, signal processing and instrumentation.		
Assessment methods	Lecture and laboratory. Term test and laboratory reports. Observation of student's work.		
Recommended readings	1. Monolakis D.G., Ingle V.K.:, Applied digital signal processing., Cambridge Univ. Press, 2011 2. Randall R.B.:, Vibration-based condition monitoring., Wiley, New York, 2011		
Knowledge	The course gives basic knowledge on methods used in engineering systems for fault detection and placement. Students know how diagnostic methods can be used in different machines and processes.		
Skills	Students have basic experience in application of knowledge obtained during lectures and studying of literature. Students understand methods and are able to identify, formulate, and solve problems connected with diagnosing faults in engineering systems. Students can use various diagnostic techniques and modern instrumentation.		
Other social competences	Students can effectively work in groups. Students undertand the role of continuous widenin and deepening of their knoledge and experiense.		

Course title	Fluid mechanics		
Level of course	first and second cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Kamil Urbanowicz	**E-mail address to the person**	Kamil.Urbanowicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-53	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Fluid Mechanics is course introducing the fundamental principles of fluid mechanics and simple engineering applications. Upon successful completion of this course, the student will understand the fundamentals of fluid mechanics and will have skills to perform calculations of simple practical systems.		
Entry requirements	Elementary mathematics (integrals, partial derivatives), completed Solid mechanics course		
Course contents	Kinematics: streamline, fluid element path, acceleration - calculations in the Euler system Calculation of fluid pressure on flat and curved walls test 1 Bernoulli equation - applications Liquid outflow through holes in tanks, hydrodynamic reactions Calculation of the real liquid flow in pressure lines test 2 Introduction to Fluid Mechanics and basic concepts: fluid element, hydrodynamic field, physical properties of fluids Hydrostatics: pressure field, liquid pressure on vessel walls, buoyancy, etc. Fluid kinematics: streamline, fluid element path, fluid state description methods, fluid element acceleration, local motion of a fluid element: deformation velocity tensor The principle of conservation of mass. Continuity equation The principle of conservation of momentum. Stress tensor The principle of conservation of energy. Closed system of equations Introduction to reology Elements of the ideal fluid theory: Euler equation, Bernoulli equation Elements of the real fluid theory: Navier-Stoke's equation, dynamic similarity of flows Introduction to aerodynamics Summary		
Assessment methods	Informative lecture with audio-visual resources Two control works		
Recommended readings	1. Y.A. Cengel, J.M. Cimbala, Fluid Mechanics: Fundamentals and Applications, McGraw-Hill Education, 2017, 4th edition 2. F.M. White, Fluid mechanics, McGraw-Hill Education, 2017, 8th edition 3. P.K. Kundu, I.M. Cohen, D.R. Dowling, Fluid Mechanics, Academic Press, 2015, 6th edition		
Knowledge	Students who successfully complete this course will have demonstrated an ability to: 1.Know the definitions of fundamental concepts of fluid mechanics including: continuum, velocity field; viscosity, surface tension and pressure (absolute and gage); flow visualization using timelines, path lines, streamlines, and streamlines; flow regimes: laminar, turbulent; 2. Apply the basic equation of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid; to manometers; to the determination of buoyancy and stability; and to fluids in rigid-body motion; 3. Use of conservation laws in differential forms and apply them to determine velocities, pressures and acceleration in a moving fluid. Understand the kinematics of fluid particles, including the concepts of substantive derivatives, local and convective accelerations, vorticity and circulation; 4. Use Euler’s and Bernoulli’s equations and the conservation of mass to determine velocities, pressures, and accelerations for incompressible and inviscid fluids; 5. Understand the concepts of static, thermodynamic, stagnation, total, and dynamic pressures and how they are used in instrumentation; 6. Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters; 7. Determine flow rates, pressure changes, minor and major head losses for viscous flows through pipes, ducts, simple networks and the effects of pumps, fans, and blowers in such systems; 8.Design simple pipe systems to deliver fluids under specified conditions; 9.Understand the concepts of viscous boundary layers and the momentum integral and use them to determine integral thicknesses, wall shear stresses, and skin friction coefficients		
Skills	After successful completing of this curse the students should be able to use the theoretical knowledge about fluid mechanics to solve practical problems in real live and at future work place.		
Other social competences	Students are aware of importance and understanding of the effects and results of engineering activities of Fluid Mechanics		

Course title	Functional materials		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Janusz Typek	**E-mail address to the person**	Janusz.Typek@zut.edu.pl
Course code (if applicable)	WIMiM-1-19	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Knowledge of basic classes of functional and multifunctional materials. Understanding of dependence of their specific properties on their structure. Ability of selection of materials and their structure for given practical applications. To be able to execute and describe lab experiments with functional materials. Student will be able to work in a group.		
Entry requirements	Basic knowledge of solid materials and electromagnetism is expected. Knowledge of condensed matter physics on the level of typical undergraduate course is highly useful but not required.		
Course contents	Introduction to lab experiments and lab reports Lab experiment: ferroelectrics Lab experiment: ferromagnets Lab experiment: piezoelectrics Lab experiment: Magnetic nanomaterials. Presentation of lab reports Electronic structure of materials (band structure in crystalline solids, classification of materials based on their electronic structure). Semiconducting materials (basic properties of semiconductors, transport properties, heterostructures and their applications). Magnetic materials (magnetic ordering, magnetic materials: metals, alloys, ferromagnetic oxides, and compounds, magnetic resonance). Nanomaterials - properties and applications. The final test.		
Assessment methods	Lecture Experiment demonstrations. Lab reports grading. Test grading. Observation of student involvment in group work.		
Recommended readings	1. Klaus D. Sattler (ed.), Handbook of Nanophysics: Functional nanomaterials, CRC Press, 2011 2. F. Duan, J. Guojun, Introduction to Condensed Matter Physics, World Scientific, 2005 3. J. Typek, Laboratory experiments instructions, Web page: www.typjan.zut.edu.pl, Institute of Physics, Szczecin, 2015		
Knowledge	Student will have knowledge of basic classes of functional and multifunctional materials, will understand the dependence of their specific properties on structure.		
Skills	Student will be able to conduct lab experiment and prepare lab report.		
Other social competences	Student is able to work in group.		

Course title	Heat transfer		
Level of course	first and second cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Anna Majchrzycka	**E-mail address to the person**	Anna.Majchrzycka@zut.edu.pl
Course code (if applicable)	WIMiM-1-20	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Heat transfer is course introducing the fundamental principles of heat transfer and simple engineering applications. Upon successful completion of this course, the student will understand the fundamentals of heat transfer and will have skills to perform calculations of heat transfer and heat exchangers.		
Entry requirements	Mathematics, physics, chemistry recommended		
Course contents	Solution of the problems covering the contents of the lectures Basics of heat transfer. Fourier's Law of Heat Conduction, thermal conductivity, steady conduction in solids with plane, cylindrical and spherical isothermal surfaces. Theory of convection: free, mixed and forced convection. The Newton's Law of cooling, The heat transfer coefficient. Heat transfer at solid fluid boundaries of uniform heat transfer coefficients at the surfaces. Heat transfer between fluids inside and outside pipes overall heat transfer coefficient, critical and economical thickness of pipe insulation. Dimensional analysis,. Flow in pipes with uniform surface heat transfer coefficient. Boiling.Condensation. Fins , fins' efficiency. Radiation: introduction, Planck's Law, Wien's Law, Stefan-Boltzmann Law, Kirchhoff's Law , Lambert's Law. Radiation between black surfaces separated by non-absorbing medium, view factor.Heat exchangers: classification, basic design methods of heat exchangers ,LMTD logarithmic mean temperature difference,e- NTU-method .		
Assessment methods	Lecture , PPT presentation Tutorials (classes) Written examination End-of -term test		
Recommended readings	1. Sadik Kakac, Hongtan Liu, Heat exchangers Selection , Rating and Thermal Design, CRC Press, BOCA RATON, LONDON,NEW YORK, WASHINGTON DC, 2002, ISBN 0-8493-0992-6, SECOND EDITION 2. Benson, Rowland S., Advanced engineering thermodynamics, 1977 3. Bejan, Adrian, Advanced engineering thermodynamics, 1988 4. Hollman J.P-Thermodynamics, Thermodynamics, Mc Graw-Hill,, 1988 5. Howell, John R., Fundamentals of engineering thermodynamics, 1987		
Knowledge	Students has knowledge on heat transfer theory and heat exchangers. Student has knowledge on solution methods of heat transfer and heat exchangers problems.		
Skills	Student is able to analyse and solve problems in the field of heat transfer. Student is able to apply knowledge and use know-how to complete tasks and solve problems of heat transfer and heat exchangers.		
Other social competences	Following the course, the student will acquire the following attitudes: proactive in development of his/her professional and personal competence, creativity in respect to heat transfer problems.		

Course title	Industrial controls		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-22	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives basic knowledge on control methods, control systems structure and their applications. Basic characteristics of the systems are explained and discussed. Students understand working principles of various control systems, know their application area and basic rules of programming their operation, are prepared to operate them. Students know typical elements of control systems like controllers, sensors, transducers, converters, relays, logical elements. Laboratory enables to deepen and apply the knowledge in practice, and operate selected control systems. Students are able to asses quality of control using different indexes of quality or system characteristics. Student can work effectively in a group.		
Entry requirements	Math knoledge on differentiation, integration, complex numbers and functions of compex variable.Basic knowledge on electrical DC and AC current circuits.		
Course contents	Relays. Logical functions and timers. Sensors. PLC controller. CNC systems. Servo drive. Control tasks and corresponding solutions. Relays and logic control. Programmable logic controllers and their programming. Continuous and digital control systems. Typical controllers. Structure of a computerised control system. A/D and D/A conversion. Sensors, transducers and signal conditioning systems. Control errors, control quality and indexes, system stability. CNC systems for controlling machine tools. Motion control. Fuzzy logic control. Microcomputers as controllers. Industrial communications.		
Assessment methods	Lecture and laboratory Term test and laboratory reports. Observation of student's work.		
Recommended readings	1. Bartelt T.:, Industrial automated systems, Delmar, Cengage Learning, New York, 2011 2. de Silva C.W.:, Mechatronics. A foundation course, CRC Press, Boca Raton, 2010 3. Soloman S.:, Sensors and control systems in manufacturing, McGraw Hill, New York, 2010		
Knowledge	Students have basic knowledge on control methods, control systems structure and their applications, can explain basic characteristics of the systems. Students understand working principles of various control systems, know their application area and basic rules of programming their operation, and are prepared to operate them. Students know typical elements of control systems like controllers, sensors, transducers, converters, relays, logical elements, are able to asses quality of control using different indexes of quality or system characteristics.		
Skills	Students can apply in practice the knowledge obtained in lectures, operate selected control systems and program their operation. Students can properly select sensors necessary for the operation of a given system. Students are able to asses quality of control using different indexes of quality or system characteristics.		
Other social competences	Students can operate in teams.		

Course title	Introduction to mechatronics		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-23	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The lecture gives basic knowledge on mechatronic systems' components - description, properties, models, interfacing methods. Upon successful completion of this course the student should understand solutions and applications shown during lectures. Student should be able to analyse the system structure and individual subsystems of a mechatronic system. In future this skill can be used when designing mechatronic systems. Student understands the need of updating his knoledge by studying literature.		
Entry requirements	Course on physics and electrical engineering. Some knowledge on electronic system is also welcomed.		
Course contents	What is mechatronics, its research area and applications. Examples of mechatronic systems. Sensors of position, temperature, pressure, flow, acoustic and optical sensors, micro sensors. Signal conditioning. Actuators – piezo, magneto-, electrodynamic, hydraulic, electric motors, Control systems. Logical systems, PLC. Digital and analog inputs and outputs of the control system. A/C and C/A converters, conversion errors. Analog and digital filters. Microcontrollers. Communication - displays and keyboards, computer mouse, serial and parallel ports, network access. Timers and counters. Remarks on programming and debugging. Mechatronic design. Modeling and simulation of mechanical structures, actuators and control systems. Mechatronic systems reliability.		
Assessment methods	Lecture. Two written tests. Observation of student's activity.		
Recommended readings	1. Bolton W., Mechatronics, Prentice Hall, London, 1999, 2-nd ed.		
Knowledge	Students have knowledge on mechatronic systems components - description, properties, models, interfacing methods. Upon successful completion of this course the student should understand solutions and applications shown during lectures.		
Skills	Students are able to analyse a mechatronic system structure and its individual subsystems. Students can apply in practice a number of ready-to-use mechatronic solutions.		
Other social competences	Students understand the role and can engage in studying subject literature individually.		

Course title	Introduction to polymer technology		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Sandra Paszkiewicz	**E-mail address to the person**	Sandra.Paszkiewicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-52	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Learning the methodology, conditions and technological basics of polymer modification to obtain improved performance properties		
Entry requirements	No prerequisites needed.		
Course contents	Chemical modification of polymers. Acquaintance with synthesis procedure of polymers. Preparation of the samples (injection moulding). Study on chemical and physical properties of the modified polymer materials. Introduction into polymer materials: definitions: mer, polymer, plastcis, degradation Analysis on the processes taking place during the processing and operation of polymeric materials. Selection of the type of modification and modifier to the operational needs of the product.		
Assessment methods	Information lecture, practical classes: laboratory Note from the test/exam.		
Recommended readings	1. Sperling H.L., Introduction to Physical Polymer Science, Wiley, 2006 2. T.R. Crompton, Characterisation of polymers, Smithers Rapra Technology Limited, 2008 3. J. R. Fried, Polymer Science and Technology, Professional Technical Reference, 2003		
Knowledge	As a result of the course, the student should be able to describe the types of polymers (definition, preparation procedures, processing of polymers etc.), the methods and purpose of polymer modification, distinguish between chemical and physical modification methods, and explain the various modification mechanisms.		
Skills	As a result of the course, the student should be able to analyse the processes taking place during the processing and exploitation of polymeric materials, select the type of modification to the operational needs of the product		
Other social competences	As a result of the course, the student will acquire the following attitudes: an active attitude towards the conditions of manufacturing polymer products, awareness of phenomena occurring in the material during production and operation.		

Course title	IT Technology in business		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Bolesław Fabisiak	**E-mail address to the person**	Boleslaw.Fabisiak@zut.edu.pl
Course code (if applicable)	WIMiM-1-53	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Ability to use selected up-to-date modern IT technologies to manage any size of business (startup, small, medium, large company) over the internet.		
Entry requirements	Advanced knowledge of networking Advanced knowledge of common IT systems (MS Win/ macOS and Linux) Advanced knowledge mobile systems (Android/ iOS) Advanced knowledge of cloud computing Own computer or laptop with up-to-date network intefaces Own modern mobile device (up-to-date tablet and/or mobile phone) Own WAN network connection (via LAN/ WiFi and/or mobile (LTE or 4G/ 5G)		
Course contents	VPN Virtual Private Networks WWW Servers SSH (Secure shell) connections File Tranfer: SFTP (Secure File Transfer Protocol) + SCP (Secure Copy) IT security: secure login/ access + antyspam/ antyvirus + backup systems Testing of network connections 2D codes: QR and Datamatrix: code geerators and readers IT systems for team work Remote access systems Electronic signatures Introduction to the IT Technology in business. Tools for wired and wireless networking in busieness. IT wired systems, wireless systems, optical systems and networks. Splitting networks using WAN to LAN+WiFi routers. Routers vs access points: role, functionality, setup and configuration. Mobile systems and mobile networking Usability, quality and stability of wired and wireless networks, interoperability based on ISO/OSI model, network performance monitoring and diagnostics (NPMD) Cloud systems and cloud computing – its usability in business. Building business identity and reputation in the internet: domain systems, CMS systems, web pages, web stores. web marketing and social networking. Building positive image of the business in the internet, NPS and CSAT measurements. Security and reliability of local IT systems, local networks, cloud systems and cloud networking VPN systems: concepts, architecture and tools of VPN networks Electronic signatures and its usability in busines Bar codes and 2D codes concepts and its usability in business and manufacturing. QR Code/ DataMatrix generators and readers. IT Systems for remote work/ remote services/ networked business systems. Remote service and remote support using IT Systems IT Systems for team work/ online systems for project management. IT solutions for Agile management in business. Mobile systems and mobile networking. IT systems in manufacturing: production preparation, CAD systems for design and CAM systems for Manufacturing, CIM Systems for integration of management, logistics, wholesale, HRM. Data transfer from/to machines: supervising of machines, KPI performance indicators. IoT/ IIoT systems (Internet of Things and Industrial Internet of Things) AI (Artificial Intelligence) systems in business – benefits and risks of AI BI (Business Intelligence) Systems		
Assessment methods	Lectures Laboratory Team work participation in lectures evaluation of lab reports		
Recommended readings	1. Stanford University, Technology Tools to Get Started at Stanford, Stanford University IT, https://uit.stanford.edu/guide/tools, 2021		

	2. David Weinberger, Tomas Chamorro-Premuzic, Darrell K. Rigby, David Furlonger, The Year in Tech, 2021: Tools for Preparing Your Team for the Future, Harvard Business Review, https://store.hbr.org/product/the-year-in-tech-2021-tools-for-preparing-your-team-for-the-future/10487, 2011 3. Linda Tucci, A guide to artificial intelligence in the enterprise, TechTarget, https://searchenterpriseai.techtarget.com/Ultimate-guide-to-artificial-intelligence-in-the-enterprise, 2021 4. Veem, White paper: 2021 Modern Data Protection, Best practices by Veeam: 2 Modern Backup and Recovery Best Practices, Veeam, https://go.veeam.com/wp-vas-clear-path-to-backup-modernization, 2021 5. Mary K. Pratt, 9 top applications of artificial intelligence in business, TechTarget, https://searchenterpriseai.techtarget.com/tip/9-top-applications-of-artificial-intelligence-in-business, 2021 6. iFirma SA, System do zarządzania biznesem, iFirma, https://www.ifirma.pl
Knowledge	Stuident will know how to use IT technoogy in business
Skills	Stuident will have skills how to start and setup IT systems in business
Other social competences	Stuident will have competences to decide and decide: which IT technoogy and/or IT system to use in business environment

Course title	Manufacturing techniques		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Małgorzata Garbiak	**E-mail address to the person**	Malgorzata.Garbiak@zut.edu.pl
Course code (if applicable)	WIMiM-1-25	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	to explain the role of technology in the metal casting and plastic working processes to describe the way of how a casting is made through design, moulding, pouring, cleaning and defects inspection student has the knowledge on blanking, piercing, deep drawing and stress state in deformed parts basics of dies construction		
Entry requirements	basic knowledge in chemistry and physics		
Course contents	Construction of dies for blanking and piercing Determination of the work hardening curves of the steel Influence of the sheet thickness and the module pressing on the folding flange during deep drawing Construction of the wire drawing die Casting design The moulding material: preparation, properties and testing Production techniques I - the manufacture of sand castings Production techniques II - the manufacture of sand castings Inspection of defects in castings Hot mechanical working of steel: purpose, range and effects. Forging: metal flow under impact pressure, fibre direction, preliminary forging operations, designing forgings. Forge plant equipment: forging equipment, hammers, forging presses. Hot die forging: dies and tools. Hot upset machine forging: description of forging machine, requirements, factors governing upsetting. Cold forming of metals: processes, fabrication of metals by cold working, presses and dies. Processes for shaping sheet: warm pressing and drawing Fundamentals of metal casting, casting design, melting furnaces, production techniques, solidification structure, defects in castings, properties of castings, inspection of casting quality, casting alloys.		
Assessment methods	lectures, description, explanation discussion laboratory exercises, laboratory manufacturing of elements laboratory reports grading writing exam		
Recommended readings	1. Campbell J., Castings, Butterworth-Heineman, 2003 2. Beeley P., Foundry technology, Butterworth-Heinemann, 2001 3. Metals Handbook v.4 Forming, 2003 4. Metals Handbook v.5 Forging and Casting, 2003 5. Helmi A. Youssef, Hassan A.El-Hofy, Mhoud H.Ahmed, Manufactoring Technology, 2003		
Knowledge	Student has knowledge necessary to understand technological processes of shaping materials structure and properties and forming products by casting and plastic working techniques		
Skills	Student has skills in forming products by casting and plastic working techniques		
Other social competences	Student can think and act in creative way and cooperate and work in team		

Course title	Measurements and industrial instrumentation		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-28	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives basic knowledge on measurements theory and measurement errors. The main part of lecture and laboratory is connected with sensors and industrial measuring systems and their elements. Students understand working principles of various types of sensors and transducers, understand the influence of errors on measurements. Laboratory exercises help students to deepen and apply their knowledge when solving practical problems. Students can properly select elements for building measuring path (sensors, transducers, instruments, storage, interfaces) and signal processing methods for different measured quantities, can carry out measurements and assess values of different kinds of measurement errors. Students can effectively work in small groups.		
Entry requirements	Basic knowledge on DC and AC curcuits; magnetic field characteristics of materials.		
Course contents	Measurement instrumentation. Measurement of displacement, velocity and acceleration. Measurement of force, torque and pressure. Strain gage measurements. Temperature measurements. Signal conditioning. Electrical measurements. Assessment of measurement accuracy. Introduction to metrology. Standards. Generalized measurement system. Measurement models. Static and dynamic response. Errors in measurements. Principles, sensors and transducers for measuring distance, motion parameters, force, pressure, strain, weight, shape, flow, temperature, illuminance, electrical, acoustic and chemical quantities,. MEMS sensors. Measuring instruments. Calibration. Data visualisation, storage and transmission. Interfacing. Signal conditioning. A/D conversion. Computer aided inspection. Computer based measuring systems. Actuators for active testing. Noise in measured signals.		
Assessment methods	Lecture and laboratory. Two term-time tests. Laboratory reports. Observation of student's activity.		
Recommended readings	1. Bartelt T., Industrial automated systems., Delmar, Cengage Learning, New York, 2011 2. Soloman S., Sensors and control systems in manufacturing, McGraw Hill, New York, 2010 3. de Silva C.W., Mechatronics. A foundation course, CRC Press, Boca Raton, 2010		
Knowledge	Students have basic knowledge on measurements theory and measurement errors, understand working principles and characteristics of sensors, transducers and industrial measuring systems, and their elements. Students know how to select elements for building measuring path (sensors, transducers, instruments, storage, interfaces) and signal processing methods for different measured quantities and measure precision, know how to assess values of different kinds of measurement errors.		
Skills	Students can solve practical problems connected with measurements in industrial conditions. Can properly select and apply various types of sensors and transducers or other elements for building measuring path (sensors, transducers, instruments, storage, interfaces) and signal processing methods for different measured quantities. Students can carry out measurements and assess values of different kinds of measurement errors.		
Other social competences	Students can effectively work in teams.		

Course title	Measurement Uncertainty: Methods and Applications		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Janusz Typek	**E-mail address to the person**	Janusz.Typek@zut.edu.pl
Course code (if applicable)	WIMiM-1-27	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	To teach methods of uncertainty calculations and to teach skills to use this knowledge in practical applications. To aquire skills to use the obtained knowledge in practical applications in lab experiments. To develop ability to work in a group.		
Entry requirements	Basic mathematics and physics Basic mathematics and physics.		
Course contents	Execution of lab experiment. Preparation of lab report. Basic concepts (uncertainty, error, probability distributions), evaluation of standard uncertainty (type A and B), combined and expanded standard uncertainty Graphical presentation of data, fitting functions to data, computer programs to calculate uncertainties. Bayesian analysis. Final test and presentation		
Assessment methods	Lecture. Lab experiment demonstration. Lab report grading The final test. Observation of class activity.		
Recommended readings	1. Guide to the expression of uncertainty in measurement, BIPM’s website, www.bipm.org, 2010 2. An introduction to the “Guide to the expression of uncertainty in measurement”, BIPM's website, www.bipm.org, 2009 3. H. J. C. Berendsen, A Student’s Guide to Data and Error Analysis, Cambridge University Press, 2011		
Knowledge	To acquire knowlegde about basic concepts (uncertainty, error, probability distributions), evaluation of standard uncertainty (type A and B), combined and expanded standard uncertainty. To know about graphical presentation of data, fitting functions to data, computer programs to calculate uncertainties, about Bayesian analysis, and preparation of lab reports.		
Skills	Student will be able to correctly calculate measurements uncertainty, construct graphical presentation of obtained data, use computer program to calculate uncertainties.		
Other social competences	Student acquires ability to work in group.		

Course title	Metal and ceramic composites		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Agnieszka Kochmańska	**E-mail address to the person**	Agnieszka.Kochmanska@zut.edu.pl
Course code (if applicable)	WIMiM-1-30	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Acquisition of knowledge on the structure and properties of metal and ceramic composites for their production techniques. Shaping the skills of selection of ceramic materials to given conditions.		
Entry requirements	Foundamentals of phisics, chemistry, and materials science		
Course contents	Basics of metal and ceramic matrix composites Matrices of metal and ceramic matrix composites. Characteristics of the reinforcing fibers, and their effect on composite mechanical properties. Properties of metal matrix composites dispersion-strengthened composites. Manufacturing of metal and ceramic matrix composites. Reactive consolidation. Predicting of metal matrix and ceramic-matrix composites properties. Mechanism of strengthening. Mechanism of reiforcement Metal and ceramic-matrix nanocomposites. Advanced applications of metal and ceramic matrix composites. Concrete Sandwich structures.		
Assessment methods	Information lecture Problem lecture Didactic film Homework in the middle of semester Written exam or essey - to be chosen by students		
Recommended readings	1. Barbero Ever, J., Introduction to composite materials design, CRC Press/Taylor & Francis Group, 2011 2. Decolon Christian,, Analysis of composite structures, Kogan Page Science, London, 2004 3. Tsai Stephen W. , Red, Strength & life of composite, 3. Tsai Stephen W. , Red Strength &Composites Design Group. Department of Aeronautics & Astronautics, Stanford University, cop., Stanford, 2008 4. Kamal K.Kar Editor,, Composite Materials, Springer-Verlag, 2017		
Knowledge	Ma wiedzę w zakresie zjawisk zwiazanych z właściwościami materiałów konstrukcyjnych.		
Skills	potrafi na podstawie teorii budowy materii rozwiązywac proste zadania dotyczące problemów materiałowo technologicznych		
Other social competences	potrafi określić priorytety dotyczące wyboru właściwego rozwiązania problemu technologiczno - materiałałowego dla zadanych warunków eksploatacji i uwarunkowań produkcyjnych		

Course title	Metallic Materials		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Małgorzata Garbiak	**E-mail address to the person**	Malgorzata.Garbiak@zut.edu.pl
Course code (if applicable)	WIMiM-1-29	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To familiarize students with the history of the development of metal materials To acquaint students with the influence of the chemical composition and technological of state on the microstructure and properties of metallic materials To familiarize students with the methods of the testing of the properties of metallic materials To acquaint students with methods of molding properties of metallic materials by heat treatment methods		
Entry requirements	Fundamentals of materials science. Basic knowledge of the chemical composition, structure of the materials and physicochemical transformation Fundamentals of mechanics and strength of materials Computer techniques knowledge		
Course contents	The influence of the carbon content and the cooling rate after austenitization the properties of the steel Effect of austenitizing temperature on hardness of steel after hardening Effect of austenitizing time on hardness of the steel after hardening The influence of the cooling medium on the properties of the steel The effect of alloying elements on the hardenability of the steel The effect of tempering temperature on the properties of the steel The susceptibility of temper unalloyed and alloyed steels Heat treatment of carbon tool steels Heat treatment of high speedtool steels The deformation strengthening of aluminium alloys The preciipitation strengthening of aluminium alloys The deformation strengthening of cooper alloys The precipitation strengthening of cooper alloys Microscopic analysis of the microstructure of steel and cast alloys Microscopic analysis of non-ferrous alloys The history of development of materials and their clasification Solutions and Iron-Carbon Phase Diagram The Microstructure of Carbon Steel at Room Temperature The Mechanical Properties of the Steel The Microstructure and Properties of the Low-Alloy Steels Diffusion - A Mechanism for Atom Migration within a Metal Austenitization Control of Grain Size by Heat Treatment and Forging Hardenability of Steel Tempering Quenching Stainless Steel Tool Steels Copper Alloys Aluminum Alloys		
Assessment methods	informative lecture laboratory assessment of the influence of carbon and alloying elements and parameters of austenitization on the properties of the metallic materials Rating messages acquired during lectures and self-study in the field of metallic materials based on the writing exam Rating messages based on reports from the laboratorium		
Recommended readings	1. George E. Totten, Rating messages based on reports from the laboratorium, WSP, Warszawa, 1993 2. Dieter G.E., Mechanical Metallurgy, International Structural Edition, John Willey, Mertals Handbook, 1981		

	3. Mitchel E. Bever, Encyclopedia of Materials Science and Enginering, Pergamon Press
Knowledge	As a result of studies, the student should know the basic types of metallic materials, dependence on the microstructure and properties as a function of chemical composition. The methods of forming and evaluating properties of metallic materials
Skills	Students should be able to choose and shape properties of a metallic material for a specific application. Students should be able to assess the properties of materials in various of technological states
Other social competences	The result of the student's participation in the classes is shaping student attitudes necessary to work effectively in a team.

Course title	Metal machining		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Janusz Cieloszyk	**E-mail address to the person**	Janusz.Cieloszyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-31	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	6	**Hours per semester**	90
Objectives of the course	Course Objectives: 1.To familiarize the student with tool nomenclature and cutting process 2 To familiarize students with the effects of process: tolerances, dimensions and shape and the geometric structure of the surface. 3. To give knowledge about heat distribution and thermal aspects of machining 4. To impart knowledge on tool materials, tool life and tool wear. 5. To educate students on failure analysis of cutting tools 6. To familiarize the student with typicla cutting process: Parting, Turning, Boring, Milling, Drilling, Grooving, Threading; Grinding, Honing –machine. 7. To impart knowledge on possibility and limitations of different process		
Entry requirements	technical drawing, engineering graphics, mechanics, materials science		
Course contents	1.Saving, 2. Parting, 3.Turning I 4.Turning II 5.Grinding I 6.Grinding II 7.Milling I 8.Milling II 9.Drilling,broach 10.Threading, 11.Gear manufacturing 12.Tool wear 13.Tool, regeneration of tools, measurement tools 14.Electrical discharge machining 15. Machinability, Development of machine tool technology: rolling, casting, deep drawing, sheet-metal working, electro discharge machining and modern metal cutting. Tools, cutting conditions. Machinability. Workpiece materials-classification. Tool materials and constructions. Tool wear. Establishing the machining method in relation to surface texture and tolerance. Typical metal cutting process: Parting, Turning, Boring, Milling, Drilling, Grooving, Threading; Grinding, Honing –machine. Machining – latest trends Laser-assisted machining (LAM), (HSM) high speed machining, (HSC) Hard machining (turning), Dry machining, Near-dry machining, Near–net-shape machining. Machining difficult-to-machine materials. Machining economics. Cutting fluid. Erosion machining; electrical discharge machining (EDM), laser machining (LM), water jet machining (WJM)		
Assessment methods	Lectures, reading assignments, projects, discussions, video presentations, multimedia presentations, and web content Student attendance and participation in class sessions play a vital role in successful course completion. Students will be expected to complete written tests, projects, and homework assignments as specified by the teacher		
Recommended readings	1. Grzesik W., Advanced Machining Processes of Metallic Materials,, Elsevier, 2008 2. Shaw M. C.,, Metal Cutting Principles,, Oxford Univ. Press., Oxford, 1996 3. Modern Metal Cutting,, AB Sandvik Coromant 1994, Sandviken, Sweden, 1994		
Knowledge	Upon successful completion of this course, the student will be competent to perform the following: • Understand various terminologies associated with the physics of metal cutting. • Recognize three major types of chips that are produced from various metals and understand the mechanics of chip formation during metal cutting operations. • Explain the factors that affect the machinability of metals. • Describe the differences between high carbon steel, tool steel and alloy steel. • Assess the effects of temperature and cutting fluids on surface finish as well as their influence on the machinability of metals.		
Skills	Designs the general form of manufacturing processes for typical parts, eg roller, wheel, gear, body, disc Uses methods of machining and assembly, conditions for their implementation in the case of typical parts (bodies, gears, shafts, screws, etc.) and assemblies Selects elements of the MTHW system (machine tool, holder, tool, object) for transitions, operations in various manufacturing methods		
Other social competences	It will assess the relationship between the costs and features of any parts and the techniques for their production. He will apply and evaluate pre-requisite technological processes for the manufacture of any products in the machine industry. Understand the importance and conditioning of manufacturing techniques in the process of creating any products in the machine industry.		

Course title	Modeling and Simulation of Manufacturing Systems		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Jardzioch	**E-mail address to the person**	Andrzej.Jardzioch@zut.edu.pl
Course code (if applicable)	WIMiM-1-32	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course deals with the technique of simulation. Simulation is often used to support management and design decisions in complex production systems.		
Entry requirements	Basics of Manufacturing Systems		
Course contents	The laboratory will be given in a computer lab, where the corresponding production systems are modeled and the performance measures are analyzed using standard simulation software. During the course, the students will work on several assignments and cases. Introduction to modeling and simulation. What is modeling of Manufacturing Systems? What is Simulation of Manufacturing Systems? Schematic of a simulation study. How to develop simulation Model? How to design a simulation experiment? How to perform Simulation Analysis? An example. What makes a problem suitable for simulation modeling and analysis? Simulation software – Plant Simulation. This course can be delivered in English or German.		
Assessment methods	Lecture, laboratory and workshop. Student attendance and participation in class sessions play a vital role in successful course completion. Students will be expected to complete written tests, projects, and homework assignments as specified by the teacher		
Recommended readings	1. Steffen Bangsow, Tecnomatix Plant Simulation, Modeling and Programming by Means of Examples, Springer, Cham Heidelberg New York Dordrecht London, 2015 2. Jardzioch A. jaskowski J., MODELING OF HIGH STORAGE SHEET DEPOT WITH PLANT SIMULATION, Adv. Sci. Technol. Res. J. 2013; 7(17):14-22, Adv. Sci. Technol. Res. J. 2013; 7(17):14-22, 2013, Adv. Sci. Technol. Res. J. 2013; 7(17):14-22		
Knowledge	Students have basic knowledge on methods of description, modeling and simulation of mechanical and mechatronic systems as well as production processes.		
Skills	Upon successful completion of this course the student should be able to prepare data and models and carry out computer simulations of mechatronic systems and typical production processes.		
Other social competences	Students can effectively work in a team.		

Course title	Modern materials for hydrogen and nuclear energetics		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Alexander Balitskii	**E-mail address to the person**	Aleksander.Balicki@zut.edu.pl
Course code (if applicable)	WIMiM-1-53	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	polish
Hours per week	3	**Hours per semester**	45
Objectives of the course	Classification of modern structural materials in hydrogen and nuclear energetics. Characteristics of materials properties - their influence and role in design; the concepts of anisotropy, advanced electroslag remelting steel technology, welded joints, residual stresses. Modern varieties of generation processes in nuclear and hydrogen energetics; examples of modern processes of high-nitrogen steels casting, modern copper alloys and nickel-cobalt superalloys, fabrication of nanocomposite structures. Standardization requirements for the design of materials structures used in nuclear and hydrogen energetics. Structural design problems with regard to fatigue strength and impact, deformation and cracking of metals under the influence of hydrogen. Modern hydrogen containing fuel systems for engines and turbines; advanced hydrogen-cooling methods and thermal protection for turbogenerators; advanced cooling methods and thermal protection for hydrogen turbines blades; hydrogen influence on crack resistance and fracture character of materials for hydrogen buffer infrastructures. Compatibility of distribution non steel gas grid materials with hydrogen. Lubricant-cooling (liquid, solid, gaseous) hydrogen-containing technological environments. Analysis of conditions of hydrogen assisted vibration cavitation resistant materials.		
Entry requirements	Fundamentals of thermodynamics, fundamentals of physics and chemistry recommended.		
Course contents	The objective of the course is to give the student knowledge on modern materials for “green” hydrogen and nuclear energetics, properties of hydrogen resistant materials, environmental pollution. Upon successful completion of this course the student has knowledge on modern materials for “green” hydrogen and nuclear energetics ang future energy production. Student is able to solve practical problems concerned with new generation of energy technologies (hydrogen buffer) for improved environmental performance and develop a system solution stabilizing the operation of electricity distribution networks. The assumption is to explain the differences in the selection of materials and the design of structures in the energy sector with examples for nuclear and hydrogen energy units, including super alloys and nanocomposites; problems of shaping the properties of materials and limiting the scope their durability. The aim of the course is to prepare students for literary studies, diagnosis and assessment problems, identifying and analyzing the observed phenomena, especially those with which the graduate will have to deal with making in practice, drawing the right conclusions, actively using the knowledge acquired during the studies and using it in application to practice or theoretical inference, conducting a logical course of arguments, independently solve specific diagnostic or design tasks, use clear and precise language.		
Assessment methods	Informative lecture with audio-visual resources. End – of – term presentation. Material prepared by the students to discuss selected topics presented at lectures and their activity during the lecture. Written test.		
Recommended readings	1. Brian Somerday, Petros Sofronis, Russell Jones, Effects of Hydrogen on Materials, ASM International, Materials Park, Ohio (Printed in the USA), 2009 2. Richard P.Gangloff and Brian P. Somerday, The problem, its characterisation and effects on particular alloy classes, Woodhead Ltd (ISBN 9781845696771), 2012 3. Richard P.Gangloff and Brian P. Somerday, Gaseous hydrogen embrittlement of materials in energy technologies, Woodhead Ltd (ISBN 9780857093899), 2012 4. A.I.Balitskii, O.V.Makhnenko, O.A.Balitskii, V.A.Grabovskii, D.M.Zaverbnyi, B.T.Timofeev. Editor A. I. Balitskii, Strength of materials and durability of structural elements of nuclear power plants, http://catalog.loc.gov, Kyiv, 2005 5. Qazi, U.Y., Future of hydrogen as an alternative fuel for next-generation industrial applications; Challenges and expected opportunities., Energies, 2022 6. Technical Database for Hydrogen Compatibility of Materials, Sandia National Laboratories: Livermore, CA, USA, 2022		
Knowledge	Students knows the basic materials used in the construction of hydrogen gas turbines, turbogenerators knows their properties, and knows the principles of their selection in the elements and functional parts of energetic devices with zero carbon emission.		
Skills	Can assess the suitability of materials for the construction of hydrogen buffer and make the right choice according to known criteria. Students knows the basic materials used in the construction of hydrogen energetic installations, knows their properties, and knows the principles of their selection in the elements and functional parts of hydrogen energetic units, resistant to hydrogen embrittlement. Can assess the suitability of materials for the construction of a hydrogen buffer and make the right choice according to known criteria.		
Other social competences	Students can effectively work in a team.		

Course title	Modern processes in manufacturing		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Janusz Cieloszyk	**E-mail address to the person**	Janusz.Cieloszyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-33	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Course Objectives: 1.To familiarize the student with no conventional machining methods 2. To familiarize the student with EDM. WEDM, WJM, LAM, HM, RET, burnishing on machning process: 3. To familiarize the student with burnishing process on CNC cutting machnies: 4. To impart knowledge on possibility and limitations of different not conventional machining methods		
Entry requirements	engineering graphics, mechanics, materials science, metal machining		
Course contents	1.Drilling operation and thermal friction drilling operation 2.Burnishing process to improve the final quality of form tools (moulds and dies) on turning and milling machines 3.Turning, threading, rolling and thread rolling on cutting machines 4.Turning and turning with self- propelled rotate tool 5.Spinning tools -new conception of machining 6.Saving, parting, electrical discharge machining 7.Machining of no conventional construction material INTRODUCTION: NON CONVENTIONAL MACHINING PROCESSES (NCMP), Non traditional machining, Definitions of various NCMP . Classification of NCMP, Historical background of new NCMP Technological processes. Non-traditional cutting processes, new spinning turning, mill-turning, new rotary tools RET; driven (DRET) or selfpropelled (SPRET). Erosion machining; laser machining (LM), water jet machining (WJM) ELECTRICAL DISCHARGE MACHINING (EDM): Fundamental principle of EDM, Equipments required for EDM process parameters, process capabilities. Application example trouble shooting, Wire EDM, Process principle and parameters, process capacities and its applications. Form drill, form tap machining. Rolling and thread rolling on cutting machines. Vibration-assisted machining (VAM) Cutting a technique called hybrid; Jet Assisted Machining (JAM) and Thermal Enhanced Machining (TEM), Air Jet Assisted Machining, Laser-assisted machining (LAM). Burnishing (Plastic working) on machine tools; machining of any surface surfaces, holes, 3D spatial surfaces, thread processing. Application, advantages and disadvantages. Curved surface finishing with flexible abrasive tool.		
Assessment methods	Lectures, reading assignments, projects, discussions, video presentations, multimedia presentations, and web content Student attendance and participation in class sessions play a vital role in successful course completion. Students will be expected to complete written tests, projects, and homework assignments as specified by the teacher		
Recommended readings	1. Davim J.P., Machining of Hard Materials., Springer 2010, London, 2010 2. A collection of new articles, papers assigned to the topics, 2011		
Knowledge	Upon successful completion of this course, the student will be competent to perform the following: • Understand various terminologies associated with the physics of Non-traditional cutting processes, new spinning turning, mill-turning, new rotary tools; driven (DRT) or selfpropelled (SPRT). cutting a technique called hybrid; Jet Assisted Machining (JAM) and Thermal Enhanced Machining (TEM), Air Jet Assisted Machining, Laser-assisted machining (LAM). Form drill, form tap machining. • Selct non-traditional machining processes for the given technological task,		
Skills	Upon successful completion of this course, the student will be competent to perform the following: • Selct non-traditional machining processes: new spinning turning, mill-turning, new rotary tools; driven (DRT) or selfpropelled (SPRT), cutting a technique called hybrid, Jet Assisted Machining (JAM) and Thermal Enhanced Machining (TEM), Air Jet Assisted Machining, Laser-assisted machining (LAM), Form drill, form tap machining for for the given technological task.		
Other social competences	It will assess the relationship between the costs and features of any parts and the not conventiona ltechniques for their production. He will apply and evaluate pre-requisite technological not conventional processes for the manufacture of any products in the machine industry. Understand the importance and conditioning of not conventional manufacturing techniques in the process of creating any products in the machine industry.		

Course title	Modern welding		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Adam Sajek	**E-mail address to the person**	Adam.Sajek@zut.edu.pl
Course code (if applicable)	WIMiM-1-49	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Gaining knowledge about the principles of metal joining Knowing the fundamental differences between the processes		
Entry requirements	Basics of Manufacturing Technology		
Course contents	Shielded Metal Arc Wedling Gas Tungsten Arc Welding Submerged Arc Welding Automated Gas Metal Arc Welding Welding in Augmented Reality Manual Laser Welding Brief introduction to metal technology Welding fundamentals (SMAW as the primal process) Why Flux Cored Arc Welding displacing regular GMAW? Still attractive Gas Tungsten Arc Welding Invaluable Thermal Cutting processes (plasma, laser and oxyfuel - welding & cutting) Review of the modern processes (special processes and resistance welding) Welding technology in practice (professional welding) The reason of welding processes measurements Computer Aided Welding Economics of living, working and welding technology		
Assessment methods	Informative lecture with multimedial aids Laboratories: welding equipment presentation, joints welding by students Rating messages acquired during written tests and lab reports Students receives the final grade based on w written work on defined subject		
Recommended readings	1. David H. Phillips, Welding Engineering: An Introduction, John Wiley & Sons, 2016 2. Andrew D. Althouse, Carl H. Turnquist, William A. Bowditch, Kevin E. Bowditch, and Mark A. Bowditch, Modern Welding, 12th Edition, Goodheart-Willcox, 2018		
Knowledge	The student will have the knowledge about modern welding processes and practical application due to conditions of efficiency and economics.		
Skills	Student will be able to apply the obtained knowledge to solve a common problems and use it in the regular welding.		
Other social competences	Student will be able to work in a team to solve problems through critical thinking.		

Course title	Monitoring of machine tools and machining processes		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives basic knowledge on theory and methods used for diagnosing machines, machine tools and cutting processes, their monitoring or supervision. Many practical examples of diagnostic processes and monitoring systems are presented. They are mainly connected with machine tools and machining processes. The course will give students basic knowledge necessary for using and developing simple monitoring systems. Student can use basic theoretical knowledge about methods used for diagnosing machines, machine tools and cutting processes, their monitoring or supervision. tudent Student can determine the structure of simple diagnostic and monitoring systems. Student can cooperat effectively in a team.		
Entry requirements	Basic knowledge on machine tools and cutting. Basics of measurements – sensors and methods.		
Course contents	Diagnostic data classification and different techniques of signal processing for failure or disturbance detection (e.g. FFT, STFT, WT, correlation, PCA etc.). Diagnostics and monitoring of systems and processes. Main concept. Role of system modelling. Selection of signals and signal processing. Symptoms. Classification problems. Limit values. Examples of monitoring algorithms. Failures in machine tool subsystems. Ccutting process disturbances. Cutting process and cutting tool monitoring problems. Practical applications – examples of machine tools monitoring, monitoring of cutting process stability, monitoring of rotating machinery.		
Assessment methods	Lecture and laboratory Two term-time tests, laboratory reports. Final test. Observation of student;s activity.		
Recommended readings	1. Rowland J.R., Linear Control Systems. Modeling, analysis, and design, John Wiley, New York, 1986 2. Clarence W. de Silva, Modeling and control of engineering systems, CRC Press/Taylor & Francis Group, 2009 3. Natke H.G., Cempel C., Model-Aided Diagnosis of Mechanical Systems. Fundamentals, Detection, Localization, Assessment, Springer, Berlin, 1997		
Knowledge	Student knows theory and methods used for diagnosing machines, machine tools and cutting processes, their monitoring or supervision. Student knows many practical examples of diagnostic processes and monitoring systems, especially those connected with machine tools and machining processes.		
Skills	Students can effectively use monitoring systems, can build formulea for signals processing, can formulate symptoms and determine limit values. .		
Other social competences	Students can cooperate in a team.		

Course title	Nanomaterials		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Magdalena Kwiatkowska	**E-mail address to the person**	Magdalena.Kwiatkowska@zut.edu.pl
Course code (if applicable)	WIMiM-1-34	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Making students knowledge about the nanomaterials, nanocomposites and advanced technologies of their manufacturing and investigation.		
Entry requirements	Basic knowledge of the chemical composition, structure, materials and physicochemical changes. Basic knowledge of the materials testing.		
Course contents	Nanoparticles, nanomaterials, nanocomposites - definitions and fundamental classification. Materials Science at the nanoscale. Synthesis and properties of nanostructural coatings. Manufacturing processes. Sintering of nanoceramics. Nanoceramics. Nanocomposites. Mechanical and nanomechanical properties. Polymer nanocomposites: definitions, structures, key factors, application potential. Nanofillers to polymers: classification, structures, physical properties. The effects of nanofillers on polymer systems. Characterization tools. Direct Methods: optical, electron, and scanning probe microscopy. Indirect methods: diffraction techniques for periodic structures.		
Assessment methods	Informative lecture with audiovisual aids, ie. educational movies, computer presentations . After participation in lecture the student proceeds to pass a written exam and receive a passing grade.		
Recommended readings	1. Brechignac C., Houdy P., Lahmani M., Nanomaterials and Nanochemistry, Springer, Berlin, Heidelberg, New York, 2007 2. Y.Gogotsi, Nanomaterials Handbook, CRC Taylor &Francis, 2006 3. Klein L.C., Processing of nanostructured sol-gel materials [in] Edelstein A.S., Cammarata R.C. (ed.), Nanomaterials: synthesis, properties and applications, Institute of Physics Publishing, Bristol, Filadelfia, 1996 4. Gupta R.K., Kennel E., Polymer nanocomposites handbook, CRC Press, 2008 5. Mai Y.W., Yu Z-Z., Polymer nanocomposites, CRC Press, 2006 6. Wang Z., L., Characterization of nanophase materials, Wiley-VCH, Weinheim, 2000 7. Kny E., Nanocomposite materials, Trans Tech. Pub.Ltd, Zurich, Enfield, 2009		
Knowledge	Student has widened knowledge about nanomaterials science and methods of manufacturing or synthesis selected nanomaterials. Student has widened knowledge about methods and tools used for nanomaterials characterization.		
Skills	Students can use sources of literature, seek and follow the development of new technologies, advanced materials and methods their indentification.		
Other social competences	Student has awareness that nanotechnology makes it possible to achieve very large effects with a minimal amount of material and that applicability to some products is limited from enviromental point of view.		

Course title	Numerical methods in technical computing		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Bodnar	**E-mail address to the person**	Andrzej.Bodnar@zut.edu.pl
Course code (if applicable)	WIMiM-1-35	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Student will develop understanding of mathematical bases of numerical methods used in problems arising in engineering and technology. Student will be prepared to apply their knowledge at future industrial or scientific work or further study. Student will demonstrate the ability to apply numerical methods for experimental data processing like approximation, interpolation, curve fitting, smoothing, finding poles and zeros of functions, solving sets of equations or ordinary differential equations, finding signal transforms and other. Student will be able to cooperate in small groups. Student can study subject literature individualy.		
Entry requirements	Finished course on mathematics (at least 2 semesters).		
Course contents	Laboratory works in MATLAB (based on representative practical examples) on approximation, interpolation, curve fitting, smoothing, finding poles and zeros of functions, numerical integration, solving sets of linear and nonlinear equations or ordinary differential equations, finding Fourier or wavelet transforms. Mathematical principles and simple examples of individual numerical methods: approximation, interpolation, curve fitting and smoothing of experimental data, finding poles and zeros of functions, solving sets of linear equations or ordinary differential equations, finding signal transforms.		
Assessment methods	Lectures and laboratory. Written test; laboratory reports. Observation of student's work.		
Recommended readings	1. Moler C.B., Numerical computing with MATLAB., The MathWorks, Inc.,, Natic, Massachusets, 2004		
Knowledge	Student understand mathematical bases of numerical methods used in problems arising in engineering and technology.		
Skills	Student will demonstrate the ability to apply numerical methods for experimental data processing like approximation, interpolation, curve fitting, smoothing, finding poles and zeros of functions, solving sets of equations or ordinary differential equations, finding signal transforms. Student is prepared to further study and to application of the knowledge in his scientific work or for solving problems met in industry.		
Other social competences	Student understands necessity of further development of his knoledge and skills. Student can cooperate in a group.		

Course title	Physics of renewable energy sources		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Janusz Typek	**E-mail address to the person**	Janusz.Typek@zut.edu.pl
Course code (if applicable)	WIMiM-1-39	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	To understand physical ideas and issues associated with renewable forms of energy. To gain experience in dealing with practical applications To understand physical ideas and issues associated with renewable forms of energy. To gain experience in dealing with practical applications. To learn working in a group.		
Entry requirements	General knowledge of physics and mathematics. Ability to perform laboratory measurements, general knowledge of measurement techniques and basics of data processing. General knowledge of physics and mathematics. Ability to perform laboratory measurements, general knowledge of measurement techniques and basics of data processing.		
Course contents	Executiion of lab experiments Introduction to solar energy. The Sun as energy producer. Characteristics of solar radiation Introduction to photovoltaic, band structure of solid state, photovoltaic effect, characteristics of the solar cells, solar collectors. Heat pumps Fuel cells. Wind energy-wind power, Betz' law, basic parameters of the wind, wind turbines. Water energy, ocean energy (OTEC, tidal, wave, salinity difference), conversion of water energy. Origin of geothermal energy, geothermal energy systems, heat pumps. Biomass energy and biomass energy systems Technologies devoted to storage and transfer of energy. The final test		
Assessment methods	Lecture Lab experiment demonstration Laboratory reports (65%) and home prepared essay on selected subject (35%). Laboratory reports. Final test Observation of class activity		
Recommended readings	1. C. Julien Chen, Physics of Solar Ebergy, John Wiley & Sons, Hoboken, New Jersey, 2011 2. B. Sorensen, Renewable energy, Elsevier, 2011 3. Lab instructilns, PHYWE System Gmbh, Goettingen, 2011		
Knowledge	Student will understand physical ideas and issues associated with renewable forms of energy.		
Skills	Student can perform and fully analysed lab experiments on the subject of renewable enrgy sources.		
Other social competences	Student will be able to work in a group.		

Course title	Polymer Processing		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Magdalena Kwiatkowska	**E-mail address to the person**	Magdalena.Kwiatkowska@zut.edu.pl
Course code (if applicable)	WIMiM-1-48	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Providing students knowledge on thermal processing of polymer materials, their theoretical and practical aspects. Processing methods of thermoplastics, their effects of polymer structure and performance		
Entry requirements	Basic knowledge on thermoplastic polymer materials		
Course contents	Rheology of thermoplastics. Practical aspects of processing methods: extrusion molding, injection molding, compression moulding, thermoforming / vacuum molding. Methods of thermal joining. Introduction to polymer materials technology. Processability and rheology of thermoplastics. Material preparation for molding. Additives. Processing methods: extrusion molding – process realization and parameters, processing units, equipment design, production lines; injection molding - process realization and parameters, processing units, equipment design, different approaches to forming; compression moulding – different approaches to forming, processing units, final products; thermoforming / vacuum molding - process realization and parameters, processing units, final products; rotational moulding. Methods of thermal joining.		
Assessment methods	Informative lecture with multimedial aids (presentations, educational movies, etc.) Laboratiories: processing equipment presentation in laboratories, experimental tests Student receives a final grade based on written tests and lab reports Student receives a final grade based on a written work on defined subject		
Recommended readings	1. Harper Ch.A., Handbook of Plastic Processes, Wiley Insc., Hoboken, 2006 2. Wilkinson A.N., Ryan A.J.,, Polymer Processing and Structure Development, Kluwer Acad., 1998 3. Cogswell F.N., Polymer Melt Rheology, Woodhead Pub. Ltd, Cambridge, 1997 4. Fridman M.L. (Edit.), Polymer Processing, Springer Verlag, 1990		
Knowledge	Student gains a knowledge on polymer materials chemical structure, physical transitions, and effects of thermal processing on formulated microstructure and materials performance, main aspects of polymer processability, typical methods of thermoplastic processing and joining, materials preparation for molding.		
Skills	Student is able to choose a suitable processing method regarding specified product form, to specify the processing aspects and conditions, is able to choose a method of joining polymer elements, is also able to operate some processing equipment		
Other social competences	Student can think and act in creative way and cooperate and work in team		

Course title	Power Generation Technologies		
Level of course	first and second cycle		
Teaching method	project / lecture		
Person responsible for the course	Aleksandra Borsukiewicz	**E-mail address to the person**	Aleksandra.Borsukiewicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-33-L	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives the fundamental knowledge about different technologies of power generation		
Entry requirements	Physics - level of first degree technical studies, Chemistry - level of first degree technical studies, Mathematics - level of first degree technical studies, Thermodynamics - level of first degree technical studies,		
Course contents	Project of power plant suplied by waste energy or geothermal energy or solar energy Introduction to the electricity generation. Daily demand of electrical energy. Coal-fired power plants. Gas turbines and combined cycle power plants. Combined heat and power. Piston-engine-based power plants. Nuclear power. ORC based power plant. Power from waste. Fuel cells. Hydropower. Solar power. Biomass-based power generation. Wind power. Geothermal power. Tidal and ocean power. Direct Energy Conversion. Energy storage technologies. Hybrid power systems. Environmental consideration.		
Assessment methods	An informative and problem-oriented lecture Workshop Writing control work Report of project		
Recommended readings	1. Breeze P., Power generation technologies, Elsevier, 2014 2. Andrews J, Jelly N., Energy science, Principles, technologies and impacts, Oxford University Press, 2007		
Knowledge	Student has knowledge about power generation methods and technologies		
Skills	After successful completing of this course the student should be able to use theoretical knowledge about power generation technologies, in order to estimate the potentials of known methods and select the most advantageous one.		
Other social competences	Student is aware of possibilities of power generation methods, and understands the effects and diversity in power generation technologies.		

Course title	Pumps, Fans and Compressors		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Zbigniew Zapałowicz	**E-mail address to the person**	Zbigniew.Zapalowicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-38	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Fundamentals information concern pumps, fans and compressors (classification of machnies, constructions, characteristic parameters, methods of capacity regulation, characteristics, set of machines, methodology of selection) Tests of machnies		
Entry requirements	Fundamental information from: physics, mathematics.		
Course contents	Test of centrifugal pump Test of centrifugal pumps - serial connections Test of centrifugal pumps - parallel connections Introduction (main information about machines to liquid and gas transport) Hydraulic losses. Hydraulic characteristic of pipe Serial and parallel connections of pipes. Eqivalent hydraulic characteristic of pipe Classification of pumps. Definition of rotation pump. Principle of pump's operation Rotary pumps. Balance of energy for pumps Characteristic parameters. Heads. Capacities. Powers. Efficiences Kinematic flow of fluid through the rotor Fundamental equation for rotation machines Losses in rotary pumps Characteristics of rotary pumps Regulation of pump's capacity Reciprocating pumps Series and parallel sets of pumps Constructions of pumps Fans. Classification of fans. Principles of operation. Characteristics. Constructions. Compressors. Classification of compressors. Principle of operation. Characteristics. Constructions.		
Assessment methods	Information lecture Control work		
Recommended readings	1. Rishel J., Water pumps and pumping system, MCGraw-Hill Professional, 2002		
Knowledge	Student knows: the phenomena that associated the flow of working fluid through the transport machines, design and exploit limitations, basic elements and principles of operation for pumps, fans and compressors Students knows the fundamental parameters and characteristics for pumps, fans and compressors and methods their regulation		
Skills	Student can to assessment the advantages and disadvantages of pumps, fans and compressors and can to select proper machines depends of their applications Student can to make the measurements of characteristic parameters and prepares characteristics of transport machine		
Other social competences	Student should be cooperate in group		

Course title	Recycling		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Sandra Paszkiewicz	**E-mail address to the person**	Sandra.Paszkiewicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-41	**ECTS points**	2
Semester	winter/summer	**Language of instruction**	english
Hours per week	1	**Hours per semester**	15
Objectives of the course	Introduction to plastic recycling on the level which gives students the basic knowledge concerning the legislative, economical and technical issues.		
Entry requirements	Completed courses of Polymer Materials II and Polymer Processing I		
Course contents	Introduction into plastic materials - definitions: recyclates, virgin grade materials etc. The effect of processing on thermoplastics. Reprocessing of thermoplastic recyclates. Processing techniques. Systems of collecting recyclable materials. Machines and devices for recycling of polymers. Sorting and processing recyclables. Filtration of wastes in melting state. Additives for recyclates. Lines for recycling of polymers. The law regulations of recycling in the world. Economical aspects of recycling of polymer materials. The problem of recycling in perspective: Europe. Rise of biopolymers		
Assessment methods	informative lectures, descriptions, explanations discussion during the lectures asking problematic questions during the lectures		
Recommended readings	1. La Mantia F., Handbook of Plastic Recycling, RapraTech., Shawbury, 2002 2. Scheirs J., Polymer recycling: Science, Technology and Applications, John Wiley and Sons, Chichester, 1998 3. Henstock M., Polymer Recycling, Rapra Technology, Shawbur, 2001 4. Bisio A., Xanthos M, How to Manage Plastic Waste, Hanser, Munich, 1994		
Knowledge	After completing the course, the student: 1. Has elementary knowledge of EU directives and EU legislation in the field of recycling. 2. Has basic knowledge on waste classification, segregation and disposal. 3. Can use the basic theoretical knowledge in the field of recycling to analyze the process of waste segregation		
Skills	1. Uses the acquired knowledge to solve dilemmas emerging in waste management. Analyzes waste management problems and proposes directional actions in this regard. 2. Can use the basic theoretical knowledge in the field of waste segregation. 3. He can see the connection of engineering decisions and their impact on environmental aspects.		
Other social competences	1. Understands the need to learn throughout life in order to raise their professional qualifications in the field of environmental protection and natural resources. 2. He can interact and work in a group and communicate effectively to solve the problem. 3. He can think and act in an entrepreneurial way with an understanding of the needs of society and the laws governing the natural environment.		

Course title	Renewable energy sources		
Level of course	first and second cycle		
Teaching method	project / lecture		
Person responsible for the course	Aleksandra Borsukiewicz	**E-mail address to the person**	Aleksandra.Borsukiewicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-37-Z	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The lecture gives the fundamental knowledge about potential and ways of RES conversion into heat and electricity.		
Entry requirements	Physics - level of first degree technical studies, Chemistry - level of first degree technical studies, Mathematics - level of first degree technical studies, Thermodynamics - level of first degree technical studies,		
Course contents	Project of ORC power plant suplied by geothermal energy or solar energy Kinds of RES, Potential and reservoirs of RES on the World and Europe. Sun as energy source. Characteristic of solar radiation. Losses of solar radiation in atmosphere. Thermal and photovoltaic conversion of solar radiation. Kinds of solar radiation converters. Passive systems of solar radiation using. Principle of function of thermal collectors and systems. Biomass. Biogas. Bio-fuels. Technologies of biomass conversion. Geothermal energy - exploitation, conversion to electricity. Hydro energy. Tidal energy. Wave energy. Potential of water in oceans, sees and rivers. Conversion of water energy into electricity. Wind energy. Conversion of wind energy into electricity. Wind energy transformers. Storage systems of heat end electricity. Hydrogen and FC. Production of hydrogen. Storage systems. Perspective ways of conversion of RES		
Assessment methods	An informative and problem-oriented lecture Workshop Writing control work Report of project		
Recommended readings	1. John Twidell and Tony Weir, Renewable Energy Resources, Routledge Taylor & Francis Group, 2015 2. Edited by Jean-Claude Sabonnadière, Renewable Energies, John Wiley & Sons, 2009		
Knowledge	Student has knowledge about obtaining and generation of usefull forms of energy from renewable energy soirces.		
Skills	After successful completing of this course the student should be able to use theoretical knowledge about renewable energy technologies, in order to estimate the potentials of available methods and select the most advantageous one.		
Other social competences	Student is aware of possibilities of usefull forms of energy generation, and understands the effects and diversity in generation energy by using renewable sources.		

Course title	Solar energy		
Level of course	first and second cycle		
Teaching method	auditory class / project / lecture		
Person responsible for the course	Zbigniew Zapałowicz	**E-mail address to the person**	Zbigniew.Zapalowicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-42	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Fundamental information about thermal solar and PV installations		
Entry requirements	Fundamental physics		
Course contents	Tutoriales according to lectures Project of solar and PV installations for fixed initial data Sun as energy sources. Characteristic of solar radiation. Parameters of solar radiation. Energy tranducers. Flat solar collectors -constuction, operation, energy balance Air collectors - construction, operation, energy balance Vaccum collectors - constructin, operation, energy balance Heat pipe collectors - construction, operation, energy balance Focusing collectors - kinds, construction, operation, energy balance Sun furance and thermal solar power installation, Heat storage in solar installations New type of collectors, Examples of solar installation Photovoltaic effect. Technology of PV cells production Kinds of PV cells Modules, panels and set of PV modules Characteristics of PV installation Elements of PV - installation Inverters, batteries Economical and ecological aspects of solar installations		
Assessment methods	Lectures, tutorials and project Control works and presentaion of project		
Recommended readings	1. Klugmann-Radziemska E., Fundamentals of Energy Generation, Wyd. Politechniki Gdańskiej, Gdańsk, 2009, pp.86-115 2. Poulek V., Solar energy photovoltaics promising trend fpr today and close future, CUA, Praha, 2006 3. Green M.T., Third generation photovoltaics: advanced solar energy conversion, 2010 4. Galloway T, Solar house a guide for the solar designer, Elsevier, Oxford, 2007 5. Planning andinstalling solar/thermal systems: a guide for installers, architects and engineers., JamesJjames Earthscan, Springer, Berlin, 2005		
Knowledge	Student knows the parameters and geometrical relations for solar radiation Student knows methods and devices to conversion of solar radiation into useful forms of energy (heat, electricity) and applications		
Skills	Student can to assessment the quantity of solar energy Student can to design the simply solar installation		
Other social competences	Student can to professionally assessment the task concern solar installations		

Course title	Statistics		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Marcin Chodźko	**E-mail address to the person**	Marcin.Chodzko@zut.edu.pl
Course code (if applicable)	WIMiM-1-26	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The course introduces the theoretical basis of statistical analysis. The course will introduce the most common methods and statistical models used in engineering. The course will familiarize you with the use of popular tools used in computer-aided statistical analyzes.		
Entry requirements	Mathematics, basics of probability theory.		
Course contents	Solving theoretical tasks in the field of: Desciptive statistics. Inferential Statistics. Distributions. Solving theoretical tasks in the field of: Bivariate Data. Pearson Correlation. Solving theoretical tasks in the field of: Binomial distribution. Poisson distribution. Multinomial and hypergeometric distribution. Solving theoretical tasks in the field of: Normal distribution. Standard normal distribution. Normal aproximation to the Binomial. Solving theoretical tasks in the field of: Estimation. Degrees of freedom. Characteristics of estimators. Confidence intervals. Solving theoretical tasks in the field of: Hypothesis testing. Type I and II errors. Steps in hypothesis testing. Using computer aided tools for solving problems in field of: Hypothesis testing. Type I and II errors. Steps in hypothesis testing. Using computer aided tools for solving problems in field of: Testing means.Testing between two means (independent and correlated) Using computer aided tools for solving problems in field of: Regression. Introduction to linear regression. R. Introduction to multiple regression. Using computer aided tools for solving problems in field of: Analysis of Variance - basics ANOVA Introduction. Variables. Desciptive statistics. Inferential Statistics. Distributions. Graphing distributions. Histograms. Plots, Charts and Graphs. Central Tendency. Shapes of Distributions. Measures of Variability. Bivariate Data. Pearson Correlation. Probability. Binomial distribution. Poisson distribution. Multinomial and hypergeometric distribution. Normal distribution. Standard normal distribution. Normal aproximation to the Binomial. Estimation. Degrees of freedom. Characteristics of estimators. Confidence intervals. Hypothesis testing. Type I and II errors. Steps in hypothesis testing. Testing means.Testing between two means (independent and correlated) Regression. Introduction to linear regression. R. Introduction to multiple regression. Analysis of Variance - basics ANOVA		
Assessment methods	Lecture information using oral presentation and examples. Group and individual work on problems given by a teacher. Practicing, statistics problems solving and results discussion. Periodical check-ups of the statistics knowledge by the students in a form of exercising tasks. Transitional evaluation of the state of progress of overall knowledge. The completion of the lecture is based on the attendance list and the verification test.		
Recommended readings	1. Douglas C. Montgomery, Applied Statistics and Probability for Engineers, A. John Wiley & Sons, Inc., 2003 2. T.T. Soong, Fundamentals of Probability and Statistics for Engineers, John Wiley & Sons, Inc., 2004		
Knowledge	The student can characterize random variables. Explain the methods of estimating the parameters of random variables. Explain the concept of statistical hypothesis and the principles of its verification. Describe ways to estimate the interdependencies between random variables.		
Skills	The student is able to develop and interpret the results of experimental research. Choose appropriate statistical tests to verify basic statistical hypotheses and verify them. Calculate the correlation coefficient and estimate the regression relationship.		
Other social competences	Student is aware of the need for continuous training in the development and analysis of observed experimental data.		

Course title	Steam and Gas Turbines		
Level of course	first and second cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Zbigniew Zapałowicz	**E-mail address to the person**	Zbigniew.Zapalowicz@zut.edu.pl
Course code (if applicable)	WIMiM-1-43	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The fundamental knowladge deal to construction and operation of steam and gas turbines		
Entry requirements	Fundamental knowledge from: mechanics, hydromechanics, physics, thermodynamics		
Course contents	Tutoriales according to lectures Introduction(main information about turbines, axial and radial turbines; steam, gas and water turbines etc.) Steam floe in guide ring Steam flow in rotor vanes Impulse stage of steam turbine Reaction stage of steamturbine Curtis stage of steam turbine Mulltistage steam turbines Construction of steam turbines and its main parts Energy balance of steam turbine; energy losses Power regulation of steam turbine Operating of steam turbine Gas turbines in power station Gas flow in turbine Constructions of gas turbine Operating of gas turbine		
Assessment methods	lecture Exam		
Recommended readings	1. Peng W.W., Fundamentals of Turbomachniery, Jhon Wiley & Sons, New Jersey, 2008		
Knowledge	Student knows the fundamental parameters and idea of operation for turbine stages and for multistage turbine Student knows basic construction elements and their function in turbine Student knows the characteristics for turbines and methods of turbine power control		
Skills	Students can to assessment the advantages and disadvantages of turbine Students can to assessment the influence of characteristic parameters on turbine power		
Other social competences	Student should be permanently educate in the range of construction and operation of turbines		

Course title	Surface engineering		
Level of course	first and second cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Jolanta Baranowska	**E-mail address to the person**	Jolanta.Baranowska@zut.edu.pl
Course code (if applicable)	WIMiM-1-45	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Zapoznanie studentów z podstawowymi pojęciami związnymi z powierzchnią ciała stałego Introduction to basic surface phenomena taking place during surface formation and exploitation Introduction to basic properties of surface layer and methods of their characterisation Introduction to basic coatings technologies		
Entry requirements	basic knowledge about materials structure and phase transformation basics of mechanics and strength of materials		
Course contents	coatings technologies testing of the properties of the coaings; preparation of materials with coatings wear testing with a pin-on-disk tribology test corrosion test of coatings calculations basic definitions, properties of surface layers, surface phenomena (adsorption, absorption, diffusion), corrosion and tribological resistance of surface layers surface treatment and coatings technologies exam		
Assessment methods	lectures, descriptions, explanations discussion during the lectures laboratories asking problematic questions during the lectures lab reports grading writting exam		
Recommended readings	1. Ed. J.R.Davis, Surface Engineering for Corrosion and Wear Resistance, ASM International, Warszawa, 2001 2. Ed. G.W. Stachowiak,, Wear Materials, Mechanisms and Practice, John Wiley & Sons, Warszawa, 2005 3. Ed. A.A.Tracton, Coatings technology: Fundamentals, Testing and Processing Techniques, CRC, Warszawa, 2006		
Knowledge	Student can name the basic definitions related to surface Student can describe the basic properties of the surface layers Student is able to describe the basic phenomena at the interphase Student can name and descibe basic coating technologies		
Skills	Student is able to test selected surface properties of the coatings Student is able to design and analyse the selected deposition process of coatings		
Other social competences	student is able to work in a team and present results of experiments		

Course title	Sustainable materials		
Level of course	first and second cycle		
Teaching method	lecture		
Person responsible for the course	Anna Szymczyk	**E-mail address to the person**	Anna.Szymczyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-54	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	polish
Hours per week	2	**Hours per semester**	30
Objectives of the course	Sustainable development is able to satisfy today's needs without endangering the capacity of future generations. It comprises three basic elements that must complement one another: environmental, economic and social sustainability. This course aims for providing a profound understanding problems of managing material life cycle in the circular economy. The most important steps of the journey form product compliance to sustainability will be presented.		
Entry requirements	There is no specific entry requirement for these course.		
Course contents	Introduction: What is sustainability? Sustainability in materials selection. Sustainability in a circular economy. How to source sustainable materials? The current state of material compliance management. Materials, water usage, and energy. Sustainability and renewability of natural resources. Sustainable development goals for advanced materials provided by industrial wastes and biomass sources. The Materials Life Cycle, Life Cycle Assessment Sustainability (LCSA), including aspects of Environmental E-CLA Steps, Social S-LCA, Economic E – LCC, The Materials Life Cycle. The journey of plastics from a linear to a circular economy. Sustainability assessments of bio-based polymers. Critical aspects in the life cycle assessment (LCA) of bio-based materials – Reviewing methodologies and deriving recommendations Opportunities and challenges for integrating the development of sustainable polymer materials within an international circular (bio)economy concept. Green Polymeric Materials: Recent Advances and Applications. Are biodegradable materials sustainable? Techno-economic, life-cycle, and socioeconomic impact analysis of enzymatic recycling of poly(ethylene terephthalate). The Chemical Recycling of Polyesters for a Circular Plastics Economy: Challenges and Emerging Opportunities. How green is stainless steel? Building and Construction Materials for Sustainable Development. Homework presentations by students and dissusion Written test		
Assessment methods	Informative lecture with audio-visual resources. Written test. Material prepared (homework) by the students to discuss selected topics presented at lectures and their activity during the lecture.		
Recommended readings	1. Michael F. Ashby, Materials and Sustainable Development, Elsevier Science, Fairford, GLOS, United Kingdom, 2022, 2nd edition, ISBN 10: 0323983618, ISBN 13: 9780323983617 2. Shakeel Ahmed, Jamia M. Islamia, Annu Ikram, Saiqa Ikram, Green Polymeric Materials: Advances and Sustainable Development, Nova Science Publishers (Verlag), 2017, e-Book, ISBN 1536122521		
Knowledge	Students will acquire knowledge about the strengths and weaknesses of LCA, and how it can be used to quantify the environmental impact of circular products. Student will be learn: - Understand the challenges of switching from a fossil source-based economy to a biobased economy; - Understand how to identify suitable raw materials and create valuable new products; - Evaluate technological, ethical, societal and economic consequences in the production of biobased and fossil products; - Understand the concept of a circular economy and understand how a circular economy deviates from the current linear system; -Analyse and develop complex circular systems using a systems thinking approach. As a result of the course the student will be able to understand problems regarding of sustainable materials development.		
Skills	Student will be able to apply knowledge of circular economy principles in design new sustainable materials and in design for recycling, in design for reuse or replace plastic with bioplastics.		
Other social competences	Student will be ready to search for new applications for existing products/solutions (adaptions) and to design new innovative products in line with the circular economy trends.		

Course title	Thermodynamics		
Level of course	first and second cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Anna Majchrzycka	**E-mail address to the person**	Anna.Majchrzycka@zut.edu.pl
Course code (if applicable)	WIMiM-1-46	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Thermodynamics is course dealing with energy and its transformation. It is a standard course that covers the First and Second Laws of Thermodynamics and concludes with applications on steam power plants, gas power cycles, and refrigeration. Upon successful completion of this course, the student will understand the fundamentals of energy and energy transfers.		
Entry requirements	Mathematics, physics, chemistry recommended		
Course contents	Solution of the problems regarding the contents of the lectures. Basic properties and concepts, work and heat, the first law of thermodynamics - closed systems, thermodynamic properties of pure substances and equations of state, open systems and the first law, the second law of thermodynamics and entropy, energy conversion - gas cycles, energy conversion - vapor cycles, combustion		
Assessment methods	Tutorials (classes) - interactive method Lectures -PPTpresentation End -term - test Written examination		
Recommended readings	1. Benson, Rowland S.- Advanced engineering thermodynamics,1977, Advanced engineering thermodynamics, 1977 2. HolmanJ.P, Thermodynamics, McGraw Hill, 1988 3. Howell, John R., Fundamentals of engineering thermodynamics, 1987 4. Karlekar B.V, Thermodynamics for engineers, New York, 1983 5. Ragone, David V.- Thermodynamics of materials. Vol. 1,21995., Thermodynamics of materials. Vol. 1, 1995 6. Samir Sarkar, Fuels and combustion, CRC Press, 2009, 3 rd Edition, ISBN 9781 4398 25419 7. Keating Eugene.L., Applied combustion, Marcrl Dekker Inc., New York,Basel, Hong Kong, 2011, ISBN- 08247-8127-9		
Knowledge	The student should be able to define basic concepts of thermodynamics and as well as identify and describe the thermodynamic processes. The student has knowledge regarding solution of thermodynamics problems.		
Skills	As a result of the course the student will be able to apply knowledge and use know-how to complete tasks and solve problems of thermodynamic processes. As a result of the course the student will be able to solve the problems regarding thermodynamic processes.		
Other social competences	The student wiill have proven ability to use knowledge, skills and personal competences in the fild of thermodynamics.		

Course title	Tools in machining processes		
Level of course	first and second cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Janusz Cieloszyk	**E-mail address to the person**	Janusz.Cieloszyk@zut.edu.pl
Course code (if applicable)	WIMiM-1-47	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Course Objectives: 1.To familiarize the student with tool nomenclature of tools 2. To impart knowledge on tool materials, tool life and tool wear. 3. To educate students on failure analysis of cutting tools 4. To familiarize the student with typicla cutting tools: parting, turning, boring, milling, drilling, grooving, threading; grinding, honing,EDM. To familiarize the student with the technological processes of machining tools To familiarize the student with the principles of selecting cutting tools		
Entry requirements	engineering graphics, metal machining		
Course contents	Saving, parting and turning tools Milling tools Grinding tools Tool wear, Tool cutting tests Tool, regeneration of tools, measurement tools Electrical discharge machining tools Tools for machining gear and threads Design of special cutting or burnishing or erosion tool The technological process of the designed tool Tools in machining processes Tool materials and constructions, cutting conditions. machinability. Tool wear. tool life Cutting Tool Geometries Turning, Single-Point Cutting Tools Milling and Multi-Point Cutting Tools Cutting tool material Drilling tools Reaming, Counterboring and countersinking tools Threading tools Erosion tools Burnishing tools Diamond tools for machining Operation and regeneration cutting, erosion and burnishing tools Elements of design typical cutting, erosion and burnishing tools. Elements of technology cutting, erosion and burnishing tools		
Assessment methods	Lectures, reading assignments, projects, discussions, video presentations, multimedia presentations, and web content Student attendance and participation in class sessions play a vital role in successful course completion. Students will be expected to complete written tests, projects, and homework assignments as specified by the teacher		
Recommended readings	1. Modern Metal Cutting,, AB Sandvik Coromant, Sandviken, Sweden, 1994, 1 2. Grzesik W.,, Advanced Machining Processes of Metallic Materials,, Elsevier, London, 2008, 1 3. Davim J. P.,, Surface Integrity in Machining,, Springer-Verlag,, London, 2010, 1 4. Catalog Kennametal, Kennametal, USA, 2018 5. MITSUBISHI MATERIALS CORPORATION Catalogue, MITSUBISHI MATERIALS CORPORATION, Japonia, 2018 6. ISCAR cutting tools catalog, ISCAR, Israel, 2018		
Knowledge			

	Upon successful completion of this course, the student will be competent to perform the following: • Understand various terminologies associated with the cuting erosin na buranishing tools • Recognize major types of the cuting, erosin na buranishing tools •Design special cutting, erosive or burnishing tools •Is able to describe the tool geometry Characterize and explain the contents of typical catalogs of tools in the book and web versions
Skills	Choose the right tool for the process Determine the correct operating conditions of the tool Regenerate tools
Other social competences	Upon successful completion of this course, the student will be competent to: understand and evaluate the importance of the tooling economy, understand and assess the importance of proper exploration.