Faculty of Electrical Engineering

WEST POMERANIAN UNIVERSITY OF TECHNOLOGY
IN SZCZECIN, POLAND

THE OFFER FOR INTERNATIONAL STUDENTS FOR THE YEAR 2024/2025 FIRST DEGREE

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
1	Advanced data processing in electrical engineering	Grzegorz Psuj	winter/summer	6	60
2	Antennas and EM wave propagation	Przemysław Łopato	winter/summer	4	45
3	Artificial Intelligence in Automation and Robotics	Krzysztof Jaroszewski	winter/summer	3	30
4	B.Sc. Thesis	- Nauczyciel WE	winter/summer	15	12
5	Basic Course of Metrology	Artur Wollek	winter	4	45
6	Biomedical Engineering	Joanna Górecka	winter/summer	7	75
7	Biomedical Technology Equipment	Joanna Górecka	winter/summer	4	45
8	Computer 3D Graphics Applications for Robotics	Maja Kocoń	winter/summer	4	45
9	Computer Animation, Augmented and Virtual Reality	Przemysław Mazurek	winter/summer	7	75
10	Computer Networks	Piotr Lech	winter	4	45
11	Computer Vision and Image Processing	Krzysztof Okarma	winter/summer	6	60
12	Digital Technology	Joanna Górecka	winter/summer	6	60
13	Electromagnetic Compatibility	Przemysław Łopato	winter/summer	7	75
14	Electromagnetic Field and Effects in the Human Body	Katarzyna Cichoń	winter/summer	6	60
15	Electronic Devices and Circuits	Witold Mickiewicz	winter/summer	6	60
16	Elements of the EV Robotaxi Power Conversion Design	Konrad Woronowicz	winter/summer	6	60
17	Fiber Optic Access Networks (FOAN)	Patryk Urban	summer	6	60
18	Fundamentals of Audio Engineering	Witold Mickiewicz	winter/summer	7	75
19	Fundamentals of Engineering Electromagnetics	Stanisław Gratkowski	winter/summer	6	60
20	Fundamentals of Web Development	Przemysław Włodarski	winter/summer	6	60
21	High Voltage Engineering	Szymon Banaszak	winter/summer	6	60
22	Human-Machine Interaction	Maja Kocoń	winter/summer	4	45
23	Introduction to Control Engineering	Paweł Dworak	winter/summer	4	45
24	Introduction to Cryptography	Maciej Burak	winter/summer	4	45
25	Introduction to Electric Circuits - part 1	Tomasz Chady	winter/summer	7	75
26	Introduction to Electric Circuits - part 2	Tomasz Chady	winter/summer	7	75
27	Introduction to Infrared Thermography	Barbara Grochowalska	winter/summer	4	45
28	Introduction to Matlab	Przemysław Orłowski	winter/summer	6	60
29	Introduction to Microcontrollers	Witold Mickiewicz	winter/summer	7	75

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
30	Introduction to Multisensor Data Mining and Fusion	Grzegorz Psuj	winter/summer	3	30
31	Machine and Deep Learning	Adam Krzyżak	summer	7	75
32	Magnetic Measurements Techniques	Grzegorz Psuj	winter/summer	3	30
33	Modern Electrical Machines	Ryszard Pałka	winter/summer	4	45
34	Network Systems Administration	Piotr Lech	summer	4	45
35	Network Traffic	Przemysław Włodarski	winter/summer	4	45
36	Neural Networks and Deep Learning	Przemysław Mazurek	winter/summer	7	75
37	Non-destructive Testing Using Electromagnetic Methods	Tomasz Chady	winter/summer	7	75
38	Object-Oriented Programming in C#	Marcin Ziółkowski	winter/summer	6	60
39	Optoelectronic sensors	Grzegorz Żegliński	winter/summer	6	60
40	Photonic elements and properties of laser light	Andrzej Ziółkowski	winter	3	30
41	Power Systems with Renewable Energy Sources	Michał Zeńczak	winter/summer	7	75
42	Programmable Automation System Based on PLC and HMI	Krzysztof Jaroszewski	winter/summer	3	30
43	Programmable Logic Devices	Witold Mickiewicz	winter/summer	4	45
44	Signal Processing	Joanna Górecka	winter/summer	6	60
45	Statistical Methods in ICT	Przemysław Włodarski	winter/summer	6	60
46	Terahertz Technique	Przemysław Łopato	winter/summer	3	30
47	Visual Programming in LabVIEW	Paweł Dworak	winter/summer	4	45

Course title	Advanced data processing in electrical engineering		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Grzegorz Psuj	**E-mail address to the person**	Grzegorz.Psuj@zut.edu.pl
Course code (if applicable)	WE-1-01	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Gaining knowledge about the methods and algorithms of data processing and analysis, methods of searching for rules and data dependencies, regression, classification, clustering, and determining optimal solutions as well. Gaining the skills to use methods and algorithms for data processing and analysis in major aspects, including optimization, regression, classification, clustering, data dimensionality reduction, and visualization ones.		
Entry requirements	Basics of informatics and electrical engineering		
Course contents	Overview of a project task Carrying out a selected topic design task concerning the application of data analysis algorithms to electrical or electronic systems Completion of the project and presentation of its results Introduction to data analysis, optimization algorithms Data transformation and dimensionality reduction methods Artificial neural networks Deep learning networks Data classification and clustering Quality assessment measures Fuzzy logic Regression methods Data integration/fusion Final Assessment		
Assessment methods	lectures with simple cases presentation practical classes in the laboratory continuous assessment final assessment		
Recommended readings	1. Edward L. Robinson, Data Analysis for Scientists and Engineers, Princeton University Press, New Jersey, USA, 2016 2. Simon Haykin, Neural Networks and Learning Machines, Pearson Education, Upper Saddle River, New Jersey, 2009, 3 3. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, Wiley-Interscience, 2000, 2 4. S.N. Sivanandam, S. N. Deepa, Introduction to Genetic Algorithms, Springer, Berlin, 2008		
Knowledge	The student has knowledge of the methods and algorithms of data processing and analysis, methods of searching for rules and data dependencies, regression, classification, clustering, as well as determining optimal solutions.		
Skills	The student knows how to use the methods and algorithms of data processing and analysis in the main aspects, including optimization, regression, classification, grouping, reduction of data dimensionality, visualization.		

Course title	Antennas and EM wave propagation		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Przemysław Łopato	**E-mail address to the person**	Przemyslaw.Lopato@zut.edu.pl
Course code (if applicable)	WE-1-02	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	During the course, students will gain a basic knowledge of the operation, design and modeling of antenna and microwave systems utilized in electrotechnics, electronics and telecommunication.		
Entry requirements	Basic course of mathematics and physics (electromagnetics)		
Course contents	Numerical modeling and measurements of antennas structures Electromagnetic waves, Maxwell’s equations Antenna parameters, types of antennas Antenna arrays, smart antennas Transmission lines, waveguides, reflection coefficient, SWR, impedance matching, Smith chart, S-parameters Active and passive microwave devices Computer aided analysis of antennas and microwave instruments (numerical techniques review) Measurements of antennas and microwave devices		
Assessment methods	Lectures with simple experiments; laboratory –measurements and computer simulations of antenna structures Lectures - written test and/or discussion laboratory – continuous assessment		
Recommended readings	1. Balanis Constantine A., Antenna Theory: Analysis and Design, John Wiley & Sons, 2005 2. Bansal Rajeev, Fundamentals of engineering electromagnetics, CRC Press Taylor & Francis, 2006 3. Collin Robert E., Foundations for microwave engineering, John Wiley & Sons, 2001		
Knowledge	During the course, students will gain a basic knowledge of the operation, design and modeling of antenna and microwave systems utilized in electrotechnics, electronics and telecommunication.		
Skills	During the course, students will gain a basic knowledge of the operation, design and modeling of antenna and microwave systems utilized in electrotechnics, electronics and telecommunication.		

Course title	Artificial Intelligence in Automation and Robotics		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Krzysztof Jaroszewski	**E-mail address to the person**	Krzysztof.Jaroszewski@zut.edu.pl
Course code (if applicable)	WE-1-03	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Delivering the basic knowledge about AI, especially in the area of GA, FL and NN Delivering basic skills in using Matlab AI toolboxes		
Entry requirements	The basic knowledge in the area of Mathematics		
Course contents	Fuzzy logic in the task of control Neural network in the task of classification Neural network in the task of approximation Neural network in the task of characters recognition Design of the function implementing the functionality of a classical genetic algorithm 1. Introduction to AI Genetic algorithms: definitions, area of using, example of working classical GA Neural networks: types of the nets, methods of learning, example of teaching the net Experts systems Fuzzy logic: definiotion of FL system, example of calculating output of the FL system		
Assessment methods	prelection individual work, with using a computer validation of the raport exam		
Recommended readings	1. Stuart Russell, Artificial Intelligence: A Modern Approach, Pearson Education Limited, England, 2014, 3rd, ISBN-13: 978-0136042594 ISBN-10: 0136042597		
Knowledge	Ability to define basic subjects connected with artificial intelligence.		
Skills	Skills in implementing and using proper method of artificial intelligence.		

Course title	B.Sc. Thesis		
Level of course	first cycle		
Teaching method	diploma thesis		
Person responsible for the course	- Nauczyciel WE	**E-mail address to the person**	a@b
Course code (if applicable)	WE-1	**ECTS points**	15
Semester	winter/summer	**Language of instruction**	english
Hours per week	0	**Hours per semester**	12
Objectives of the course	The main goal of the diploma thesis is to check the degree of obtaining engineering competences during the studies. Teaching a student the methodology of searching for source materials and the proper use of them. The ability to write technical texts and to make drawings and graphs illustrating the results obtained. Teaching how to write a technical text and in particular to present the assumptions, purpose and methodology of solving the problem posed in the diploma thesis. Understanding the practical aspects of the application of copyright and related rights.		
Entry requirements	The work is of a project or research nature. Its result may be, for example, a computer program, a laboratory stand, a device model or the results of tests carried out with the use of professional devices or programs. It is supposed to testify to the student's acquisition of appropriate engineering competences related to the studied subject during the studies. Knowledge of basic issues related to the subject of the diploma thesis. Knowledge of copyright in the area related to the use of sources when writing a diploma thesis. The ability to write technical texts and to make drawings and graphs illustrating the results obtained.		
Course contents	Methodology of preparation of the Bachelor's Diploma Thesis, its illustrative and text part, scope of the design, description and the legal issues. Methods of information selection by the contemporary scientific methods. Methods of analytical studies, plagiarism prevention. Students presentation on selected topics related to their Bachelor's Diploma Thesis.		
Assessment methods	Individual work with the diploma thesis supervisor. Successive, orally passed to the graduate, evaluation of the progress in the implementation of the diploma thesis. Substantive assessment of the diploma thesis included in reviews prepared by the supervisor and reviewer.		
Recommended readings	1. Honczarenko J., Poradnik dyplomanta (Graduate Guide), Wyd. PS, Szczecin, 2000 2. Szablon pracy dyplomowej realizowanej na Wydziale Elektrycznym Zachodniopomorskiego Uniwersytetu Technologicznego w Szczecinie (Thesis template for the diploma project carried out at the Faculty of Electrical Engineering of the West Pomeranian University of Technology in Szczecin), Szczecin, 2021 3. Regulamin Studiów Wyższych Zachodniopomorskiego Uniwwersytetu Technologicznego w Szczecinie (Academic Regulations of the West Pomeranian University of Technology in Szczecin), Szczecin, 2021		
Knowledge	Has knowledge in the field of electrical engineering necessary to understand the relationships occurring in circuits, networks, devices and electrotechnical systems.		
Skills	The student can independently search for the necessary information and prepare simple presentations and reports on the work done		
Other social competences	The student is aware of the responsibility for the implementation of the commitments undertaken, understands the importance of learning and transferring this knowledge to other people.		

Course title	Basic Course of Metrology		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Artur Wollek	**E-mail address to the person**	Artur.Wollek@zut.edu.pl
Course code (if applicable)	WE-1-04	**ECTS points**	4
Semester	winter	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	To provide a basic knowledge in the field of metrology. The student learns: typical methods of measurement methods and tools necessary for analyzing the results of the measurements, as well as the current state and development trends in the field of sensors, transducers and measurement systems.		
Entry requirements	Mathematics, Physics		
Course contents	Voltage and current measurement Frequency, period and time measurement Oscilloscope as a measurement instrument Resistance measurement Measurement of impedance components Measurement methods of compensation Magnetic measurements Rotational speed measurement Strain gouge measurement Temperature measurement Basic concepts of metrology, units and the measurement system, measurement standards. Measuring scales. Basic methods of measurement. Analysis of accuracy of measurement: systematic and random errors, the uncertainty of measurement. Electrical quantities measurement. Measurement of the frequency, period and time. Measurement of voltage and current. Measurement of resistance and impedance. Non-electrical quantities measurement. Classification of sensors and transducers for measuring non-electrical values. Static and dynamic properties of sensors and transducers. Temperature measurement methods. Measurement of rotational speed. Pressure measurements. Measurement of the magnetic properties of solids. Measuring systems. DAQ cards in measuring systems.ADC and DAC converters. Interfaces in measuring systems. Software of the measurement systems.		
Assessment methods	Lecture, Lab Lectures: grade, Lab: accomplishment of Lab tasks		
Recommended readings	1. Evaluation of measurement data — Guide to the expression of uncertainty in measurement, JCGM, 2008 2. Northrop R.B., Introduction to instrumentation and measurements, CRC Press, 2005 3. Sidor T., Electrical and Electronic Measurement and Instrumentation, AGH, 2006 4. Sydenham P.H., Handbook of Measurement Science, John Wiley & Sons Ltd., 1983 5. The Metrology Handbook, ASQ Quality Press, 2004		
Knowledge	The student can choose the typical measurement methods and appropriate sensors and transducers, as well as to assess the usefulness of new solutions for the implementation of the tasks associated with electrical engineering.		
Skills	The student can choose the typical measurement methods and appropriate sensors and transducers, as well as to assess the usefulness of new solutions for the implementation of the tasks associated with electrical engineering.		

Course title	Biomedical Engineering		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Joanna Górecka	**E-mail address to the person**	Joanna.Gorecka@zut.edu.pl
Course code (if applicable)	WE-1-05	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To provide up to date knowledge on methods and techniques used in acquisition, processing and analysis of biosignals and to develop practical skills useful in this field.		
Entry requirements	Mathematics, Physics, Informatics, Electronics, Signal theory, Signal processing, Biomedical Engineering.		
Course contents	Biosignal acquisition, processing and analysis using specialized equipment (sensors, transducers, amplifiers etc.) and software tools - LabView. Chosen biosignals analysis using software tools: MATLAB. Chosen biosignals analysis using software tools - LabView. Filtration of recorded biomedical signals. Assembly and test of heart rate monitor. Assembly and test circuit of EMG sensor. Wireless biomedical signal transfer. Using computer tools in processing and analysis of biological signals Implementing algorithms applied to different biosignals. Biosignals: definitions, classification. Bio-measurements: (bio)sensors, electrodes, transducers, amplifiers. Methods and techniques of biosignal acquisition, processing and analysis. Filtration of biomedical signals Electrophysiology systems: ECG, EEG, EMG, ERG/VEP/P300. Biosignal analysis in time and frequency domain: spectral analysis, FFT, STFT, time-frequency analysis, Wavelet Transformation. Methods of statistical biosignal analysis. MATLAB and LabView environments in biosignal processing and analysis, dedicated toolboxes. Examples of advanced ECG, EEG, VEP/P300 processing and analysis.		
Assessment methods	oral presentation (lectures), practical work in lab grade, accomplishment of lab tasks		
Recommended readings	1. Bronzino J. D. (ed.), Biomedical Engineering Handbook, CRC Press, IEEE Press, 1995 2. Shortliffe E. H., Perreault L. E, Medical informatics. Computer applications in Health Care, Addison-Wesley Publ. Comp., Readng, Mass, 1990 3. Oppenheim, A.V. and Schafer W, Discrete-time signal processing, Prentice Hall, 1999		
Knowledge	The student has knowledge on methods and techniques used in acquisition, processing and analysis of biomedical signals as well as on research methodology used in this field.		
Skills	The student has practical skills useful in this area regarding bio-measurements (instrumentation, specialized software tools).		

Course title	Biomedical Technology Equipment		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Joanna Górecka	**E-mail address to the person**	Joanna.Gorecka@zut.edu.pl
Course code (if applicable)	WE-1-06	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	To provide basic knowledge on Biomedical technology: instrumentation, equipment, software, specialized systems, and to develop practical skills useful in this area of engineering		
Entry requirements	Mathematics, Physics, Informatics, Electronics		
Course contents	Biosignals and biomeasurements Biosignal acquisition, processing and analysis using specialized transducers, amplifiers, equipment and software tools: MATLAB and LabView. Demonstration of medical equipment in hospitals (e.g. brain systems) Biomeasurements, biomedical instrumentation, biosignals (1-D, 2-D) acquisition, processing and analysis Equipment: ECG, EEG, EMG, VEP/P300. Basic medical imaging systems. Medical telematics, IT in e-Health Computer aided medical diagnosis		
Assessment methods	oral presentation (lectures), practical work in lab Lectures: grade, Lab: accomplishment of lab tasks		
Recommended readings	1. Bronzino J. D. (ed.), Biomedical Engineering Handbook, CRC Press, IEEE Press, Boca Raton, Florida, USA, 1995 2. Bemmel, van J. H., Musen M. A., Handbook of Medical Informatics, Bohn Stafleu Van Loghum, Springer, Germany, 1997 3. Christensen D. A., Ultrasonographic Bioinstrumentation, J. Wiley & Sons, New York, USA, 1988 4. Huang H. K., PACS in Biomedical Imaging, VCH Publ. Inc., New York, USA, 1996		
Knowledge	The student has basic knowledge on biomedical technology (instrumentation, equipment, software, specialized systems and standards used in this field).		
Skills	The student has practical skills useful in the area of biomedical technologies regarding their development, implementation, exploitation and assessment.		

Course title	Computer 3D Graphics Applications for Robotics		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Maja Kocoń	**E-mail address to the person**	Maja.Kocon@zut.edu.pl
Course code (if applicable)	WE-1-07	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Learning how to design and control robots in a 3D environment.		
Entry requirements	Basic programming skills.		
Course contents	Introduction to robotic platforms and simulators. The process of producing three-dimensional elements. Modeling in Blender and OpenSCAD. Motion control techniques in three-dimensional space. Obtaining data on human movement. Robotic kinematics and simulation techniques. Robot movements planning. Robot modelling and control in a graphical environment for a selected situational context. Overview of the most common robotic platforms and simulators. Robotic kinematics and simulation techniques. Acquisition of 3D objects and motion control techniques in three-dimensional space. Techniques of analysis and synthesis of human movement. Obtaining data on human movement. The use of three-dimensional graphics in the design of virtual representations of robots. Virtual and augmented reality in robotic systems. The process of producing three-dimensional elements. Modeling in Blender and OpenSCAD.		
Assessment methods	Lecture. Laboratory course. Exam on the last lecture meeting. Grades based on tasks performed during laboratory classes.		
Recommended readings	1. Kenny Erleben, Jon Sporring, Knud Henriksen, Henrik Dohlmann, Physics Based Animation, Charles River Media, 2005 2. Lentin Joseph, Jonathan Cacace, Mastering ROS for Robotics Programming: Best practices and troubleshooting solutions when working with ROS, Packt Publishing, 2021, 3rd Edition		
Knowledge	Students gain knowledge about robot modelling and control in a graphical environment. They will become familiar with current trends in social robotics.		
Skills	Students develop skills in how to design and control robots in a 3D environment.		

Course title	Computer Animation, Augmented and Virtual Reality		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Przemysław Mazurek	**E-mail address to the person**	Przemyslaw.Mazurek@zut.edu.pl
Course code (if applicable)	WE-1-08	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Basic knowledge related to augmented reality		
Entry requirements	Computer Graphics		
Course contents	Project related to selected AR topic 2D and 3D modelling Techniques for tracking objects Techniques for tracking camera Keying techniques Image and video compositing techniques Test of knowledge		
Assessment methods	Instructional method/informative lecture Practical method/project Passing the project A pass in the form of a choice test		
Recommended readings	1. Blender Videotutorials 2. K. Babilinski, J. Linowes, Augmented Reality for Developers, Packt Publishing, 2017 3. D.Schmalstieg, T.Hollerer, Augmented Reality: Principles and Practice, Addison-Wesley Professional, 2016 4. Photoshop Videotutorials		
Knowledge	Knowledge related to augmented reality		
Skills	Basic skills related to AR		

Course title	Computer Networks		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Piotr Lech	**E-mail address to the person**	Piotr.Lech@zut.edu.pl
Course code (if applicable)	WE-1-09	**ECTS points**	4
Semester	winter	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Describing the network structure, equipment and transmission lines. Modelling of the network. Describing the role of network protocols. Describing the role of network services. Acquainted with a TCP / IP and the Web. The basic skills in using tools for configuration, control and network analysis.		
Entry requirements	Basic computer skills and computer applications.		
Course contents	Collecting basic information about the computer network. Configuring network interfaces. Analysis of the network protocol stack. Encapsulation. Testing the network. The use of IP, UDP, TCP network applications. Differences implementing TCP UDP. The network project - the application layer switches 2 and 3. Splitting a network and design IP network using routers. Access devices and WiFi. Core Network Services - e-mail, ftp, etc. HTML Basics - design and implement a simple web page. Simple CMS - instalation. Introduction to network security. The hazard analysis. Basic concepts. Splitting a network. Network topologies. The model ISO / OSI. Encapsulation. The model of the Internet network. Introduction to TCP / IP. Ethernet standard. IP addressing. Distribution of IP networks. TCP/IP stack. Network equipments of the second layer. The third layer switches. Virtual Networks. Spanning Tree Protocol. Routing. Routing protocols.		
Assessment methods	lecture discussion laboratory exercises test evaluation reports		
Recommended readings	1. Rod Scrimger (Author), Paul LaSalle (Author), Mridula Parihar (Author), Meeta Gupta (Author), TCP/IP Bible		
Knowledge	Knowledge of basic configuration of computer networks and IP networks. Understanding of layered models in networking. Understanding of protocols.		
Skills	Addressing in computer networks.		

Course title	Computer Vision and Image Processing		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Krzysztof Okarma	**E-mail address to the person**	Krzysztof.Okarma@zut.edu.pl
Course code (if applicable)	WE-1-10	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course is intended to present a unified approach to image processing techniques with introduction to image analysis and its applications		
Entry requirements	Basic knowledge of Matlab or similar environments, basic knowledge about programming and signal processing		
Course contents	Software project in chosen environment related to some specific computer vision algorithms Digital image – classes, representations and conversion methods. Digital image acquisition. Arithmetical and logical operations on digital images. Geometrical operations, matrix notation. Colour models. Colour quantisation methods - reduction of the number of colours. Local processing and filtration using convolution filters. Frequency-based image processing methods. Deformations, bilinear projection and morphing. Histogram and histogram-based operations. Binarization. Morphological operations. Image segmentation. Labelling techniques in image processing. Measuring methods using image analysis. Lossy and lossless image compression standards. Image and video quality assessment methods. Nonlinear filtration of colour images. Basics of photogrammetry and 3D Vision. Applications of machine vision in automation and robotics.		
Assessment methods	lectures based on presentations nad case studies project based learning written test and/or oral discussion project assessment		
Recommended readings	1. Pratt W.K., Digital Image Processing, Wiley Interscience, New York, 1991, 2nd Edition (or later) 2. Foley J.D. et al, An Introduction to Computer Graphics, Addison-Wesley, 2000 3. Pavlidis T., Algorithms for Graphics and Image Processing, Computer Science Press,, Rockville, 1982 4. Russ J.C., The Image Processing Handbook, CRC Press, 1999		
Knowledge	knowledge about typical image processing and analysis methods and their applicability		
Skills	ability to solve a chosen problem related to image processing or analysis		

Course title	Digital Technology		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Joanna Górecka	**E-mail address to the person**	Joanna.Gorecka@zut.edu.pl
Course code (if applicable)	WE-1-11	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To provide basic knowledge on digital circuit theory and design and to develop skills in analysis, testing and designing digital circuits using product data sheets as well as application notes The student has knowledge on digital circuit theory, methods and techniques of digital circuit analysis and synthesis, as well as digital circuit design. He has skills in the field of analysis, testing and designing digital circuits using product data sheets, application notes as well as dedicated software tools.		
Entry requirements	Mathematics, Informatics, Fundamentals of semiconductor electronics		
Course contents	Switching functions minimisation. Realising logic functions with gates and different modules. Logic gates testing (switching functions, static and dynamic characteristics). Flip-flops, registers and counters testing. Testing time-dependent circuits, multi-vibrators, generators. Testing arithmetic circuits. Testing memories, input circuits and digital displays. Transmission of digital signals. Analogue versus digital technique. Number systems. Binary codes, BCD codes. Basics of binary arithmetic. Automata, logic circuit, digital circuit – basic definitions. Boolean Algebra, fundamental thorems. Switching (Boolean) functions, simplification, minimisation. Realising logic functions with gates, multiplexers and demultiplexers, ROMs, PLA modules. Digital logic circuit realisation techniques & technologies - overview, comparison, development. Time-dependent circuits, multi-vibrators, generators. Flip-flops, logic description. Fundamentals of digital functional blocks - modules (combinatorial and sequential). Digital control system, logic description – algorithms. Basics of microprogramming technique. Introduction to ASICs, PLD modules – classification, development.		
Assessment methods	oral presentation (lectures), practical work in lab Written exam, accomplishment of practical lab tasks		
Recommended readings	1. Beards P. H., Analog and Digital Electronics. A First Course, II ed., Prentice Hall, 1991 2. Nelson V. P., Nagle H. T., Digital Logic Circuit Analysis and Design, Prentice Hall, New Jersey, 1995 3. Burger P., Digital Design. A Practical Course, John Wiley & Sons, New York, 1998		
Knowledge	The student has knowledge on digital circuit theory, methods and techniques of digital circuit analysis and synthesis, as well as digital circuit design.		
Skills	He has skills in the field of analysis, testing and designing digital circuits using product data sheets, application notes as well as dedicated software tools.		

Course title	Electromagnetic Compatibility		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Przemysław Łopato	**E-mail address to the person**	Przemyslaw.Lopato@zut.edu.pl
Course code (if applicable)	WE-1-12	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Gaining the knowledge about coupling mechanisms, sources of electromagnetic interference and methods of their measurement and minimization. Gaining skills related to the analysis and reduction of electromagnetic interference.		
Entry requirements	Basics of Physics and Electrical Engineering		
Course contents	Measurements and numerical analysis of electromagnetic field shielding systems. Electromagnetic emission of electrical devices - measurements in the near field. Electromagnetic emission of electrical devices - standardized measurements. Measurements of immunity of electrical systems to electromagnetic disturbances. Disturbances and filtering in electrical circuits. Overview of a project task. Carrying out a selected design and analysis of the operation of the electrical system meeting the requirements of electromagnetic compatibility. Completion of the project and presentation of its results Basic aspects of electromagnetic compatibility (EMC). Terminology. Sources of interference and coupling mechanisms. Sources of pulse and sinusoidal electromagnetic disturbances. Environmental and normative conditions, characteristics and measurements of conducted disturbances in electrical systems. Environmental and normative conditions, characteristics and measurements of radiated disturbances in electrical systems. Environmental and normative conditions, characteristics and measurements of immunity of electrical systems to electromagnetic disturbances. Surface charges and electrostatic discharge (ESD). Methods of preventing the effects of electrostatic discharges. Shielding, signal integrity, wiring, grounding and filtration techniques. The influence of electromagnetic radiation on living organisms. Protection zones. Guideline of the design of electrical and electronic systems in the context of electromagnetic compatibility. Selection of electrical materials acording to the EMC principles. Reflections, crosstalk and radiation within electrical and electronic systems - identification of emission areas and possible paths of disturbance propagation in electrical systems. Methods of analysis of potential problems with the use of electrical schemes. Overview of sample projects with possible erroneous EMC solutions. Assessment of lectures.		
Assessment methods	lectures with simple cases presentation practical classes in the laboratory continuous assessment final assessment		
Recommended readings	1. Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley & Sons, New Jersey, USA, 2006 2. Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2004		
Knowledge	The student has knowledge of the mechanisms of couplings and sources of electromagnetic interference as well as methods of their measurement and minimization.		
Skills	The student is pable to assess the operation of the electrical system in terms of electromagnetic compatibility (EMC), can make a basic analysis of EMC problems, propose and apply a measurement method		

Course title	Electromagnetic Field and Effects in the Human Body		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Katarzyna Cichoń	**E-mail address to the person**	Katarzyna.Cichon@zut.edu.pl
Course code (if applicable)	WE-1-13	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To provide up to date knowledge on analysis and modeling of EM fields in the human body, and to develop practical skills in this area		
Entry requirements	Mathematics, physics		
Course contents	Methods and ways of calculating electric and magnetic fields; numerical modeling of electromagnetic field; magnetic induction tomography and magnetoacoustic tomography with magnetic induction for biomedical applications; examples of medical applications of electromagnetic fields; biological effects of electromagnetic fields; basics of image visualization in medical imaging systems Basic concepts of electric and magnetic fields; Maxwell’s equations; electromagnetic waves; numerical modeling of electromagnetic field ; magnetic induction tomography, magnetoacoustic tomography, magnetic induction for biomedical applications; examples of medical applications of electromagnetic fields; biological effects of electromagnetic fields; image formation principles in imaging system using electromagnetic fields (magnetic resonance imaging, electron paramagnetic resonance imaging).		
Assessment methods	Lectures laboratory – computer simulations Written test and/or discussion Continuous assessment		
Recommended readings	1. Cheng D. K., Fundamentals of Engineering Electromagnetics., Addison-Wesley Publishing Company, Inc., New York, 1993 2. Durney C.H., Basic Introduction to Bioelectromagnetics, CRC Press LLC, Boca Raton, 2001 3. Malmivuo J., Plonsey R., Bioelectromagnetism, Oxford University Press, New York, 1995 4. Chari M. V. K., Salon S. J., Numerical Methods in Electromagnetism, Academic Press, San Diego, 2000 5. Sadiku M.N.O., Numerical Techniques in Electromagnetics, CRC Press LLC, Boca Raton, 2001		
Knowledge	On successful completion of this course students will have knowledge on methods for analysis and modeling of EM fields in living systems.		
Skills	On successful completion of this course students will have practical skills useful in this area.		

Course title	Electronic Devices and Circuits		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Witold Mickiewicz	**E-mail address to the person**	Witold.Mickiewicz@zut.edu.pl
Course code (if applicable)	WE-1-14	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To provide knowledge on electronic semiconductor devices selected topics on analog electronic circuits.		
Entry requirements	Mathematics Physics		
Course contents	Introduction to laboratory stands and equipment Static and dynamic characteristics of diodes. Static and dynamic characteristics of BJT. Static and dynamic characteristics of MOSFETs. Rectifiers. Discrete transistor amplifier circuits measurement Frequency characteristics measurement of passive circuits Electronic voltage regulators. Term to complete the backlog Applications of operational amplifiers. Active filters. Audio power amplifier measurements Oscillators. Laboratory skills revision Conduction in semiconductors. Diodes. Bipolar Junction Ttransistors characteristics. Transistor biasing and thermal stabilization. Small-signal low-frequency transistor model. Low-frequency transistor amplifier circuits. The high-frequency transistor. Field-effect transistors. Integrated circuits. Operational amplifiers. Feedback amplifiers and oscillators. Active filters circuits. Large-signal amplifiers. Optoelectronics devices. Rectifier and power supplies.		
Assessment methods	Lectures Laboratory exercises Written test Raports assessments		
Recommended readings	1. Boylestad R.L., Nashelsky L., Electronic devices and circuit theory, Pearson, 2013, 11		
Knowledge	The student has knowledge on basic electronic devices and circuit, methods and techniques of analog circuit analysis.		
Skills	The student has skills in the field of analysis, testing and designing simple electronic circuits using product data sheets, application notes as well as dedicated software tools.		

Course title	Elements of the EV Robotaxi Power Conversion Design		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Konrad Woronowicz	**E-mail address to the person**	konrad.woronowicz@zut.edu.pl
Course code (if applicable)	WE-1-15	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The aim of the course is to acquire deeper understanding of the principles of electromagnetics as they apply to wireless charging of the electric car as well as the priniples and performance factors of electric motors in electromobility.		
Entry requirements	Basic knowledge of electric machines and electromagnetis. Understanding of power electronics dc ot ac onverters - principles, design, analysis. Basic knowledge of C, Python or Java.		
Course contents	Learning electromagnetic software modeling techniques for permanent magnet motors and WPT systems. The main objective of the course is to learn the basic operating requirements of the automated driverless service. This is followed by learning the design principles of the robotaxi's Wireless Charging System (WCS) as well as the PMSRM (Permanent Magnet Synchronous Reluctance Motor). Students will also learn the skills in WPT and PMSRM modeling and calculation techniques using Maxwell3d and Maxwll2d electromagnetic software.		
Assessment methods	Lectures and computer laboratory exercises Exam checking the theoretical knowledge. Individual project.		
Recommended readings	1. Rashid,, Power Electronics, 2011 2. Kazimierczuk, Czarkowski, Resonant Power Converters, Wiley, New York, 2012 3. Woronowicz, Safaee, Time-Domain Analysis of Votage-Driven Series-Series Resonant Power Transfer Topology, IEEE Transactions on Power Electronics, 2017, Volume 32		
Knowledge	Basic knowledge about wireless power transfer and permanent magnet motors		
Skills	Knowledge of WPT topologies. Ability to model electromagnetic WPT and motor structures Understanding resonant converters.		

Course title	Fiber Optic Access Networks (FOAN)		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Patryk Urban	**E-mail address to the person**	patryk.urban@zut.edu.pl
Course code (if applicable)	WE-1-16	**ECTS points**	6
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The primary objective of this course is to obtain fundamental knowledge on FOAN design rules and factors influencing decisions along the design process. This is to be preceded by getting familiar with FOAN components as well as architectural and topological options for FOANs. The secondary objectives of this course are: to understand the economics of FOANs; to get familiar with various relevant job profiles through face-to-face networking with professionals in the field of optical access networks; to exercise students' presentation skills by orally reporting their project results.		
Entry requirements	Academic courses: Math, Physics. Moreover, it is recommended that course participants are familiarized with the basics of fiber optics e.g. through attending the course Fiber Optics Installation or alike. Although, essentials with this respect will be recalled during the course.		
Course contents	Project work- FOAN Network Design. Project report and presentation. FOAN Applications: Drivers and Business Needs. Bandwidth Requirements in Access Networks and Evolution of Access Networks. Generic FOAN Network Planning. FOAN Economics and Its Impacts onto FOAN Design. FOAN Terminology, Fiber Optic Symbols and FOAN-related Standards. Access Network Architectures and Transmission in FOAN. Passive Optical Network Essentials and Next Generation FOAN Outlook. FOAN Topologies, Components, Subsystems and Devices. FOAN Node Positioning. FOAN Network Design Optional: Fiber-To-The Building Design Deep-dive. Loss Budget and Passive Optical Network Class.		
Assessment methods	Lectures- multimedia presentations Project report and presentation (seminar)		
Recommended readings	1. FTTH Handbook, 2016, v7, http://www.ftthcouncil.eu/documents/Publications/FTTH_Handbook_V7.pdf		
Knowledge	At successful completion of this course the students will be familiar with Fiber Optic Access Network: architecture of networks, transmission parametres, ITU-T standards, FOAN components as well as architectural and topological options for FOANs.		
Skills	At successful completion of this course the students will be familiar with Fiber Optic Access Network: architecture of networks, transmission parametres, ITU-T standards, FOAN components as well as architectural and topological options for FOANs.		

Course title	Fundamentals of Audio Engineering		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Witold Mickiewicz	**E-mail address to the person**	Witold.Mickiewicz@zut.edu.pl
Course code (if applicable)	WE-1-17	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To provide knowledge on Audio Engineering, psychoacoustics basics and selected topics on electroacoustics (sound fields, transducers, sound reinforcement, sound processing). To provide knowledge on Audio Engineering, psychoacoustics basics and selected topics on electroacoustics. The skills to use, measure and design basic electroacoustical systems.		
Entry requirements	Basic knowledge in Mathematics and Physics		
Course contents	Human hearing sense models and properties Audio signal analysis methods Sound wave parameters measurement Microphones measurements Loudspeaker measurements Loudspeaker cabinet design Reverberation time measurements and acoustical adaptation design Speech intelligibility measurement Introduction to sound processing in Matlab Compression and enhancement of audio signal 3-D audio enhancements of 2-channel sound. Filtering and sound effects. Various individual or small group projects in Audio Engineering. Objectives of Audio Engineering. Basics of technical and musical sound description. Music and noise. Sound waves properties. Propagation, reflection, absorption, diffusion of sound waves. The decibel scale. Human auditory system. Elements of psychoacoustics – monaural and binaural hearing effects. Spatial hearing. Measurements of sound field parameters. Audio signal analysis methods. Fundamentals of room acoustics and perceiving sound in different environments. Elements of building acoustics. Electroacoustical transducers and electroacoustical systems. Directivity and angular coverage of loudspeakers. Hearing aids. Two- and multichannel reproduction systems. Hi-fi, cinema and car sound systems. Audio compression. HRTF technology and 3-D audio systems. Microphone technique. Analog and digital recording systems. DAW. Digidal audio signal processing. Production of speech and music recordings. On location recording techniques. Public address and conference systems. Analog elements of audio systems. Analog to digital and digital to analog audio signal conversion. Digital audio systems. Sound as noise.		
Assessment methods	Lectures Laboratory exercises Written test Reports assessment		
Recommended readings	1. Everest F. A., Master handbook of acoustics, McGraw-Hill, 2001 2. Howard D. H., Acoustics and psychoacoustics, Focal press, 2001		
Knowledge	To provide knowledge in various sound systems engineering		
Skills	To provide skills in various sound systems engineering		

Course title	Fundamentals of Engineering Electromagnetics		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Stanisław Gratkowski	**E-mail address to the person**	Stanislaw.Gratkowski@zut.edu.pl
Course code (if applicable)	WE-1-18	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course is intended to present a unified approach to electromagnetic fields (advanced undergraduate level)		
Entry requirements	Mathematics (a knowledge of vector calculus is helpful, but not necessary, since a short introduction to vectors is provided); physics		
Course contents	Electrostatics: calculation of electric potential, energy and forces. Calculation of capacitances. Static magnetic fields: calculation of magnetic field, inductances, magnetic energy and forces. Time-varying electromagnetic fields: electromagnetic induction, skin effect, proximity effect, eddy currents. Electromagnetic field concept. Vector analysis. Electrostatics: Coulomb's law, Gauss's law and applications, electric potential, electric dipole, materials in an electric field, energy and forces, boundary conditions, capacitances and capacitors, Poisson's and Laplace's equations, method of images. Steady electric currents, current density, equation of continuity, relaxation time, power dissipation and Joule's law, boundary conditions. Static magnetic fields: vector magnetic potential, the Biot-Savart law and applications, Ampere's law, magnetic dipole, magnetic materials, boundary conditions, inductances, magnetic energy, forces and torques. Time-varying electromagnetic fields and Maxwell's equations: Faraday's law, Maxwell's equations, potential functions, time-harmonic fields, Poynting's theorem, applications of electromagnetic fields. Plane wave propagation: plane waves in lossless media, plane waves in lossy media, polarization of wave.		
Assessment methods	Lectures with simple experiments, laboratory – computer simulations Lectures – written and oral exam; laboratory – continuous assessment		
Recommended readings	1. Cheng D. K., Fundamentals of Engineering Electromagnetics., Addison-Wesley Publishing Company, Inc., New York, 1993 2. Pollack G. L., Stump D. R., Electromagnetism, Addison Wesley Publishing Company, Inc., New York, 2002 3. Stewart J. V., Intermediate Electromagnetic Theory, World Scientific Publishing Co. Pte. Ltd., London, 2001 4. Chari M. V. K., Salon S. J., Numerical Methods in Electromagnetism, Academic Press, San Diego, 2000		
Knowledge	On successful completion of this course: Students will be familiar with the different vector operators used in Maxwell's equations Students will have an understanding of Maxwell's equations		
Skills	Students will be able to select the most appropriate laws/theorems/solution techniques for electromagnetic field analysis. Students will be able to describe and understand the basic concepts underpinning electricity and magnetism such as potential and field.		

Course title	Fundamentals of Web Development		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Przemysław Włodarski	**E-mail address to the person**	Przemyslaw.Wlodarski@zut.edu.pl
Course code (if applicable)	WE-1-19	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course is intended to present a set of technologies that enable creation of the fully functional web page, working seamlessly on mobile, tablet and large screen browsers		
Entry requirements	Some programming experience (helpful but not necessary)		
Course contents	Software project based on selected problem related to the web development technology HTML5 and CSS3: syntax, images, hyperlinks, tables, multimedia, etc. Box model, positioning Essential components of JavaScript: variables, arrays, loops, functions JQuery: chaining, DOM elements, ajax, plugins Server-side scripting language (PHP, Python): dynamic content, form processing, file handling, objects Design and implementation of database for web projects using MySQL (keys, data types, privileges system) Interacting with file system, generating images, session control user authentication and personalization, responsive design		
Assessment methods	Lectures based on presentations and solutions of selected problems Project based learning written test and / or oral discussion activity project assessment test		
Recommended readings	1. Welling L., Thomson. L., PHP and MySQL Web Development, 4th Edition, 2009 2. Duckett J., JavaScript and JQuery: Interactive Front-End Web Development, 1st Edition, 2014		
Knowledge	Knowledge of web development basics, including front-end as well as back-end side		
Skills	Ability to create web pages from scratch		

Course title	High Voltage Engineering		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Szymon Banaszak	**E-mail address to the person**	Szymon.Banaszak@zut.edu.pl
Course code (if applicable)	WE-1-20	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The aim of the subject is to acquaint students with high voltage technology, especially with phenomena related to high voltages, construction of insulation systems, methods of preventing or generating discharges, lightning and surge protection.		
Entry requirements	It is necessary to have basic information in the field of physics, electrical engineering, material engineering.		
Course contents	Introduction to high voltage laboratories Safety in high voltage laboratory Testing the dielectric strength of air in various electric field distributions Testing the dielectric strength of insulator under AC and impulse voltage Testing the voltage distibution in multielectrode systems Testing the influence of barriers on the dielectric strength of air Mid-semester test Observation of the initial voltage of partial discharges Measurements of the parameters of the ferroresonance Testing the voltage distribution of series layered solid dielectrics under AC and DC voltage Testing the parameters of the surge arrester Measuring methods for high voltage Final test Introduction to high voltage engineering Economic issues of high voltage application Electric fields in various electrodes setups Practical applications of high voltage Dielectric strength and discharge development mechanisms in vacuum/gas/liquids/solids Electric discharges, lightnings and protection against them High voltage metrology and testing Final test		
Assessment methods	Lecture Laboratories Written test. Written test.		
Recommended readings	1. E. Kuffel, W. S. Zaengl, J. Kuffel, High voltage engineering: fundamentals, Newnes (An imprint of Elsevier), 2004 2. Peek F.W., Dielectric Phenomena in HIgh Voltage Engineering, McGraw-Hill Book Company, Inc., 1915 3. M.S. Naidu, V. Kamaraju, High Voltage Engineering, Tata McGraw-Hill, 2009 4. H.M. Ryan, High Voltage Engineering and Testing, The Institution of Electrical Engineers, 2001		
Knowledge	Student gains knowledge on high voltage engineering including economic issues of high voltage application, practical applications of high voltage and high voltage metrology and testing.		
Skills	Student is able to use methods and devices for measurement of high voltages, for proper operation and development of high voltage insulation systems, knows safety precautions in high voltage engineering.		

Course title	Human-Machine Interaction		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Maja Kocoń	**E-mail address to the person**	Maja.Kocon@zut.edu.pl
Course code (if applicable)	WE-1-21	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Learning how to design modules to improve the quality of human-machine interaction.		
Entry requirements	Basic programming skills.		
Course contents	Introduction, basic methods and tools supporting the design of human-machine interaction systems. Computer graphics applications for user-machine interaction modelling. Human face detection. Facial expression analysis. Human motion recognition: head and hand gestures. Project and realisation of a basic interactive system. Introduction to human-machine interaction. The principal channels of communication as a medium in the communication process. Virtual and augmented reality technologies in interaction systems. Social robotics, current standards and regulations. Simulators and serious games. Assistive technology and adaptive tools to support people with disabilities. User detection and recognition. Object recognition and manipulation.		
Assessment methods	Lecture. Laboratory course. Exam on the last lecture meeting. Grades based on tasks performed during laboratory classes.		
Recommended readings	1. Takayuki Kanda, Hiroshi Ishiguro, Human-Robot Interaction in Social Robotics, CRC Press, 2017 2. Kerstin Dautenhahn, Alan H. Bond, Lola Canamero, Bruce Edmonds, Socially Intelligent Agents. Creating Relationships with Computers and Robots, Springer, 2002 3. Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human - Computer Interaction, Willey, 2011		
Knowledge	Students gain knowledge about new trends in the field of human-machine interaction.		
Skills	Ability to develop skills in designing modules to improve human-machine interaction.		

Course title	Introduction to Control Engineering		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paweł Dworak	**E-mail address to the person**	Pawel.Dworak@zut.edu.pl
Course code (if applicable)	WE-1-22	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Students will be able to analyze a simple process and design control loops.		
Entry requirements	Basics knowledge of physics, mathematics and signal processing.		
Course contents	Characteristics of basic elements and elementary systems. Transfer function approach. Determination of transfer functions for simple systems. P, PI, PD and PID control. Closed loop systems. Feedforward and feedback systems. Fuzzy logic and neural networks in control engineering. Control history and state of the art. Classification of control systems. Principles of automatic control. Closed loop systems. Feedback systems. Characteristics of basic elements and elementary systems. Frequency response representation – frequency domain specifications. Transfer function approach. Determination of transfer functions for simple systems. Stability of linear systems. Introduction to design – compensation techniques – P, PI, PD and PID control. Gain scheduling, fuzzy logic, neural networks in control engineering.		
Assessment methods	Lectures and practical presentations. Practical exercises. Continuous assessment. Final assessment.		
Recommended readings	1. Control System Design, Goodwin G., Graebe S.F., Salgado M.E., Prentice Hall		
Knowledge	Students will be able to analyze a simple process and design the control loops		
Skills	Students will be able to analyze a simple process and design the control loops		

Course title	Introduction to Cryptography		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Maciej Burak	**E-mail address to the person**	Maciej.Burak@zut.edu.pl
Course code (if applicable)	WE-1-23	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The course explains the workings of basic cryptographic primitives and protocols and how to use them in real world applications. Students will learn how to choose and apply basic cryptographic techniques to real-world applications.		
Entry requirements	The course is self contained, however basic knowledge of probability theory will be helpful. In order to complete the labs, basic programming knowledge is required (preferably in the C language).		
Course contents	Vigenere (XOR) and Vernam (OTP) ciphers Block ciphers, modes of operations, semantic security. Stream ciphers. Cryptographic hash functions, passwords and their weaknesses, brute force dictionary attacks, salt. Data integrity, authenticated encryption. Key management and distribution. Public key systems PKI, TLS/SSL, Certificates Unix security, authentication, authorisation, secure network protocols Overview and history of cryptography Vigenere (XOR) and Vernam (OTP) ciphers. Perfect security. Stream ciphers. Cryptographic hash functions, passwords and their weaknesses, brute force dictionary attacks, salt. Block ciphers, modes of operations, semantic security. Data integrity, authenticated encryption. Key management and distribution. Public key systems, certificates. SSL/TLS. OS Security, integrity, authorisation, authentication protocols		
Assessment methods	Lecture Labs Self study Labs outcome/reports assesment written tests		
Recommended readings	1. Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press 2. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 2016 3. Ross Anderson, SECURITY ENGINEERING, Wiley, 2010		
Knowledge	Students understand basic cryptographic prymitives and their application in operating systems and application security		
Skills	Students choose and apply cryptographic techniques to real-world applications.		

Course title	Introduction to Electric Circuits - part 1		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Tomasz Chady	**E-mail address to the person**	Tomasz.Chady@zut.edu.pl
Course code (if applicable)	WE-1-24	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To teach basics of electrical circuit theory To teach how to solve electrical circuits in various conditions Upon successful completion of this course students should be able to: - perform design and analysis of AC and DC circuits, - select optimal method of circuit analysis for the specific case, - use electric circuit simulator, - work independently and collaboratively to understand and formulate problems, and solve these problems using the provided tools and methods.		
Entry requirements	Academic course of mathematics and physics		
Course contents	Basic resistive circuits analysis DC circuits analysis Basic AC circuits analysis AC sinusoidal circuits analysis Resistive circuits DC circuit analysis Ideal and real energy storage elements Sinusoidal steady-state analysis Ideal and real resonance, frequency characteristics Introduction and electric circuit variables (Definitions, Units, Types of signals, Circuits and current flow, units, voltage, power and energy) Circuit elements (linear model, active and passive elements, independent and dependent elements) Resistive circuits (resistors, Ohm and Kirchhoff’s law, basic circuit analysis) Circuit theorems (superposition, substitution, fitting, Thevenin’s and Norton’s theorem) Circuit analysis (nodal analysis, mesh analysis) Energy storage elements (inductors, capacitors) Sinusoidal steady-state analysis (classical method, phasor method, circuit law in phasor method) Ideal and real resonance, frequency characteristics Computer simulators for circuit analysis (Spice and Matlab)		
Assessment methods	laboratory exercises practical exercises Informative lecture continous assessment final assessment		
Recommended readings	1. W.H. Hayt, J.E. Kemmerly, Engineering circuit analysis, McGraw-Hill Book Company, ISBN 0-07-027393-6 2. J.O. Attia, Pspice and Matlab for Electronics, CRC Press, 2002, ISBN 0-8493-1263-9		
Knowledge	Upon successful completion of the course, the student will be able to: • think analytically and creatively to draw conclusions and solve problems, • apply Ohm's and Kirchhoff's laws to solve for unknown voltage and/or currents • simplify series and parallel combinations of passive and active elements • use nodal analysis to write simultaneous equations • use mesh analysis to write simultaneous equations • apply superposition to linear circuits analysis • use Thevenin / Norton equivalent circuits to analyze circuits linear and selected nonlinear circuits • analyze steady state sinusoidal circuits using the advanced circuit analysis techniques (phasor method) • use phasor diagrams to visualize responses of the circuits • analyze RLC circuits in case of resonance • use basic instruments to measure voltages and currents • identify and apply the most appropriate circuit analysis technique		
Skills	Student can solve electrical circuits under various conditions		

Course title	Introduction to Electric Circuits - part 2		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Tomasz Chady	**E-mail address to the person**	Tomasz.Chady@zut.edu.pl
Course code (if applicable)	WE-1-25	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To teach how to solve electrical circuits in various conditions To teach how to use computer simulators for circuits analysis Upon successful completion of this course, the student should be able to: - work independently and collaboratively to understand and formulate problems, and solve these problems using the provided tools and methods, - use in a careful, precise manner the electric circuits simulators in order to - analyze the circuits in transient and steady state, - solve circuit in transient state using Laplace transform, - solve circuits using two-ports networks, - analyze and design circuits with operational amplifiers and mutual inductances.		
Entry requirements	Academic course of mathematics, physics, Introduction to electric circuits 1		
Course contents	Three phase circuits Self and mutual inductance Analysis of circuits in the transient state Two-port circuits analysis Passive and active filters Three phase circuits (symmetric Y and triangular, unsymmetrical circuits, power, reactive power compensation) Self and mutual inductance (ideal and with ferromagnetic core transformers) Transient phenomena (DC and AC circuits) The Laplace transformation (direct and inverse transformation) Analysis of complex circuits in the transient state The amplifiers (the operational and ideal operational amplifier) Two-port’s (passive, active, equations, T and Pi scheme, A, A-1 Y, Z, h, g parameters, relationship between parameters, interconnection of two port networks) Fourier series (formulas, spectrum, power, compensation reactive power) Filters (passive, active and digital) Computer simulators for circuit analysis (Spice and Matlab)		
Assessment methods	laboratory exercises Informative lecture continous assessment final assessment - written exam		
Recommended readings	1. W.H. Hayt, J.E. Kemmerly, Engineering circuit analysis, McGraw-Hill Book Company, ISBN 0-07-027393-6 2. J.O. Attia, Pspice and Matlab for Electronics, CRC Press, 2002, ISBN 0-8493-1263-9		
Knowledge	Upon successful completion of the course, the student will be able to: • think analytically and creatively to draw conclusions and solve problems, • identify, formulate, and solve engineering problems • analyze steady state sinusoidal three phase circuits, • use phasor diagrams to visualize responses of the three phase circuits, • analyze transient state in the first and second order RLC circuits by solving the differential equations and using the Laplace transform. • identify and apply the most appropriate circuit analysis technique, • know the characteristics of the opamp, • use opamps in order to achieve the desired function, • use Fourier series to analyze circuits with no sinusoidal sources, • use the two port networks, • design passive and active filters with desired characteristics, • use computer simulators (SPICE) for numerical circuit modelling and analysis, • critically evaluate their chosen problem solving techniques and the accuracy of their answers.		
Skills	Student can solve the problems and simulate the operation of advanced AC circuits under various conditions.		

Course title	Introduction to Infrared Thermography		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Barbara Grochowalska	**E-mail address to the person**	Barbara.Szymanik@zut.edu.pl
Course code (if applicable)	WE-1-26	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Students will learn basics theoretical aspects of heat transfer and active infrared thermography. Students will learn how to use an active thermography in practice.		
Entry requirements	Course in mathematics and physics. Basic programming skills - C++, matlab		
Course contents	Chosen experimental problem - active infrared themography. Numerical modelling of the problem, experimental methodology, experiments, image and data processing. Introduction to thermal emission. Blackbody. Planck's Law. Wien Displacement Law. Stefan-Boltzmann Law. Reflection, absorption, transmission. Emissivity. Introduction to heat transfer. Thermal conductivity. Conduction, radiation, convection heat transfer. Analitycal approach - one dimentional heat transfer. Numerical modelling - FEM. Infrared sensors. Introduction to image and data processing. Active and passive thermography. Other NDT techniques, comparison. Thermal wave theory. Pulsed, stepped heating, lock-in thermography. Heating sources. Quantitative data analysis in active thermography. Thermal contrast. Defect evaluation. PPT, statistical methods, neural network, wavelets. Concept of thermal tomography. Active thermography - case studies.		
Assessment methods	Lecture. Presentation. Self study. Continous assessment. Final assessment. Exam, project report assessment.		
Recommended readings	1. X. Maldague, Theory and practice of infrared technology for nondestructive testing, Wiley, 2001 2. W. Minkina, S. Dudzik, Infrared Thermography: Errors and Uncertainties, Wiley, 2009		
Knowledge	After this course the student will be able to: - think analytically to solve the complex engineering problems, - use the theory of heat transfer and infrared radiation to solve the chosen problems, - design and conduct the experiment in the field of active thermography, - use dedicated laboratory devices and software, - use COMSOL software to create numerical models analysing heat transfer and infrared radiation phenomena - use Matlab to process experimental data - prepare scientific reports, - draw the conclusions from the experiments, analyse critically the results.		
Skills	After this course the student will get the skills about: - solving the complex engineering problems concerning , heat and infrared radiation, designing and conducting experiments in the field of active thermography, using dedicated laboratory devices and software, using COMSOL software to create numerical models and preparing scientific reports.		

Course title	Introduction to Matlab		
Level of course	first cycle		
Teaching method	laboratory class / project		
Person responsible for the course	Przemysław Orłowski	**E-mail address to the person**	Przemyslaw.Orlowski@zut.edu.pl
Course code (if applicable)	WE-1-27	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Understanding the MATLAB environment Being able to do simple calculations using MATLAB Being able to carry out simple numerical computations and analyses using MATLAB Understand the main features of the MATLAB development environment Use the MATLAB GUI effectively Design simple algorithms to solve problems Write simple programs in MATLAB to solve scientific and mathematical problems		
Entry requirements	Basic skills in mathematics		
Course contents	Introduction to computational tools: Matlab, Scilab, and Octave Matlab computer application, Matlab online, Matlab mobile application, reading sensors on the phone, Matlab drive. Opening and modifying the script, saving data. Matlab Publisher - generating reports in doc, pdf, and html formats. Data types. Generating vectors, arrays. Regular and logical indexing. Basic array operations. Single and multidimensional arrays, integer and logical array indexing, array operations, joining, reducing, block operations. Generating periodic signals with given parameters and shape: sine, rectangle, triangle, saw, pulse, trapezoid - symmetric and asymmetric variant, one- and two-half signal rectifiers. Visualization: Line Plots, Image/Surface Plots. Creating graphs in 3D space for functions with 1 and 2 independent variables and in the form of a set of irregular points belonging to a certain surface. Determining cross-section of planes. Programming: User Functions, Flow Control. -Defining input-output arguments, functions with a variable number of input and output variables, nested functions. Interactive functions and scripts (Live Script), interactive elements, export in the form of a report to a doc file. Debugger and profiler – tools for diagnosing and correcting errors and assessing program execution time. On the example of the 1-dimensional Brownian motion model. Accelerating program execution using parallel computation and the compiler. Data import from Excel. Designing an interactive GUI using AppDesigner. Simulink – solving and simulation of differential equations by the transformation into a block diagram. Symbolic calculations, solving algebraic equations, and systems of equations. Project related to selected computational topic.		
Assessment methods	demonstration simulation work using computer and Matlab software practical exercises accomplishment of the lab tasks final assesment and validation of the report		
Recommended readings	1. Matlab Manuals, Mathworks Inc., 2019 2. SIMULINK Model-Based and System-Based Design Using Simulink, Mathworks Inc., 2019 3. MATLAB Getting Started Guide, Mathworks Inc., 2019, http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf		
Knowledge	Understand the main features of the MATLAB development environment		
Skills	Being able to carry out simple numerical computations and analyses using MATLAB		

Course title	Introduction to Microcontrollers		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Witold Mickiewicz	**E-mail address to the person**	Witold.Mickiewicz@zut.edu.pl
Course code (if applicable)	WE-1-28	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	The student will know the internal structure of microcontrollers and microprocessor systems, will understand the principles of their operation and programming. Will know the principles of designing the electronic devices based on microcontrollers. The student will know, how to write the programs for microcontrollers in C language and run and test it on educational kit.		
Entry requirements	Mathematics, Informatics, Digital Technique		
Course contents	Description of didactic work station. Presentation of software tools for AVR - Atmel Studio. Introduction to C language for microcontrollers. Simple examples programs in C. Programming of I/O ports of ATmega microcontroller. Timers in ATmega microcontroller. Use of Normal and CTC modes for generating time intervals. Interrupt system of ATmega microcontroller. Revision programming exercise. Control of 7-segment multi digit numeric LED display. Entering digital data into microcontrollers with use of electric contacts, switches and matrix keyboard. Revision programming exercise. Stepper motor control. Analog to Digital converter programming. Use of timer PWM mode based on selected examples. Data transmission through serial communication devices UART. LCD display control. External interrupts. End of term revision programming exercise. Practical exam. General microprocessor construction, block diagram of microprocessor system. Microprocessor vs microcontroller. Architecture of microprocessor systems. I/O port as basic communication channel in microprocessor system. Construction of I/O port based of selected examples microcontroller families. Electric and timing parameters of I/O port. Examples of connecting external devices to I/O port. I/O port programming examples. Microprocessor instructions: structure, methods of writing instructions, execution cycle, 1-byte and multi-byte instructions. List of microprocessor instructions, types of instructions. Assembler language, translating programs. General information about high level languages used in microcontrollers programming. Timers in microcontrollers. Construction, modes of work, use and programming. Review of typical solutions. Pulse Width Modulation - PWM mode of timers. Basic concepts of microprocessor technology: data bus, tri-state buffer etc. Interrupt system - operating principle, use of interrupts in microcontrollers programming Synchronous and asynchronous serial communication. Communication device USART, serial interfaces: SPI, I2C (TWI). Parameters, areas of using. Review of serial interfaces in various microcontroller families. Analog to Digital converters and Digital to Analog converters in microprocessor system. Characteristics, parameters of converters. Review of A/D and D/A converters in various microcontroller families. Clock system of microprocessor, clock signal distribution. Microprocessor and microcontroller supervisory circuits - watchdog. Power-down, Power-save modes. RTC circuits. Final Test Review of most popular microcontroller's families and embedded platforms: state of the art and development trends.		
Assessment methods	oral presentation (lectures), practical work in lab Written exam Accomplishment of practical lab tasks		
Recommended readings	1. Kernighan B., Ritchie D., The C programming language, Prentice Hall, New Jersey, 1998 2. Williams E., AVR Programming: Learning to write software for hardware, Maker Media Inc., 2014, 1 3. M. Ali Mazidi, S. Naimi, S.Naimi, AVR microcontroller and embedded systems: Assembly and C, Pearson Education Limited, 2014		
Knowledge	To provide basic knowledge in 8-bit microcontrollers.		
Skills	To provide skills in creating application software using C language for 8-bit microcontrollers.		

Course title	Introduction to Multisensor Data Mining and Fusion		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Grzegorz Psuj	**E-mail address to the person**	Grzegorz.Psuj@zut.edu.pl
Course code (if applicable)	WE-1-29	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	This course is intended to present an introduction to the multisensor data fusion concept and theory followed by the case study.		
Entry requirements	Academic course of mathematics. Academic course of informatics (knowlegde and skills in the programming, basics of Matlab programming)		
Course contents	Design and implementation of data processing algorithm (in Matlab, Python, etc.) for the specified by teacher case. Presentation of the final solution and the report. Introduction: motivation, concepts and theory of data mining and data fusion. Data mining process and data fusion models and architectures. Data registration: concepts and theory, algorithms partition and basic description, examples. Data mining and data fusion algorithms: concepts and theory, algorithms partition and basic description. Quality assessment factors of performance evaluation. Case study of data fusion applications.		
Assessment methods	Lectures with simple cases presentations Project – design and implementation of data fusion algorithm Lectures – oral exam Project – report assessment		
Recommended readings	1. D. L. Hall, Sonya A. H. McMullen, Mathematical Techniques in Multisensor Data Fusion, Artech House Publishers, 2004 2. M. E. Liggins, D. L. Hall, J. Llians, Handbook of Multisensor Data Fusion, CRC Press LLC, 2009, 2nd ed. 3. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier Inc., 2011		
Knowledge	Student knows the basic theory about the data fusion concept, models, architectures and levels division, as well as the data registration general procedure and basic algorithms quality assessment factors.		
Skills	Student can design, adopt, proceed and assess the data fusion algorithm for exemplary cases.		

Course title	Machine and Deep Learning		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Adam Krzyżak	**E-mail address to the person**	Adam.Krzyzak@zut.edu.pl
Course code (if applicable)	WE-1-30	**ECTS points**	7
Semester	summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	This course is intended to present a unified approach to machine learning techniques and algorithms and their applications in practical problems.		
Entry requirements	Basic knowledge of Matlab or Mathcad environments Basic knowledge about programming Basic knowledge of linear algebra, probability and statistics		
Course contents	Students prepare individual project with the requirements given by the teacher. Classification Generative vs. discriminative learning Naive Bayes Gaussian discriminant analysis Linear models: linear and polynomial regression L2 and L1 regularization Sparse models, logistic regression Non-linear models: decision trees, instance-based learning, random forest, adaboost, shallow neural networks Support vector machines and kernels Computational learning theory Unsupervised learning: clustering K-means, mixture models, density estimation, expectation maximization Autoencoder, PCA Structured models: graphical models, Bayes nets. Learning in dynamical systems: Hidden Markov Models and other types of temporal/sequence models. Approximate inference. Gibbs sampling. Deep belief learning. Survey of deep neural network architectures Convolutional neural networks Recurrent neural networks, attention, transformers Generative adversarial networks (GANs)		
Assessment methods	Traditional lecture. Students prepare individual projects and reports. Written exam (test) / project work		
Recommended readings	1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006 2. Yoshua Bengio, Aaron Courville and Ian Goodfellow, Deep Learning, MIT Press, Cambridge, Massachusetts, USA, 2016 3. Aurelian Geron, Hands-on Machine Learning with Scikit-Learn, Keras & TensortFlow, O'Reilly, Sebastopol, CA, USA, 2023, 3 4. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, Cham , Switzerland, 2023 5. Christopher Bishop and Hugh Bishop, Deep Learning, Springer, Cham, Switzerland, 2024		
Knowledge	Knowledge of basic machine learning algorithms. Ability to implement some machine learning algorithms in chosen environment (e.g. Matlab).		
Skills	Students will get the skills about creating algorithms related to the machine learning theory and also ability to implement some machine learning algorithms in chosen environment (e.g. Matlab).		

Course title	Magnetic Measurements Techniques		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Grzegorz Psuj	**E-mail address to the person**	Grzegorz.Psuj@zut.edu.pl
Course code (if applicable)	WE-1-31	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	This course is intended to present a basic knowledge of magnetic measurements and and their practical application.		
Entry requirements	Academic course in mathematics and physics.		
Course contents	Introduction to the topic of the project. Implementation of a project task in the laboratory. Presentation of the results and discussion of the achieved solutions. Fundamentals of magnetic measurements. Sources of magnetic fields. Magnetic materials and their properties. Magnetic sensors. Magnetic field measurement. Systems for measurements of magnetic materials.		
Assessment methods	Lectures with multimedia presentation. Project – design, analysis and practical implementation of magnetic measurements systems. Lectures – oral exam Project – continous assessment with final report evaluation.		
Recommended readings	1. Tumanski S., Handbook of magnetic measurements, CRC Press, Taylor & Francis Group, Boca Raton, 2011 2. Bozorth R. M., Ferromagnetism, IEEE Press, New Jersey, 2003		
Knowledge	Student will gain the basic knowledge about magnetic measurements concept, magnetic materials, sensing device and measuring systems.		
Skills	Student is able to design / adopt and analyze the operation of the measuring system and carry out the magnetic measurements.		

Course title	Modern Electrical Machines		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Ryszard Pałka	**E-mail address to the person**	Ryszard.Palka@zut.edu.pl
Course code (if applicable)	WE-1-32	**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 the fundamental and expert knowledge about construction, development, numerical evaluation and optimization of modern electrical machines.		
Entry requirements	Basics of electrical engineering, basics of electrical machines, electromagnetic field theory, numerical methods.		
Course contents	Carrying out the selected project. The course gives the knowledge about construction of modern electrical machines: • Permanent magnet excited synchronous machines, • Transverse flux machines, axial flux machines, • Switched reluctance machines, • Different electrical machines for hybrid and pure electric vehicles.		
Assessment methods	Lecture Project Written exam Project work		
Recommended readings	1. Gieras J. F., Wing M., Permanent magnet motor technology, Wiley&Sons, 2008 2. Austin Hughes, Electric Motors and Drives, Elsevier Ltd., 2006 3. Chiasson J., Modeling and high-performance control of electric machines, Wiley&Sons, 2005 4. Larminie J., Lowry J., Electric Vehicle Technology Explained, Wiley&Sons, 2003 5. Gieras J. F., et al., Noise of Polyphase Electric Motors, CRC Press, 2006 6. Pyrhoenen J., et al., Design of Rotating Electrical Machines, Wiley & Sons, 2008		
Knowledge	The student has increased knowledge of new solutions on methods and techniques used in modern electrical machines as well as on research methodology used in this field.		
Skills	The student has practical skills useful in this area regarding design, calculation and optimizaton of electrical machines.		

Course title	Network Systems Administration		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Piotr Lech	**E-mail address to the person**	Piotr.Lech@zut.edu.pl
Course code (if applicable)	WE-1-33	**ECTS points**	4
Semester	summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The ability to use administrative tools. Familiarization with the administration type networks LAN and WAN. Understanding the issues related to the administration of selected network services, user accounts and computer systems caused or information.		
Entry requirements	Basic knowledge of computer networks and support for applications and operating systems.		
Course contents	Selected aspects of network administration with devices Layer 2 and Layer 3 ISO / OSI model. Administration and managage access networks and WAN - simulation. Creating a virtual network environment. IP network design. Configuration and management of virtual devices and serwerwerami. Differences in administacji network systems on the network example, Linux and Windows. Managing user accounts and resources. Administration selected network services Installation, configuration and administration of the web server. Installation, configuration and administration of Joomla. Web-based tools to assist the administration of network devices and services. Design scenarios and implementation backup for given parameters. Examination of the laboratory The network administrator. Managing user accounts and resources depending on the operating system. Administrator Tool observation network traffic, network protocol analysis, selected aspects of network security. Simulations. Selected aspects of configuration, management and administration of network devices. Configuration and administration of access devices, access to adminstracji WAN. Configuration and management of network services such as: mail, FTP, SQL, Web. Construction, administration and management of advanced content management systems. Backups, backup scenarios. Management and administration of multimedia networks.		
Assessment methods	lecture discussion laboratory tasks test evaluation report assessment of laboratory tasks		
Recommended readings	1. Thomas A. Limoncelli, The Practice of System and Network Administration, Second Edition		
Knowledge	Working knowledge of networking terms and concepts pertaining to system administration, terms that characterize the attributes of networks and aspects of network operation.		
Skills	Ability to observation of system behavior. Ability actions taken to accomplish sysadmin related to administration tasks.		

Course title	Network Traffic		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Przemysław Włodarski	**E-mail address to the person**	Przemyslaw.Wlodarski@zut.edu.pl
Course code (if applicable)	WE-1-34	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	This course is intended to present selected issues of ICT network traffic and performance evaluation		
Entry requirements	Fundamentals of computer networks		
Course contents	Computer network configuration for different network setups Capturing, filtering and inspecting of L2 and L3 layers Traffic synthesis based on stochastic processes Delay and loss analysis based on selected generation models Collecting data using SNMP Traffic shaping for different queueing disciplines (TBF, HTB, SFQ, etc.) Analysis of basic queues in real computer networks Configuration of multicast and real-time applications Configuration and performance evaluation for different network setups Delay and loss analysis Network traffic generation model Synthesis of traffic flows based on stochastic processes Collecting data using SNMP Traffic shaping and control using classless (SFQ, GRED, TBF) and classful (HTB, CBQ, PRIO) queueing disciplines Basic queues and their impact on network traffic		
Assessment methods	Lectures based on presentations and solutions of selected problems Laboratory tasks and exercises Written test and / or oral discussion Assessment of accomplished tasks and exercises test		
Recommended readings	1. Armitage G., Quality of Service in IP Networks: Foundations for a Multi-service Internet, 2000		
Knowledge	Knowledge of network traffic issues and performance evaluation		
Skills	Ability to configure and control network traffic in various applications (best effort, real-time)		

Course title	Neural Networks and Deep Learning		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Przemysław Mazurek	**E-mail address to the person**	Przemyslaw.Mazurek@zut.edu.pl
Course code (if applicable)	WE-1-35	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Basic knowledge related to neural networks and deep learning		
Entry requirements	Computer science		
Course contents	Design of system with neural network Fundamentals of Pattern Recognition Artificial Neural Networks Convolutional Neural Networks Test of Knowledge		
Assessment methods	Instructional method/informative lecture Practical method/project Passing the project A pass in the form of a choice test		
Recommended readings	1. I. Goodfellow, Y. Bengio, A.Courville, Deep Learning, MIT Press, 2016 2. Ch.C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 2018 3. T. Masters, Practical Neural Network Recipes in C++, Morgan Kaufmann, 1993		
Knowledge	Knowledge related to neural networks and deep learning		
Skills	Skills related to design systems with neural networks and deep learning		

Course title	Non-destructive Testing Using Electromagnetic Methods		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Tomasz Chady	**E-mail address to the person**	Tomasz.Chady@zut.edu.pl
Course code (if applicable)	WE-1-36	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To teach basics of electromagnetic methods of NDT To teach how to apply specific method of NDT in practical applications Upon successful completion of this course, the student will be able to: - use THz imaging system, eddy current system, MFL system, computer and digital XRay system, - use in a careful, precise manner the numerical simulator in order to analyze the electromagnetic transducers for NDT, - select appropriate NDT method for specific case, - work independently and collaboratively to understand and formulate problems, and solve these problems using the provided tools and methods.		
Entry requirements	Academic course of mathematics Academic course of physics Academic course of electrotechnics or circuit theory Basic knowledge of Matlab programming		
Course contents	Magnetic field sensing DC and AC magnetic field methods of ferromagnetic materials testing and evaluation Eddy current testing of conductive materials Numerical modeling in NDT (eddy current, microwave/terahertz methods) Terahertz testing of dielectric and composite materials Digital radiography Non-destructive testing - the introduction, the basic idea, the historical background Overview of different methods of non-destructive testing Transducers for measuring magnetic fields Non-destructive testing using Barkhausen noise Method of flux leakage Eddy current method Evaluation of low conductivity materials using electromagnetic waves of high frequency Computer and digital radiography Numerical modeling in NDT using Matlab and Comsol The algorithms of digital signal processing in NDT Algorithms for identification in NDT Data fusion algorithms Computer systems in NDT Industrial tomography Overview of commercial non-destructive testing systems		
Assessment methods	Informative lecture Laboratory exercises Written exam (Lect.) Continuous assessment (Lab)		
Recommended readings	1. Blitz J., Electrical And Magnetic Methods Of Non-Destructive Testing, Springer- Verlag, 1997		
Knowledge	Upon successful completion of the course, the student will be able to: identify, formulate, and solve engineering problems in the field of NDT, explain the principles of the major NDT methods, identify advantages and limitations of nondestructive testing methods and to select the appropriate techniques for inspections in specific application, use selected software for numerical modelling of NDT systems, use selected hardware for practical NDT (i.e. THz TDS or digital detectors for X-ray testing, critically evaluate their chosen problem solving techniques and the accuracy of their answers.		
Skills			

Upon successful completion of the course, the student will be able to: identify, formulate, and solve engineering problems in the field of NDT, explain the principles of the major NDT methods, identify advantages and limitations of nondestructive testing methods and to select the appropriate techniques for inspections in specific application, use selected software for numerical modelling of NDT systems, use selected hardware for practical NDT (i.e. THz TDS or digital detectors for X-ray testing, critically evaluate their chosen problem solving techniques and the accuracy of their answers.

Course title	Object-Oriented Programming in C#		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Marcin Ziółkowski	**E-mail address to the person**	Marcin.Ziolkowski@zut.edu.pl
Course code (if applicable)	WE-1-37	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course is intended to present object-oriented programming techniques in C# language.		
Entry requirements	Mathematics		
Course contents	Application structure in C# Data Types Loops Static Methods Exceptions Files and Streams Arrays Structures Classes Constructor Inheritance Application structure in C# Data Types Loops Static Methods Exceptions Files and Streams Arrays Classes Constructor Structures Inheritance Abstract Classes Polymorphism Collections Windows Forms		
Assessment methods	Traditional lecture Computer laboratory In-class assessments		
Recommended readings	1. A. Hejlsberg, M. Torgersen, S. Wiltamuth, P. Gold, The C# Programming Language, Addison-Wesley, 2011		
Knowledge	Students will get the knowledge about modern object-oriented language.		
Skills	Students will be able to write a program based on modern object-oriented programming language.		

Course title	Optoelectronic sensors		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Grzegorz Żegliński	**E-mail address to the person**	Grzegorz.Zeglinski@zut.edu.pl
Course code (if applicable)	WE-1-38	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The course will provide the basic knowledge of modelling methods of IR optoelectronic sensor and their applications. The students will get ability to design of modern optoelectronic sensor systems with emphasis on advanced fiber-optic sensor systems.		
Entry requirements	Academic courses: Mathematics, Physics.		
Course contents	The sensor software tools- lab training. The distance optical fiber sensor. The Light intensity-modulated fiber-optic displacement sensor. The fiber optic interferometric device. The characteristics of VIS diode lasers. The detector measurements for IR aplications. The laser driver. The amplifiers for detectors. Temperature measurements by pirometer. The optical strain sensor based on fiber. Optoelectronic sensors for arduino platform. The subbsision tiime deadline for lab reports Project work- The simple microcontroler circuit with a optoelectronic sensor for industrial application. Optoelectronic sensor technologies. Multimode and singlemode fiber optic sensors. The birefringe in optical fibers. PM fiber sensors. Bragg fibers. Holey and Photonic Crystal Fibers. Photonic Bandgap Guidance. Diode lasers for sensors. Detectors. Electronic drivers for sensor transmitters and receivers. Splitters and couplers for sensor systems. Optoelectronic sensors in the medicial applications. Industrial applications (The robotic industrial line, gas sensors, automotive sensors). Sensor for IoT . Health monitoring. New optoelectronic sensors for environment monitoring.		
Assessment methods	Lectures- multimedia presentations Lab exercises Final report Test Lab report		
Recommended readings	1. Giancarlo C Righini , Antonella Tajani, Antonello Cutolo, An Introduction to Optoelectronic Sensors, Series in Optics and Photonics: Volume 7 , World Scientific, Singapore, 2009 2. Asit Baran Maity, Optoelectronics and Optical Fiber Sensors, University Bookstore, B-74,New delhi, India,, New delhi, India,, 2013		
Knowledge	At successful completion of this course the students will be familiar with special optical fiber and optolectronic sensors modelling and design.		
Skills	At successful completion of this course the students will be familiar with special optical fiber and optolectronic devices - modelling and design. The course will also provide the basic knowledge of optoeletronic sensors and their applications.		

Course title	Photonic elements and properties of laser light		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Andrzej Ziółkowski	**E-mail address to the person**	Andrzej.Ziolkowski@zut.edu.pl
Course code (if applicable)	WE-1-39	**ECTS points**	3
Semester	winter	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Students will get the knowledge about fundamentals of light theory and the skills to build simple photonic setup and investigate of laser beam properties.		
Entry requirements	Basics of physics, in particular basic issues of optics.		
Course contents	Student performs a project in the form of an labratory setup or numerical task in the area of laser optics. The properties of light as an electromagnetic wave, in particular the laser beams. Methods of describing the phenomena of interference, diffraction and polarization of light. Selected photonic elements and optical systems.		
Assessment methods	Lectures Laboratory course Final report and design presentation.		
Recommended readings	1. B. E. A. Saleh, M. C. Teich, Fundamentals of Photonics, Wiley Series in Pure and Applied Optics, 2007 2. E. Rosencher, B. Vinter, Optoelectronics, Cambridge University Press, Cambridge, 2002 3. K. Izuka, Engineering Optics, Springer, 2008		
Knowledge	During the course, students will gain a basic knowledge of the properties of laser beam and simple optical systems.		
Skills	Student will be able to design, build and test simple photonic setup.		

Course title	Power Systems with Renewable Energy Sources		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Michał Zeńczak	**E-mail address to the person**	Michal.Zenczak@zut.edu.pl
Course code (if applicable)	WE-1-40	**ECTS points**	7
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Knowledge about composition and operation of power system, Skills of calculation in power system: load flows, short-circuits Skills of investigation of basic phenomena in power system.		
Entry requirements	Basis of electrical engineering Mathematics Physics		
Course contents	Calculation of load flow study Calculation of voltage losses and drops Calculation of short-circuits currents, Measurements of currents and voltages in power system Measurements of voltage drops Investigation of radial networks Investigation of voltage control in power system Investigation of short-circuits Investigation of non-homogeneous network. Composition of power system Methods of generation of electrical energy Photovoltaic power plants Wind power plants Nuclear power plants Geothermal power plants Methods of energy storage Power stations Equivalent diagrams, voltage loss and voltage drop, vector diagrams Load flow study, power losses Control of active power and frequency Control of voltage and reactive power Basic interferences in power system		
Assessment methods	Informative lecture Problem-based lecture Subject exercises Laboratory exercises Continuous assessment in laboratory Final test on the end of classes and lectures		
Recommended readings	1. Grigsby L.L., The Electric Power Engineering Handbook, CRC Press, New York, 1998 2. Grigsby L.L., Electric Power Generation, Transmission and Distribution, CRC Press, New York, 2007		
Knowledge	Student is able to calculate different state in power system.		
Skills	Student is able to calculate different state in power system.		

Course title	Programmable Automation System Based on PLC and HMI		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Krzysztof Jaroszewski	**E-mail address to the person**	Krzysztof.Jaroszewski@zut.edu.pl
Course code (if applicable)	WE-1-41	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	To form skills of programming automation system consists of: Programming Logical Controllers (PLC's) - in the control level and Human Machine Interfaces (HMI's) – in operation level. Moreover, subject with diagnostic and fault tolerant control algorithms will be brought closer. During practical parts of the course SIMATIC by SIEMENS devices will be used: PLC: S7-1200, HMI: KTP600 to build controll system.		
Entry requirements	Basic of mathematical logic. Basic of electrical engineering. Basic of information technology.		
Course contents	Operation of digital I/O Counting number of events Time counting Analog signals Introduction - task explanation Concept of control system PLC programming Visualization design System validation Documentation preparation Presentation of achievemets Programmable Logic Controlers - introduction PLC - basic logic - digital I/O PLC - counters PLC - timers PLC - other functions		
Assessment methods	Lecture with usig PC Practical tasks with using PC, PLC and HMI devices Exam Task realisation marking		
Recommended readings	1. Nebojsa Matic, Introduction to PLC controllers, MikroElektronika, 2009 2. SIEMENS, manuals, SIEMENS		
Knowledge	Ability to design automation system including elementary diagnostics and built project on PLC and HMI.		
Skills	Ability to design automation system including elementary diagnostics and built project on PLC and HMI.		

Course title	Programmable Logic Devices		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Witold Mickiewicz	**E-mail address to the person**	Witold.Mickiewicz@zut.edu.pl
Course code (if applicable)	WE-1-42	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	To provide knowledge on programmable logic devices and their use in modern digital system design Student will be able to describe the building blocks in modern CPLD and FPGA integrated circuits. Student will be able to design and test simple digital apliances using programmable IC's and hardware description language.		
Entry requirements	Basic knowledge on digital circuits and informatics		
Course contents	Introduction to the programming environment and laboratory board Implementation of combinational circuits. Part 1. Implementation of combinational circuits. Part 2. Register circuits. Part 1 – synchronous flip-flops and shift register. Register circuits. Part 2 – counters. The implementation of synchronous machines in programmable logic devices. Elimination of switches contact debouncing. VGA video generator in the FPGA structure. Final test. Design and testing of various digital systems designed using FPGA laboratory boards. Categorization of programmable logic devices. Design systems for SPLD and CPLD. Configuration memory. Properties and configuration of logic blocks (LUT, FF) and I/O in FPGA. Specialized blocks – RAM, multipliers. Distribution of clock signals (PLL, DLL). Metastability. Abstraction levels in digital systems description. Elements of VHDL. Designing paths. Design environments for FPGA design. JTAG. Systems on Chip. Structured ASIC.		
Assessment methods	Lectures work in laboratory Projects design Reports written assessment written test		
Recommended readings	1. Skahill K., VHDL. Design of programmable logic devices, Prentice Hall, 2001 2. Sunggu Lee, Design of computers and other complex digital devices, Prentice Hall, 2000 3. Zwolinski Mark, Digital System Desin withVHDL., Pearson Education Limited, 2004, 2		
Knowledge	Student will be able to describe the building blocks in modern CPLD and FPGA integrated circuits.		
Skills	Student will be able to design and test simple digital apliances using programmable IC's and hardware description language.		

Course title	Signal Processing		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Joanna Górecka	**E-mail address to the person**	Joanna.Gorecka@zut.edu.pl
Course code (if applicable)	WE-1-43	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To provide up to date knowledge on methods and techniques used in acquisition, processing and analysis of signals and to develop practical skills useful in this field.		
Entry requirements	Mathematics		
Course contents	Discrete-Time Signals Fourier Transform Theorems Discrete-Time Random Signals z-Transform properties Examples of filter design technique Computation of the Discrete Fourier Transform (FFT analysis) Fourier analysis of signals using the Discrete Fourier Transform Discrete Hilbert Transforms properties Introduction to Discrete-Time Signals and Systems Fourier Transform Theorems The z-Transform Sampling of Continuous-Time Signals Transform analysis of Linear Time-Invariant Systems Structures for Discrete-Time Systems Filter Design Techniques The Discrete Fourier Transform Discrete Hilbert Transforms		
Assessment methods	oral presentation (lectures), practical work in lab grade, accomplishment of lab tasks		
Recommended readings	1. Oppenheim A.V, Schafer R.W., Digital Signal Processing, 2001 2. Oppenheim A.V, Schafer R.W., Discrete-Time Signal Processing, Prentice Hall; 2 edition, 1999 3. Proakis J.G., Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall; 3rd edition, 1995		
Knowledge	The student has knowledge on methods and techniques used in acquisition, processing and analysis of signals as well as on research methodology used in this field.		
Skills	The student has practical skills useful in this area regarding signal measurements (instrumentation, specialized software tools).		

Course title	Statistical Methods in ICT		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Przemysław Włodarski	**E-mail address to the person**	Przemyslaw.Wlodarski@zut.edu.pl
Course code (if applicable)	WE-1-44	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course is intended to present statistical methods in ICT for analysis and modeling purposes		
Entry requirements	Mathematics, basics of computer networks		
Course contents	Project based on selected problem in ICT using statistical methods and models Statistical data analysis, random variables, distributions, stochastic processes Traditional models in Telecommunication Networks: Poisson, Markov Modulated Poisson Process (MMPP) Estimation of self-similarity in computer networks: R/S analysis, variance-time plot, Index of Dispertion for Counts (IDC), peridogram and wavelet analysis, Whittle and local estimators Superposition of heavy-tailed on/off sources, FARIMA processes, Pareto Modulated Poisson Process (PMPP) Markov Modulated Bernouli Process (MMBP), circulant embedded matrix method, Spatial Renewal Processes (SRP) Methods based on power spectrum of fractional Gaussian noise Queueing models in telecommunication networks: M/M/1/(K), M/D/1/(K), M/G/1/(K), G/M/1/(K), G/G/1/(K) Generation of self-similar traffic using traditional and self-similar models		
Assessment methods	Lectures based on presentations and solutions of selected problems Project based learning Written test and / or oral discussion Project assessment		
Recommended readings	1. Medhi J., Stochastic models in queueing theory. Academic Press, 2nd edition, 2002 2. Gross D., Harris C.M., Fundamentals of queueing theory. Wiley-Interscience, 3rd edition, 1998 3. Park, K., Willinger, W., Self-similar network traffic and performance evaluation, 2000		
Knowledge	Knowledge of statistical methods in ICT for evaluation of network performance		
Skills	Ability to analyze and generate network traffic using statistical methods in ICT		

Course title	Terahertz Technique		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Przemysław Łopato	**E-mail address to the person**	Przemyslaw.Lopato@zut.edu.pl
Course code (if applicable)	WE-1-45	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	This course is intended to present a basic knowledge of terahertz technique and its application in modern industry		
Entry requirements	Basic course of mathematics and physics (electromagnetics)		
Course contents	Modeling and measurements of structures in terahertz technology Introduction to electromagnetic waves. Generation and detection of EM waves in the THz frequency range. Materials properties and metamaterials in THz frequency range. Passive devices in terahertz technology. CAD of terahertz systems. Overview of available terahertz systems. Application of terahertz technique in spectroscopy, imaging, biomedical engineering, public safety and short-range wireless transmissions.		
Assessment methods	Lectures in form of multimedia presentation Project – designing, measurements and computer simulations of terahertz devices/systems Lectures – oral exam Project – continous assessment		
Recommended readings	1. Sakai K., Terahertz optoelectronics, Springer, Berlin, 2005 2. Mittleman D. (Ed.), Sensing with terahertz radiation, Springer, Berlin, 2010 3. Miles R. E., Harrison P., Lippens D., Terahertz sources and systems, Kluwer, Dordrecht, 2001		
Knowledge	During the course, students will gain a basic knowledge of the operation, design and modeling of measurement systems that use electromagnetic waves in the terahertz range.		
Skills	During the course, students will gain a basic knowledge of the operation, design and modeling of measurement systems that use electromagnetic waves in the terahertz range.		

Course title	Visual Programming in LabVIEW		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paweł Dworak	**E-mail address to the person**	Pawel.Dworak@zut.edu.pl
Course code (if applicable)	WE-1-46	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Students will be able to write programs in a graphical LabVIEW environment. Should be able to pass the CLAD certification exam.		
Entry requirements	Basics of programming.		
Course contents	Introduction to LabVIEW environment. Navigating LabVIEW. Troubleshooting and Debugging VIs. Implementing a VI, Developing Modular Applications. Using Sequential and State Machine Algorithms. File I/O Techniques. Moving Beyond Dataflow, Solving Dataflow Challenges with Variables. Controlling the User Interface, Event Programming. Creating and Distributing Aplications Introduction to LabVIEW environment. Navigating LabVIEW. Troubleshooting and Debugging VIs. Implementing a VI, Developing Modular Applications. Using Sequential and State Machine Algorithms. File I/O Techniques. Moving Beyond Dataflow, Solving Dataflow Challenges with Variables. Controlling the User Interface, Event Programming.		
Assessment methods	Lectures and practical presentations. Practical exercises. Continuous assessment. Final assessment.		
Recommended readings	1. NI, National Instruments documentation, NI forum, 2016		
Knowledge	Students will be able to write programs in a graphical LabVIEW environment. Should be able to pass the CLAD certification exam.		
Skills	Students will be able to write programs in a graphical LabVIEW environment. Should be able to pass the CLAD certification exam.		