Studies programme part 1

General characteristics of studies	
Main area (specialisation) of the studies:	**Institute of Informatics and Mechatronics**
The area (specialisation) of the studies *(the name of the area (specialisation) must be appropriate to the contents of the programme and especially to the expected learning outcomes)*	**Computer control systems engineering**
Level of education: *(first and second degree studies, uniform master degree studies)*	**second degree studies**
Educational profile: *(general, applied)*	**applied profile**
Mode of studies: (full-time studies, part-time studies) Optional specific study systems (e.g. remote, dual)	**full-time studies**
Number of semesters:	**3**
Training (total length):	**480 hours by the end of 3 semester**
OHS training in the following extent:	**8 hours at the beginning of 1 semester, performed as part of module Occupational safety and ergonomics**
Number of ECTS credits necessary to obtain qualifications corresponding to the level of study	**90**
Total number of ECTS credits obtained:	
in classes that require the direct participation of academic teachers or other lecturers:	**72**
in the course of classes in the humanities or social sciences:	**4**
as part of the training:	**18**
as part of the modules of classes related to practical professional preparation:	**76,6**
for classes conducted in a remote system (applies to studies in a remote system):	**0**
Procentowy udział liczby punktów ECTS dla każdej dyscypliny (dotyczy kierunku przyporządkowanego do więcej niż jednej dyscypliny):	
leading discipline: automatics, electronics and electrical engineering	**61 % - 61% of the total number of ECTS credits**
discipline (disciplines): technical computer science and telecommunication	**20 % - 20 % of the total number of ECTS credits**
discipline (disciplines): mechanical engineering	**19 % - 19 % of the total number of ECTS credits**
Total student workload	**2323**
Professional title obtained by a graduate:	**master**
Indication whether the opinions of interested parties were taken into account in the process of defining learning outcomes and in the process of preparing and improving the programme *(indicate with whom employers the agreements are signed, meetings have taken place; how are the graduates monitored, etc.)*	**Innovlabs sp z o.o.; Logon SA; Asseco Poland S.A.**
Prerequisites (expected competences of the candidate - especially in case of second degree studies)	**Completed engineering studies. Knowledge of the English language at the B2 level**
Area (specialisation) - major relation	**Mechatronics**

Study programme part 2

Area (specialisation): **Computer control systems engineering**

Educational modules with the assumed learning outcomes						
Educational modules	**Subjects** (* - shall mean the subject possible for selection)	**Assumed learning outcomes**	**Programme content for achieving learning outcomes**	**Credit rigor**	**Number of ECTS**	**Ways of verifying the assumed learning outcomes achieved by the student**
Canonic subjects						
Management and entrepreneurship	Organizational culture - Learning organization	K_U09, K_K06	Learning organizations; 2.Organizational culture; 3.typology of organizational cultures; 4.governance of knowledge in the organization; 5.Review of studies on organizational cultures	Zo	1	test, class attendance
	Project management and team building	K_W10, K_W13, K_U08	1.identification of needs; 2. Management of issues; 3. Building of human relations; 4. Communication management; 5. Delegation of tasks; 6. Risk management; 7.Change management; 8. IT management support systems.	Z	1	test, class attendance, activity in the classroom
	Enterprise Game	K_W10, K_W12, K_K05	1. Techniques for creating the correct presentation; 2.Public events; 3.Working under time pressure in the team; 4. The rules of the Games in the Company; 5. Work together on business issues; 6. Public presentation of solutions.	Zo	1,5	E-learning platform test
Practical philosophy	Introduction to Philosophy	K_K03	1. Types of human knowledge; 2. Philosophy of Interest; 5.Practical Philosophy; 6.Basic issues of philosophy; 7.Maximistic Philosophy; 8.Minimalist Philosophy	Zo	2	E-learning platform test
Modern technologies	Basics of distance learning	K_U01, K_U09	1. Life-learning - the pace of change in the surrounding world, the methods of self-training; 2. Security of information systems - logging into WSG systems, network security components; 3.Working with LMS - where information appears, sources of knowledge, activation methods, methods of communication, methods of verification of learning outcomes.	Z	0	E-learning platform test
Flexible education	Polish language	K_U06, K_U07	1. Training of listening, speaking, reading and writing skills in everyday life and fundamental social contacts - setting up and maintaining contacts in official and informal positions; 2.Providing information on one's own; 3.Shopping skills; 4. The use of catering, transport and accommodation services, expressing basic needs in respect of-/day-to-day situations	Zo	2	test, class attendance, activity in the classroom
	Introduction to scientific information*	K_W09, K_W11, K_U01	1. The concept of information and its use in science; 2.Sources of scientific information; 3.Directories and bibliographical databases; 4.Knowledge base; 5.Licensed databases; 6. Open repositories; 7.Finding information on the Internet; 8.Using thematic services; 9. Use of scientific search engines; 10.Using multisearch engines; 11.Use of library information and search systems.	Z	1	E-learning platform test
	Polish Language Culture*	K_U04	Developing listening, speaking, reading and writing skills within the scope of everyday life and basic social contacts - establishing and maintaining contact in official and unofficial situations, providing information about yourself, shopping, using gastronomic services, transport and accommodation, expressing basic needs in the above situations	Zo	4	test, class attendance, activity in the classroom
	Library Training*	K_U01, K_U05	1. Central Library (or branch libraries) and its online collections; 3.Online catalog; 4.Sharing of tables; 5.Databases	Z	0	E-learning platform test
	Pre-Medical First Aid*	K_K04, K_W10	1. Circulatory CPR - algorithms; 2.unconscious unconscious; 3.Non-blocked respiratory; 4.The risk of life associated with the nervous system. 5.Disclosure and proceeding; 6. Diseases and emergency conditions requiring assistance in the respiratory system, cardiovascular system. 7.Rejuvenation, thermal burn, chemical burn, electric shock; 9. Types of wound and their supply, hemorrhages; 10.Government of movement, head, vertebral column; 11. Treatment in various states of danger to life and disease; 12. Symptomps and proceedings	Z	1	E-learning platform test
	Specialist IT Systems	K_U02	1. Working with Microsfot Visio: Creating UML diagrams using Visio; Application of templates; Connecting to data sources; Advanced Visio features; 2. Microsoft Project: Organization of work in MS Project; Creating teamwork schedules in MS Project; Advanced schedule formatting	Z	1	test, class attendance, activity in the classroom
Basic subjects	Thermodynamics	K_W01, K_U03	1. Introductory points: Pressure; Operation, Heat, Energy, Power; Temperature; Dynamic and kinematic viscosity coefficient; Balance of substances; 2.First principle of thermodynamics: Energy balance; System energy, internal energy, enthalpy, ways of entering and exiting energy; Mechanical work; 3. Gas state equation: Excellent gas; Thermal balance of gases; Internal energy and entropy of gases; Gas changes; phase changes of substances; Van der Waals equation; 4. Second thermodynamic principle: Conditions of thermodynamic equilibrium; 5. Compressors, motors, heating pumps.	Zo/E	2	Exam
	Analitycal Mechanics	K_W01, K_W03, K_W04, K_W06, K_W08	1. Movement equations: Generalized coordinates; principle of least action; principle of relative importance of Galilee; function of the Lagrange free point of material; function of the Lagrange layout of physical points; 2. Retention rights: Energy; momentum; Mechanical polarity; 3. Integrating motion equations: One-dimensional movement; Determination of potential energy from vibration period 4. Rigid body movement: Inertia peak; hard body momentum; Rigid body movement equation; Euler equation and equation; Rigid body contact;Principle of smallest action; Movement in non-inertial reference system ;5. Canonical equations: Hamilton equations; Routhha function; function as a function of coordinates; Maupertuis principle; Liouville drilling; Hamilton-Jacobago equation; Function of Routhha; Function as a function of coordinates; Principle of the Maupertuis; drilling of Liouville; Equalization of Hamilton-Jacobago; Distribution of variables; Properties of multidimensional traffic; 6. Mechanical vibration; Motor-operated movement phases; Pink vibration movement; Minimum operating principle; Free movement of the system with one degree of freedom; Force vibration of the system with one degree of freedom; Principle of smallest action 7. Vibrations in multi-degree systems	Zo/E	4	Exam. Activity in laboratory classes, passing individual laboratory exercises. Assessment of reports.
	Technical Mechanics	K_W01, K_W03, K_W04, K_W06, K_W08	1. Basics: Object, role and structure of mechanics; Fundamental concepts and body models; Basic physical laws; Basic static concepts; Asjoys and the principle of the statics; 2. Force reduction: Reduction of the center force system; reduction of the flat force system; Fusges of any force reduction; Balance conditions; arrangement of two parallel forces; 3. Friction: Slip discs; shrink disc; rolling disc (resistance); 4. Mechanical geometry of flat figures and masses: Center of gravity and center of mass; Moments of inertia; Parallel degree II Transformation; 5. Internal forces in mechanical systems: External power of the internal forces; Internal component forces; Sign convention and relationship between internal forces	ZoE	4,5	Exam. Activity in laboratory classes, passing individual laboratory exercises. Assessment of reports.

discipline (disciplines): mechanical engineering

Module A	Data Aquisition with Matlab	K_U02, K_W07	Using MATLAB to Make Plots: subplots, script and function files, matrix operations, acquisition of data from multimeter, acquisition fo data from oscilloscope. Signals: elementary signals, the Laplace transform, using Matlab for finding the Laplace transforms of time functions, the inverse Laplace transform, convolution, properties and theorems of the Fourier Transform, using MATLAB for finding the Fourier Transform of time functions, the Discrete Fourier Transform (DFT), the Fast Fourier Transform (FFT). Ardunio to Matlab: communication using serial port functions, Matlab Support Package for Arduino, Simulink Support Package for Adruino. Raspberry Pi to Matlab: Raspberry Pi support from Matlab, Raspberry Pi support from Simulink, Raspberry Pi support from Matlab Coder, use the Raspberry Pi camera board to capture images and video, optical characeter recognition, pattern matching. Data collection in the cloud: ThingSpeak platform, JSON data format, REST API, energy monitoring example, air quality example.	E/Zo	3	Exam. Activity in laboratory classes, passing individual laboratory exercises. Assessment of reports.
	3D Modelling and Visualization *	K_W04, K_U02	1. Introduction to user interface of 3D design software; 2. Scenes and Objects; 3. Navigating in 3D Space: Panning, Orbiting, Zooming, Rotating, Selecting and moving object; 4. Modelling, Resizing, Rotating , Meshe, Curves, Sculpting; 5. Texturing: Designing textures, Mesh faces, Materials, Applying textures, Grid; 6. Rendering	Zo	2	Project evaluation.
	Introduction to 3D Design	K_W04, K_U02	1. Introduction to 3D coordinates; 2. Interface overview; 3. Selecting, creating and editing objects; 4. Transforming objects; 5. Managing scenes, files and projects; 6. Modelling: Polygonal Modeling, Sculpting; 7. Lighting and shading: Applying color and shader to an object, Creating materials, Texture mapping and previewing; 8. Rendering: Quality, Render speed, Diagnostics	Zo	1	Project evaluation.
	3D Cross-platform applications	K_W07, K_U02	1. Overview of Unity interface; 2. Creating and importing assets to Unity Project: Simple object modelling, Using Asset Store, Importing assets; 3. In-game world design, Moving and rotating elements, Applying textures to models, Scenes, Cameras and characters; 4. Designing multi-platform applications: Overview of available systems in Unity, 2D and 3D applications, Developing scripts in C#, Applying scripts to objects; 5. Targeting and testing of applications	Zo	4	Activity in laboratory classes, passing individual laboratory exercises. Test
	Virtual and Augmented Reality Design	K_W07, K_U02	1. Introduction to Virtual Reality: Oculus Rift, HTC Vive, PS 4 VR, Google Daydream; 2. Introduction to Augmented Reality with Microsoft HoloLens; 3. Unity development: Designing and animating game worlds for virtual reality applications, Creating objects and applications for augmented reality; 4. Modeling, texturing and importing VR/AR objects; 5. Deploying applications to VR/AR systems	Zo	4	Project evaluation.
	Artificial Intelligence	K_W07, K_U03	1. Artificial neural networks: Neuron and its models; Overview of the methods of network learning; Non-linear one-way networks; Radio base functions networks; Resurrection networks; Self-organising networks; stacking networks; Best architecture and learning dataset; Selected uses of neural networks; Implementation of neural networks; 2. Logic is blurred: Collections; Interpretation and designation of functions of belonging; Operations in collections; Model of Mamdai; Model of Takage-Sugeno; Neuronowo-rozmyte; Examples of uses; 3. Genetic algorithms: Genetic algorithms and traditional optimization methods; Basic concepts of genetic algorithms; Classical genetic algorithm; Solution coding; Programming function; genetic operators; Customisation function; genetic operators; Individual selection; Genetic algorithms for multi-criteria optimization; Examples of genetic algorithms; evolutionary algorithms; 4. Expert systems: Types of expert systems; Structure of the expert system; Rerepresentation and coding of knowledge; proposal; Tools of implementation; Examples of use of expert systems	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Machine learning	K_W03, K_W06, K_W04, K_U02	Machine learning Fundamentals of Machine Learning: typical applications, supervised and unsupervised learning, Python libraries for machine learning. Regression: linear regression, non-linear regression, model evaluation methods. Classification: K-nearest neighbour, decision trees, logistic regression, support vector machines, model evaluation. Unsupervised Learning: K-means clustering in machine learning, hierarchical cluster analysis, density-based clustering. Introduction to recommender systems: content-based recommender systems, collaborative filtering.	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Modern Control Theory	K_W02, K_W05, K_U03	1) Control enginnering – revision: concept of a system; open-loop systems; closed-loop systems; time-omain analysis; design in frequency domain; design in the s-plane; system modelling; mathematical models of mechanical systems; mathematical models of thermal systems; mathematical models of electrical systems; mathematical models of fluid systems. 2) Digital control systems: sampling; the z-transform; stability in the z-plane; digital compensator design. 3) Design in state-space: the concept of state; controlability; observability; state variable feedback design; full-order state observer; reduced-order state obserer; controller examples. 4) Fuzzy logic contol systems: fuzzy set theory; fuzzy set operations; fuzzy relations; fuzzy logic control. 5) Application of neural network control systems to modelling, estimation and control. 6) Application of genetic algorithms to control systems design.	E	2	Exam
	Elective Subject: Data transmission	K_W07, K_U02	Introduction to communication system: communication systems, modulation, bandwidth requirement, channel capacity, baud rate, data rate, bit, bytes and characters, communication modes, synchronous and asynchronous system, error detection, error correction, transmission characteristics, data coding, UART and USART. Modulation: theory of amplitude modulation, frequency spectrum of AM wave, representation of AM, theory of frequency modulation, mathematical representation of FM, frequency spectrum of FM wave. theory of phase modulation, comparison of different modulations, digital modulation: modulation circuit, demodulation circuit, ASK, FSK, PSK, PWM, PAM, PP/M. Serial communication: balanced and unbalanced transmission lines, RS-232 interface, RS-422 interface, RS-485 interface, current loop, GPIB, USB interface, common serial communication problmes, design examples. Cabling: copper based cables, coaxial cables, twisted pair cables, fiber optic cabls, definition of noise, external and internal noise, noise calculation, frequency analysis of noise, source of electrical noise, electrical coupling of noise, shielding and grounding, noise suppression techniques, cable ducting, design examples. Industrial protocols: introduction to protocols, CAN, Fieldbus and DeviceNet system, modbus protocol, HART, industraial Ethernet - EtherCAT.	Zo	1	Activity in laboratory classes, passing individual laboratory exercises. Test
	Elective Subject: Wireless Interfaces	K_W07, K_U02	Types of signals and the antennas used for communication; methods of signal propagation; techniques of multiplexing; analog modulation and digital modulation; spread spectrum technology; medium accessing techniques; data security consideration. Short distance communication protocols: Bluetooth; Bluetooth Low Energy; iBeacon; Zigbee; Z-Wave; 6LoWPAN; hardware platforms; power consumption. Long distance communicaton protocols: NB-IOT; LoRaWAN; Sigfox; developement boards; power consumption. Wireless idenfication: RFID; RFC. Design examples: home automation; sensor networks; smart devices; IOMT.	Zo	1	Activity in laboratory classes, passing individual laboratory exercises. Test

	Selected Methods of Control Systems Design	K_W02, K_W05, K_U02	2. PID control: feedback control; the 3 actions of PID control. structures of PID controllers; digital implementation; D filter design; anti-windup strategies; use of a feedforward action; tunning methods. 2. Introduction to adaptive control: real-time parameter estimation; self-tuning regulators; model-reference adaptive systems. 3. Optimal control systems design: the LQ regulator - continous, discrete; the LQ tracking problem - continous, discrete; the Kalman filter; LQG control system design; LQ H2-optimal control; H inf-optimal contol. 4. Robust control systems parametric robustness analysis; the basic perturbation model; the small gain theorem; stability robustness of feedback systems; structured singular value robustness analysis; combined performance and stability robustness; Internal Model Control.	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Python Programming	K_W01, K_W07, K_U02	1. Introducing to Python: Syntax, Variables, Lists, Arrays, Operators, Logical expressions, Loops, Dictionary, Functions; 2. OOP in Python: Classes, Members of classes, Objects, Inheritance, Iterators, Working with Data; 3. Exercises	E/Zo	3	Activity in laboratory classes, passing individual laboratory exercises. Exam
	Rapid Prototyping	K_W03, K_W06 , K_W04, K_U02	1. Introducing to prototyping; 2. Arduino and Raspberry Pi as a base for Rapid Prototyping; 3. Arduino IDE; 4. Designing electronic devices: Fritzing software, Breadboards; 5. Building electronic devices 6. Introducing to 3d Printing: Materials, Printers types, Using 3d pronter; 7. Designing 3D models; 8. Building own solutions	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Intelligence decision systems	K_W07	Introduction to Decision Support Systems; 2. Decision-making Models; 3. Decision-making Strategies; 4. Expert Systems; 5. Data mining, OLAP; 6. Multi-dimensional data; 7.Framework; 8. Scripts; 9.Semantic networks; 10. Ontologies	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Team Project	K_U07, K_U08 , K_K01, K_K03	1. Teamwork: Roles, Methodologies, Tools; 2. Students will be divided into small grups and then will work of them own solutions in one of presented methodology; 3. At the end of all classes students will have to present their work progres; 4. At the end of the term groups will have to present their solutions and make presentations.	Zo	6	Project evaluation. Activity in laboratory classes
	CAD Systems	K_W06, K_U02	1. Solid modeling: parts and sheet metal parts; 2. Creating 3D assembly documentation; 3. Creating 2D assembly documentation; 4. Creating 2D executive documentation; 5. Frames; 6. ERA; 7. Simulations (FEM); 8. Simulations (motors)	Zo	2	Project evaluation.. Activity in laboratory classes
	HMI design	K_W07, K_U02	1. User Interface design: basics of vector graphic software; interfaces of mobile applications; designing for multiple devices and resolutions; preparing layouts for coding - cutting the layout into individual elements and exporting for different resolutions 2. Programming in Java for mobile devices: starting project in Android Studio; preparing Java classes and layouts in Android Studio; implementing graphic design into the Android Studio project; handling buttons, activities, switching between screens; role and uses of string.xml; preparing multiple language versions of mobile applications. 3. Adaptation of the application for various devices and resolutions: problems connected to dpi, ppi	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	PLC programming	K_W02, K_W07, K_U02	Technical guide for PLC basic system configuration of PLC-based process control; I/O refresh; cycle time; interrupt tasks; I/O allcation; CPU unit memory area; choosing a programming language for application. Ladder Diagrams(LD): instruction location and execution conditions; adressing I/O memory areas; data formats; refresh timing; condition flags; sequence input instructions; sequence output instructions; sequence control instructions; timer instructions; counter instructions; comparison instructions; data manipulation instructions; math and conversion instructions; logic instructions; subroutines instructions; interrupt control; high-speed pulse outputs; serial communication; network communication; clock instructions. Sequential Fuction Charts(SFC): elements of SFC; SFC program operation; SFC programming workflows; creating steps and transitions; creating action block; simulated transition tests; simulated operation tests; checking for program errors. Function Block/Structured Text: FB library; ST language; creation of a Function Block using ST; entering the FB to the Ladder Diagram. Using Matlab for PLC programming. Lab exercises: stepper motor control; DC motor control; electro-hydraulic control system; electro-pneumatic control systems; traffic lights simulator; HMI-PLC integration; ADAM-PLC integration.	Zo	4	Activity in laboratory classes, passing individual laboratory exercises. Test
	Embedded Systems Design	K_W02, K_W05, K_W08, K_U01	Design: Introduction to Embedded System embedded system overview, classification of embedded systems, hardware and software in an embedded system. Hardware design issue: core of the embedded system, memory, sensors, acutators, power-supply(battery,solar,energy harvesting), PCB design for embedded system(EMC). Memory: memory write ability and storage permanence, types of memory, memory hierarchy and cache. Interfacing: I/O addressing, interrupts, DMA, arbitration, multilevel bus architecture, communication protocols: SPI, I2C, I2S, CAN, UART. Embedded software: low-level programming, optimizing for speed/memory, interrupt service routines, data types, functions, multithreading programming. Real Time Operating System (RTOS): operating system basics, task, process and thread, multiprocessing and multitasking, task scheduling, task synchronization. Design examples: closed loop control system, PID controller implementation, user interface implementation(LED display, LCD, TFT, analog gauge,keyboards), interfacing to sensors and actuators.	Zo	4	Activity in laboratory classes, passing individual laboratory exercises. Test
	Digital Signal Processing	K_W02, K_W05, K_U03	Introduction: complex numbers; the z-transform; sampling theorem; statistics,probability noise; ADC and DAC; convolution; properites of convolution; random signals. Matlab for digital signal processing: functions and variables; plotting data; multidimensional arrays; bitwise operators; vectorizing code; signal processing toolbox. Frequency analysis of signals: Fourier series; the Discrete Fourier Transform; application of the DFT; Fourier Transform properties; the Fast Fourier Transform; aliasing; buffering and windowing. Digital filters: filter basics; FIR and IIR filters; MA filters; windodow-sync filters; recursive filters; chebyshev filters; filters comparision.	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Signal Processing with LabView	K_W02 , K_W05, K_U03	1.Introduction to LabView: building a simple VI, structures and subVIs, building a front panel (controls,indicators), building a block diagram(express VI,terminal icons,wires,structures), debugging(probe tool,profile tool), building a system VI with Express VIs, building a system VI with regular VIs VISA, Getting a signal into LabView: data aquisition hardware, sampling and quantization, signal reconstruction, fast fourier transform, aliasing, windowing, discrete fourier transform, short-time fourier transform, discrete wavelet transform. Digital filters digital filter design toolkit, analysis of filter design, FIR filtering systems design with DFDT, IIR filtering systems design with DFDT, building an filtering system using filter coefficients, filter design without DFDT. Adaptive filtering: system indentification, noise cancellation. Generating signals with LabView: basic functions, sinc function, chirp sequence, white gaussian noise.	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
Area subjects						

	Mobile devices programming	K_W07, K_U02	1. Using Android UI objects: Buttons; EditTexts; TextViews; Layouts; Views; Events; 2. Communication inside Android application: Saving and reading data; Shared Preferences, Intents; 3. Creating synchronous and asynchrous methods in Android; 4. Using HTTP protocol for communication with remote Application Programming Interface (API): RESTful Web services; JSON data format; GET and POST methods; 5. Long-running background operations: Service; AlarmManager; 6. Google Maps SDK for Android: Getting API Key; Configuration; Using markers with popups; 7. Configuring and developing notifications under certain conditions;	Zo	1	Activity in laboratory classes, passing individual laboratory exercises. Test
	Network interfaces	K_W02, K_W07, K_U02	1. Interfaces of the local area networks, 2. The physical layer of the Ethernet interfaces, 3. Normal Link Pulse (NLP) and Fast Link Pulse (FLP) protocols, 4. Data link layer and frame formats in Ethernet interfaces, 5. EtherChannel - an effective way of port aggregation, 6. WAN interfaces - ADSL, V.35, HSSI, SmartSerial, 7. Optical interfaces - single-mode and multi-mode fibers, wavelengths, 8. Attenuation and dispersion (mode, chromatic, waveguide, matrial dispersion), 9. Wavelength Division Multiplexing (WDM) techniques, 10. UniDirectional Link Detection (UDLD) protocol	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
	Modern Power Supply Systems	K_W02, K_W05, K_U02	Systems: Introduction to power semiconductors: using thyristors and triacs; thyristor and triac applications; power MOSFETs; high voltage bipolar transistors; IGBTs. Linear regulators: power dissipation in linear regulators; the low dropout regulator; packaging and thermal management; PCB layout. Switched mode power supplies: using power semiconductors in switched mode topologies; output rectification; magnetics design; resonant power supplies. Design examples: buck converter; boost converter; SEPIC converter; Cuk converter; Zeta converter; flyback converters; forward converters; half-bridge converter; full-bridge converter. Energy harvesting. Rechargeable batteries in power supply systems.	Zo	4	Activity in laboratory classes, passing individual laboratory exercises. Test
	Hardware platforms for IOT	K_W05, K_W07, K_U02	1. Software and programming tools for IOT devices prototyping: ESP Easy; ESP-Open-RTOS; MicroPython; NodeMCU; Mongoose OS; PlatformIO; 2. IOT devices prototyping: ESP8266 and ESP32 cores; RaspberryPi IOT gateway; LoRa32u4 development board; Prototyping LoRa using Arduino platform - Arduino MKR board; SiPy development platform; 3. Platforms and tools for data visualization: Connecting ESP32 to Amazon cloud, Cayenne MQTT and ESP8266; NodeRED and ESP8266; ThingsSpeak; 4. Applications examples: Smart clothes; Smart buildings – house access control; Sensor networks – ar quality, environmental measurement systems, PV monitoring system; Health monitoring system	Zo	2	Activity in laboratory classes, passing individual laboratory exercises. Test
Training	Internship "Employee competencies"	K_W10, K_W11, K_W12, K_W13, K_U09, K_K04, K_K05, K_K06	1. Health and safety rules (work with computer technology equipment, workplace ergonomics); 2. Operate an IT business or business that relies to a large extent on the information technology tools available in its business; 3.Training of skills to combine existing knowledge studies and skills in, inter alia, design and programming, operating systems, business practice and IT institutions; 4.Training of best practice for a future employee	Z	6	Assessment of the internship book , Assessment of the test on the e-learning platform
	Industry internship	K_W03, K_W04, K_W07, K_W08, K_W10, K_W11, K_W12, K_W13, K_U09, K_K04, K_K05, K_K06	1. To be familiar with the organization of the undertaking, the structure of employment, management and activities carried out. To understand the business management system, in particular: The whole of technical and technological issues, the role of technical progress, the quality system resulting from compliance with EU standards and quality, environmental protection, in accordance with EU specialised agencies directives; 2. Become familiar with the technology of products or with the services that your company can provide in terms of mechatronical solutions. Whenever possible, actively participate in the work of the project, technological and implementation teams. 3. Prevent the general principles of the circulation of technical documentation between individual business units, with particular reference to those involved in mechanical engineering technologies; 4. To learn about the economic and legal conditions for the implementation, development and operation of mechanical systems and the conduct of technology security policies in a given enterprise; 5. Understand enterprise hardware and techniques for diagnosing hardware failures; 6. Be familiar with the safety systems of machinery and electrical equipment.	Z	12	Assessment of the internship book and the implementation of the internship program
Degree awarding process	Master's seminar	K_W09, K_U01, K_U03, K_U05	Master thesis. The research nature of the master's work, the principles of writing literature and literature references in technical works, the methods of formulating an objective of work, and ways of achieving an objective of work - the idea of a master's work. Activity formulating a goal for selected topics. Use of scientific bibliographic databases, scientific articles and patent databases.	Z	5	Activity in the classroom, evaluation of the presentation of the project.
	Master's seminar and preparation for the diploma exam	K_W01, K_W07, K_U01, K_U02, K_U03	Creating a presentation on the results of own thesis in Polish and English. The principles of public intervention and presentation of achievements from his own master's career. Review the contents of the Diploma Exam.	Zo	5	Activity in the classroom, evaluation of the presentation of the project.
	Methodology of Scientific Research	K_U04, K_U07, K_K01, K_K02, K_K03	1. Methodology as science; 2.Knowledge and science; 3.methodological personalities of science; 4. Scientific research as problem solving; 5. Selected research methods and techniques; 6. Algorithms of typical scientific understanding; 7.Construction and dynamism of scientific theory; 8. Management of research; 9.Principles of preparation and presentation of scientific work; 10.Principles of the design of the measuring tool, construction of the questionnaire, improvement of the questionnaire; Type of survey, techniques for improving the feedback of questionnaires, coding of data; 12.Calculation of measurement using Excel statistical functions - measurement of panel trends and dispersion, correlation and regression factors, measurement of phenomena dynamics.	Zo	2	Activity inclasses, passing individual exercises. Test
	Computer Methods for Formulating Scientific Data	K_U04, K_U07, K_K01, K_K02	Data formats and types : general; currency; accounting; dates; time; percentage; fractional; scientific; text; special; non-standard. 2. Graphs as data files : graphs for statistical data; functional relationship graphs; special charts: Surface, radar, stock-exchange, ring-shaped; 3. Statistical compilation of measurement data: Error of measurement and its types; uncertainty of measurement and evaluation; estimation of standard deviation estimator; standard deviation estimation; Gauss breakdown; extended uncertainty, confidence intervals; Q-Dixon test; 4.Statistical analysis of measurement series (populations): Correlation of results, correlation coefficient; conarianescence; mortgage testing: Chi2 test, F-Snedecora test, t-Studenta, Hampela test; 5.Aproximacy and smoothing of data : Data "smoothing" techniques; method of least squares; approximations of 2-6 degree diametrically; approximation of all functions.	Z	1	Passing individual exercises.