# PROGRAMME OF EDUCATION

**FACULTIES**: ***Electrical Engineering, Mechanical Engineering, Microsystem Electronics and Photonics***

**MAIN FIELD OF STUDY:** ***Mechatronics***

**in area of technical science**

**EDUCATION LEVEL:** ***1-st level engineering study***

**FORM OF STUDIES*: full-time***

**PROFILE:** ***general academic***

**SPECIALIZATION**:

**LANGUAGE OF STUDY:** ***Polish***

Content:



Microsystem Electronics and Photonics Faculty Council resolution no. ***9/1/2016-2020*** of **21.09.2016**

In effect since ***01.10.2016***

**Attachment no. 1 to Programme of Education**

# Educational effects
# in the field of study: *Mechatronics*
# at the first level – general academic profile

**Faculty: Electrical Engineering, Mechanical Engineering, Microsystem Electronics and Photonics**
**Field of study: Mechatronics**
**Level of studies: first level, full time study**

Location of the field of study in the area (areas) of education

*Mechatronics*, belongs to the range of studies in technology and it is connected with such fields of studies as *Mechanics* and *Machine Building, Electrical Power Engineering and Electronics, Informatics and Automatics and Robotics.* At Wrocław University of Science and Technology, the interdisciplinary field of study – *Mechatronics* is provided by three Faculties:

1. Faculty of Mechanical Engineering (W10),
2. Faculty of Electrical Engineering (W5) and
3. Faculty of Microsystem Electronics and Photonics (W12).

Within the first educational level, three areas of graduation have been proposed:
- Mechatronics in Machine Building and Automotive Engineering
- Mechatronics in Automatics and Measurements
- Mechatronic Microsystems

Explanation of symbols:
**K** – field-of-study educational effects
**W** – category of knowledge
**U** – category of skills
**K** (after line/dash) – category of social competences

| **Educational effects at the first level study in *Mechatronics*** | **DESCRIPTION OF EDUCATIONAL EFFECTS**<br><br>**After completion of the first level study in *Mechatronics* field of study the graduate:** | **Correlation with educational effects for 1st level study in area of technical sciences (T) and engineering competences (I)** |
|---|---|---|
| **KNOWLEDGE** | | |
| K1MTR_W01 | has knowledge in the field of mathematics including algebra, analysis, statistics as well as mathematical and numerical methods necessary to describe mechanical and electrical problems | T1A_W01 |
| K1MTR_W02 | has knowledge in the field of physics, including mechanics, thermodynamics, optics, electricity and magnetism, nuclear physics and solid state physics as well as the knowledge necessary to understand the basic physical phenomena occurring in electronic elements and circuits and their surroundings | T1A_W01 |
| K1MTR_W03 | has basic knowledge in the area of metrology and measurement systems, measurement uncertainty and data handling, knows and understands the methods of measurement of basic electrical and mechanical properties, including the geometrical ones, knows the principles of operation of measurement systems and instruments for measurements of electrical and mechanical properties | T1A_W03 |
| K1MTR_W04 | has basic knowledge in the area of manufacturing engineering, with a special emphasis on the principles of quality management and ways of running business | T1A_W08<br>InzA_W03<br>T1A_W09<br>InzA_W04 |
| K1MTR_W05 | has basic knowledge on intellectual property protection, especially industrial property and copyright law; is able to use the resources of patent information | T1A_W08<br>InzA_W03<br>T1A_W10<br>T1A_W11 |
| K1MTR_W06 | has knowledge concerning principles of construction description (projections, views, cross-sections, systems), dimensioning and standardization issues in construction description, methods of graphical representation of geometric figures and description of electronic circuits | T1A_W03<br>T1A_W04 |

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| K1MTR_W07 | has knowledge on the basic chemistry, especially about crystallography and physico-chemical properties of inorganic and organic materials, including the relations between the properties and structure, in terms of widely understood materials engineering;<br>has a well-ordered knowledge about technical materials applied in mechatronics (mechanics, electrical power engineering and electronics), their structure, properties and applications;<br>has knowledge on the strength of materials, necessary for strength dimensioning in simple and complex states of stress in materials and systems | T1A_W01<br>T1A_W04 |
| K1MTR_W08 | has ordered and theoretically grounded knowledge in the field of mechanics, especially: statics and mass geometry, kinematics of a material point, reactions in statically determinate systems, centers of gravity and moments of inertia | T1A_W03 |
| K1MTR_W09 | has knowledge concerning the structure, kinematic and dynamic analyses and designing of kinematic machine systems, devices and robots; is familiar with the process of structural design;<br>has ordered knowledge on the structure and operating principles of the components and units of mechanical systems used in mechatronic systems as well as the methods of developing models and computational methods applicable to these systems | T1A_W03<br>T1A_W04 |
| K1MTR_W10 | has ordered and theoretically grounded knowledge concerning principles of operation of electric driving systems and control systems for machines and mechatronic devices;<br>has basic knowledge about the elements of hydraulic and pneumatic driving units and systems | T1A_W03<br>T1A_W04 |
| K1MTR_W11 | has knowledge about the structure and operation of machine tools, shaping of objects and surfaces as well as basic parameters of technological processes, methods of bonding (welding, soldering, friction welding), plastic working and casting | T1A_W04<br>T1A_W07<br>InzA_W02<br>InzA_W05 |
| K1MTR_W12 | is familiar with the first and the second principle of thermodynamics for the analysis of thermal and mechanical processes; has basic knowledge on the process of heat transmission and cycles of engines and compressors;<br>has basic knowledge on the mechanics of gas and liquid flow | T1A_W03 |
| K1MTR_W13 | has basic knowledge on electromagnetic field, single-phase and three-phase electronic circuits, generation and transformation of electric energy | T1A_W02<br>T1A_W03 |
| K1MTR_W14 | has ordered and theoretically grounded knowledge concerning principles of operation of electronic semiconductor devices | T1A_W03<br>T1A_W04 |

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| K1MTR_W15 | has ordered basic knowledge on the operation, structure, properties and parameters of sensors and sensor systems (including the intelligent ones and microsensors) for various applications, for example: automotive industry, medicine, household goods, entertainment, etc.<br>has ordered and theoretically grounded knowledge concerning operation, structure and basic micromechanical parameters of actuators and specific mechano-electric microsystems | T1A_W03<br>T1A_W04<br>T1A_W05 |
| K1MTR_W16 | has ordered and fundamental knowledge concerning the structure of microprocessor systems, I/O system control, control algorithms, A/D and D/A conversion and microprocessor programming techniques in machine- and C-language | T1A_W02<br>T1A_W07<br>InzA_W02<br>InzA_W05 |
| K1MTR_W17 | has knowledge on industrial automatics, especially in the analysis of systems in time and frequency domain, description of continuous and discrete systems, operator transmittance, system stability, control and adjustment;<br>has basic practical and ordered knowledge concerning the applied control algorithms, including the fuzzy and neural ones, in typical engineering tasks with a special emphasis on the parametric and non-parametric methods of data processing;<br>has basic knowledge concerning the structure and operation of industrial robots | T1A_W02<br>T1A_W04<br>T1A_W07<br>InzA_W02 |
| K1MTR_W18 | has basic knowledge on the techniques and materials employed in electronic packaging | T1A_W03<br>T1A_W06<br>InzA_W01 |
| K1MTR_W19 | has basic, ordered and theoretically grounded knowledge in the field of informatics, software engineering and computer architecture especially in hardware domain; furthermore, has knowledge on implementing and testing computer programs as well as developing and saving documentation of computer software | T1A_W02<br>T1A_W07<br>InzA_W02<br>InzA_W05 |
| K1MTR_W20 | has basic, ordered and theoretically grounded knowledge concerning networks as well as computer and industrial buses | T1A_W02<br>T1A_W04<br>T1A_W07<br>InzA_W02 |
| K1MTR_W21 | has basic, ordered and theoretically grounded knowledge about the methods of digital processing of signals and images; is able to characterize basic mathematical tools, necessary to design the systems for digital signal processing, and present algorithms in the form enabling their effective implementation | T1A_W02<br>T1A_W04<br>T1A_W07<br>InzA_W02 |

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| K1MTR_W22 | has basic, ordered and theoretically grounded knowledge in the field of techniques, methods and numerical tools for adding engineering work at the stage of design; especially, has the knowledge concerning planning and analyzing experimental results as well as numerical modeling and simulation in an interdisciplinary range | T1A_W03<br>T1A_W07<br>InzA_W02 |
| K1MTR_W23 | has knowledge concerning a functional description of mechatronic systems and methods of integration of mechanic, hydraulic, electric and informatic sub-systems into complex mechatronic systems; is familiar with the current state and the newest trends in the development of mechatronics | T1A_W05<br>T1A_W06<br>InzA_W01 |
| K1MTR_W24 | has detailed knowledge concerning specific issues in modeling and design of mechatronic systems | T1A_W04 |
| K1MTR_W25 | is familiar with methods of drawing conclusions (induction, deduction, abduction); has basic knowledge necessary for understanding social and philosophical aspects of engineering activities | T1A_W02<br>T1A_W08<br>InzA_W03 |
| K1MTR_W26 | has basic knowledge necessary to understand the ethical and social aspects of engineering activities | T1A_W01 |
| K1MTR_W27 | knows and understands the basic principles of industrial property protection and copyright law; is able to use the resources of patent information | T1A_W04<br>T1A_W07<br>InzA_W02<br>T1A_W08<br>InzA_W03 |
| K1MTR_W28 | has basic theoretical knowledge on management; has elementary knowledge about enterprise management and organization and basic methods, models and functions of management;<br>is also familiar with management functions, organization strategies and levels of planning in an organization; understands the development trends in management in terms of economic development | T1A_W03<br>T1A_W04<br>T1A_W09<br>InzA_W04<br>T1A_W11 |
| K1MTR_W29 | has ordered knowledge on the operation principle of passive and active electronic devices; knows their parameters and characteristics; knows how to use the devices properly | T1A_W04 |
| K1MTR_W30 | has ordered theoretical knowledge in the field of photonics, including the knowledge necessary to understand physical basis of the operation of the elements of an optical transmission path and knows the areas of application of photonic systems, especially in automotive industry, electric power engineering and microsystems | T1A_W04 |
| K1MTR_W31 | has ordered theoretical knowledge on the structure and operation of basic analog and digital electronic circuits | T1A_W04 |

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| K1MTR_W32 | has knowledge concerning paradigm of object oriented programming and UML language notation | T1A_W04 |
| K1MTR_W33 | has basic knowledge on the operation and programming of PLC control systems | T1A_W04 |
| | achieves results in the category of KNOWLEDGE in one of the following graduation areas:<br>• Mechatronics in Machine Building and Automotive Engineering (**Attachment no. 1**)<br>• Mechatronics in Automatics and Measurements (**Attachment no. 2**)<br>• Mechatronic Microsystems (**Attachment no. 3**) | |
| **SKILLS** | | |
| K1MTR_U01 | is able to use mathematical apparatus to describe the mechanical and electronic phenomena, and for signal controlling and processing;<br>is able to use numerical methods to solve the basic engineering problems | T1A_U09<br>InzA_U02 |
| K1MTR_U02 | is able to identify and describe physical phenomena associated with mechanical, electrical and electronic issues | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_U03 | is able to design a measurement experiment, choose suitable instruments and measurement systems which would enable the measurement of basic electric and mechanical properties, including the geometrical ones and characterizing mechatronic elements; is able to assess a measurement uncertainty and handle measurement results | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_U04 | is able to use appropriate methods and tools for quality improvement; is able to assess different forms of economic activities to meet current market needs and demands;<br>is conscious of the responsibility for his/her own work and is prepared to obey the rules of team-work; steadily improves his/her professional qualifications, applies industrial safety rules and is familiar with the principles of work in laboratory and industrial environment | T1A_U12<br>InzA_U04 |
| K1MTR_U05 | is able to draw spatial geometric shapes using traditional drawing techniques (technical draft) and computer aided drawing (2D and 3D); is able to make and read a technical documentation in form of a drawing;<br>can read and interpret the drawings and schemes used in technical documentation (machine and electrical engineering) | T1A_U02<br>T1A_U03 |

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| K1MTR_U06 | depending on the level of the studied language: has the knowledge, skills and competence in accordance with the requirements set for the level B2 ESKOJ; acquires, understands and interprets specialized texts; uses in spoken and written linguistic tools in typical academic language and the working environment of the engineer<br>or<br>has the knowledge, skills and competencies in line with the requirements specified for the C1 level ESOKJ; follows with understanding<br>and formulate statements on topics related to the discipline of study and professional work, using measures appropriate to the situation; reads, interprets, evaluates and creates texts concerning specialist topics; uses the language skills in interpersonal relations and communication in international academic and professional environment | T1A_U01<br>T1A_U03<br>T1A_U04<br>T1A_U06 |
| K1MTR_U07 | is able to choose materials suitable for specific applications, carry out basic studies of materials, assess basic properties of materials (at micro and macro-level);<br>is able to conduct the basic strength tests and measure displacement and distortion | T1A_U15<br>InzA_U07 |
| K1MTR_U08 | is able to perform reduction of a force system, assess reaction in statically determinate systems, determine characteristics of bending moments, shearing forces normal to beams and frames and centers of inertia;<br>is able to determine velocity and acceleration in the kinematics of particle | T1A_U09<br>InzA_U02 |
| K1MTR_U09 | is able to analyze the operation of basic mechanisms by analytical methods and using software;<br>is able to use computational models to choose construction properties of elements and mechanical units and make a graphical representation of the designed system | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_U10 | is able to determine and measure electrical and electro-mechanical parameters of driving systems and define the method of controlling the parameters of the systems;<br>is able to analyze and choose the components of hydraulic and pneumatic systems | T1A_U08<br>InzA_U01<br>T1A_U14<br>InzA_U06<br>T1A_U16<br>InzA_U08 |

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| K1MTR_U11 | is able to choose proper technology for accomplishing a task taking into account material parameters and methods of measurement of obtained results; is able to assess the effect of basic parameters on the results of casting, subtractive and additive machining, bonding and identify the disturbing factors ( e.g. distortion) | T1A_U11<br>T1A_U16<br>InzA_U08 |
| K1MTR_U12 | is able to determine specific heat of gas, volumetric efficiency of compressors and carry out an investigation of heat transfer;<br>is able to make a computation of flows (conducts, pipelines and slits) and assess the characteristics of pipelines | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_U13 | is able to solve static and dynamic problems concerning electric field and circuits, can specify and use the principles of selecting components for the circuits supplying electric receivers | T1A_U09<br>InzA_U02 |
| K1MTR_U14 | is able to use the recognized methods, mathematical models and computer simulations to analyze and assess the operation of electronic devices and simple analog electronic circuits | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_U15 | is able to choose and apply appropriate sensors to measure various physical quantities and use them later in the measuring, monitoring and controlling systems; is able to test basic characteristics of sensors;<br>is able to explain the principle of operation of specific microsystems, can use chosen microsystems and assess correctness of their operation by performing suitable tests | T1A_U01<br>T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02<br>T1A_U10<br>InzA_U03 |
| K1MTR_U16 | is able to define general requirements for microprocessor system for a particular application, is able to design the structure of the system, choose the software, write a computer program in a low-level language, according to the control algorithm | T1A_U07 |

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| K1MTR_U17 | is able to develop dynamic models of objects, formulate the conditions and goals of control, define a control system, perform an analysis and synthesis of the automation systems and tuning of PID controllers;<br>has an ability to use correctly basic control algorithms and techniques, apply proper modeling, approximation and classification techniques with the use of neural and fuzzy algorithms; uses in practice suitable methods of network learning and interprets the connections between an object inputs and outputs;<br>is able to program industrial robots | T1A_U09<br>InzA_U02<br>T1A_U10<br>InzA_U03<br>T1A_U14<br>InzA_U06 |
| K1MTR_U18 | is able to design a technological process for the fabrication of an electronic device, taking into account assumed application and economic criteria, with the use of proper methods, techniques, tools and materials | T1A_U12<br>InzA_U04<br>T1A_U16<br>InzA_U08 |
| K1MTR_U19 | is able to choose appropriate informatics tools and hardware to realize an assumed task from the field of informatics, develop algorithm documentation, use a proper programming language, tools and equipment for the development, implementation and testing of computer programs and prepare documentation of computer software | T1A_U13<br>InzA_U05<br>T1A_U15<br>InzA_U07 |
| K1MTR_U20 | has an ability to analyze the principles of functioning of network protocols and interfaces and design simple communication networks; is able to apply in practice the used solutions and network configurations, depending on the chosen problem specification | T1A_U01<br>T1A_U10<br>InzA_U03<br>T1A_U16<br>InzA_U08 |
| K1MTR_U21 | chooses appropriate methods, algorithms and tools necessary for digital processing of signals and images, is able to design and implement algorithms and correctly interpret the results of performed analyses | T1A_U15<br>InzA_U07<br>T1A_U16<br>InzA_U08 |
| K1MTR_U22 | is able to choose proper tools to add engineering jobs and use them in practice in software engineering (Matlab/Simulink, LabView, 3D modeling, MES);<br>analyzes and interprets the obtained results using experiment design methods, optimization, numerical modeling, simulation, analysis and verification of results | T1A_U07 |

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| K1MTR_U23 | is able to design, integrate and model a simple mechatronic system and subsequently verify the correctness of operation of such system | T1A_U09<br>InzA_U02<br>T1A_U16<br>InzA_U08 |
| K1MTR_U24 | is able to explain and justify the undertaken engineering task, identify partial tasks, make a work plan on the project and present the work flow and results in form of oral presentation and records;<br>analyzes complexity of a task, establishes priorities for accomplishment the undertaken task with the use of selected methods and tools | T1A_U01<br>T1A_U03<br>T1A_U04<br>T1A_U05<br>T1A_U14<br>InzA_U06 |
| K1MTR_U25 | is able to acquire information from literature, integrate and interpret liberal texts | T1A_U02 |
| K1MTR_U26 | is able to acquire information from literature, integrate and interpret scientific texts from the area of engineering ethics | T1A_U01 |
| K1MTR_U27 | is able to use law codes and apply legal regulations in situations typical of professional practice | T1A_U01 |
| K1MTR_U28 | is able to apply specialized vocabulary from the field of quality management, read basic ISO standards of 9000 series, with understanding and give examples of management solutions which fulfill the requirements and guidelines of these standards | T1A_U01<br>T1A_U03<br>T1A_U04 |
| K1MTR_U29 | is prepared to business activity in industrial environment, is familiar with industrial safety rules associated with workplace | T1A_U11 |
| K1MTR_U30 | is able to use statistical methods in topics related to mechanics and electrical engineering | T1A_U01 |
| K1MTR_U31 | can perform basic acceptance and operating tests for low-voltage electrical installations; can act properly in the case of failure of electrical equipment resulting in threat to life, health and the environment | T1A_U09<br>InzA_U02<br>T1A_U11 |
| K1MTR_U32 | is able to use catalogues of elements; is able to apply recognized elements for designing simple electronic circuits | T1A_U16<br>InzA_U08 |
| K1MTR_U33 | is able to apply the known optoelectronic components and simple optical fiber systems in engineering practice | T1A_U15<br>InzA_U07 |

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| K1MTR_U34 | is able to design electronic circuits responsible for measurement and processing of sensor signals, and depending on complexity level, run and measure the functional properties of designed analog or digital systems intended for control and measuring (detection) | T1A_U16<br>InzA_U08 |
| K1MTR_U35 | is able to apply an object oriented approach for designing and programming; is familiar with the languages of object programming at high level | T1A_U07<br>T1A_U16<br>InzA_U08 |
| K1MTR_U36 | is able to select correctly the configuration of PLC controller systems for the accomplishment of particular control and management tasks and perform their programming | T1A_U14<br>InzA_U06 |
| | achieves the results in the category of SKILLS in one of the following graduation areas:<br>• Mechatronics in Machine Building and Automotive Engineering (**Attachment no. 1**)<br>• Mechatronics in Automatics and Measurements (**Attachment no. 2**)<br>• Mechatronic Microsystems (**Attachment no. 3**) | |

| COMPETENCES | | |
|---|---|---|
| K1MTR_K01 | understands the need and knows the possibilities of lifetime learning process (2-nd and 3-rd level studies, post-graduate studies, courses) in raising the professional, personal and social competences | T1A_K01 |
| K1MTR_K02 | is conscious of the importance and understands beyond technical aspects and consequences of the mechatronic engineer activity, including the environmental aspects and responsibility for undertaken decisions | T1A_K02<br>InzA_K01 |
| K1MTR_K03 | is able to co-operate and work in a team, taking up different roles | T1A_K03 |
| K1MTR_K04 | is able to define priorities in realization of a task established by self or someone else | T1A_K04 |
| K1MTR_K05 | correctly recognizes and settles dilemmas associated with professional activity | T1A_K05 |
| K1MTR_K06 | is able to think and act in an entrepreneurial way | T1A_K06<br>InzA_K02 |
| K1MTR_K07 | is conscious of the importance and understands humanistic aspects and consequences of engineering activities; recognizes the impact of technical activities on environment and connected with it social responsibility of science and technology | T1A_K01 |
| K1MTR_K08 | correctly recognizes and settles dilemmas associated with performing professional activities; is conscious of the social role of technical university graduates; understands the need to formulate and share in society the information concerning technical achievements and other aspects of engineering activity; is able to share such information and opinion in a clear way, justifying various points of view | T1A_K05<br>T1A_K07 |
| K1MTR_K09 | understands legal aspects and consequences of engineering activities | T1A_K05<br>T1A_K06<br>InzA_K02 |
| K1MTR_K10 | understands the ideas of standardization, certification and integration of the management systems including quality, environmental protection, industrial safety and information security; understands the concept of management through quality; recognizes the basic problems of quality management, including the cost of quality and the methods of solving this problem; knows the general rules of establishing and developing the forms of individual entrepreneurship | T1A_K01<br>T1A_K06<br>InzA_K02<br>T1A_K07 |
| K1MTR_K11 | is conscious of necessity of individual and group activities extending beyond engineering activities | T1A_K01<br>T1A_K04 |

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| K1MTR_K12 | is conscious of the social role of technical university graduates, especially understands the need to formulate and share in society – among the others by mass-media – the information and opinions concerning the achievements of mechatronics and other aspects of mechatronic engineer activity; takes efforts to share such information and opinions in a clear way | T1A_K07 |
| K1MTR_K13 | has a sense of responsibility for own work and willingness to comply with the principles of teamwork and improve accountability for jointly implemented activities | T1A_K03 |
| K1MTR_K14 | thinks that the conscious and systematic physical activity during studies and after graduation, helps in improvement of life quality | T1A_K01<br>T1A_K03 |
| K1MTR_K15 | is able to interact and work in a group, assuming different roles in it and can think critically and argue his position, so that he can appropriately select priorities and the means to implement stated tasks stated by him or others | T1A_K04 |

**Attachment no. 1 AREA OF GRAUDATION Mechatronics in Machine Building and Automotive Engineering**

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| **KNOWLEDGE** | | |
| K1MTR_M_W01 | mastered the principles of efficiency assessment and applying flexible automation production | T1A_W06<br>InzA_W01 |
| K1MTR_M_W02 | knows the structures of production process and its elements, the characteristics of production techniques, principles of material selection and the form of semi-finished goods; knows technical documentation and technological processes of different class objects | T1A_W04<br>T1A_W06<br>InzA_W01<br>T1A_W07<br>InzA_W02 |
| K1MTR_M_W03 | has knowledge concerning the survey and classification of driving systems, including the hybrid ones, energy sources, principles of controlling, energy receivers | T1A_W04 |
| K1MTR_M_W06 | has basic knowledge concerning operation and programming of the systems controlling the motion of CNC machine tools | T1A_W04 |
| K1MTR_M_W07 | has knowledge concerning the hazards resulting from industrial activity and machine using, knows international conventions and Polish regulation about environmental protection and ecological aspects of machine designing, using and modernizing | T1A_W08<br>InzA_W03 |
| **SKILLS** | | |
| K1MTR_M_U01 | is able to design simple machine units using synthesis methods; is able to identify experimentally basic characteristics of mechanical systems | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02<br>T1A_U16<br>InzA_U08 |
| K1MTR_M_U02 | is able to design, assess and choose a structure of flexible production system on the basis of technological data including the family of workpieces | T1A_U16<br>InzA_U08 |
| K1MTR_M_U03 | is able to design a technological process of specific machine parts | T1A_U14<br>InzA_U06<br>T1A_U16<br>InzA_U08 |

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| K1MTR_M_U04 | is able to identify experimentally the parameters of different drives and their loads | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_M_U07 | is able to develop an algorithm for motion control and its implementation for CNC controllers for machine tools | T1A_U16<br>InzA_U08 |
| K1MTR_M_U09 | is able to design a technological process of specific machine parts | T1A_U14<br>InzA_U06<br>T1A_U16<br>InzA_U08 |

**Attachment no. 2 AREA OF GRAUDATION Mechatronics in Automatics and Measurements**

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| **KNOWLEDGE** | | |
| K1MTR_MAP_W01 | has ordered knowledge concerning the principles of operation and control of power engineering electronic systems | T1A_W03<br>T1A_W04 |
| K1MTR_MAP_W02 | has ordered knowledge concerning active and intelligent materials applied in the transducers of mechatronic systems | T1A_W04<br>T1A_W05 |
| K1MTR_MAP_W03 | has ordered knowledge concerning model application for designing and testing of control systems in mechatronics | T1A_W03<br>T1A_W04 |
| K1MTR_MAP_W04 | has ordered knowledge concerning developing of mathematical models of the systems and processes initiated by time sequence of events | T1A_W01<br>T1A_W03 |
| K1MTR_MAP_W05 | has basic knowledge concerning algorithms for numerical solution of linear and nonlinear dynamic problems | T1A_W03 |
| K1MTR_MAP_W06 | has ordered knowledge on the design and using the systems in intelligent buildings | T1A_W04 |
| K1MTR_MAP_W07 | has knowledge concerning the methods of fabrication of thin-film materials (vacuum evaporation, magnetron sputtering, plasma polymerization) applied in mechatronic systems | T1A_W04<br>T1A_W06<br>InzA_W01<br>T1A_W07<br>InzA_W02<br>InzA_W05 |
| **SKILLS** | | |
| K1MTR_MAP_U01 | is able to design and carry out the measurements of electrical characteristics as well as extract the basic parameters characterizing power electronic converters | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_MAP_U02 | is able to choose an active material or a converter using the material, suitable for the requirements of a particular mechatronic system | T1A_U13<br>InzA_U05 |

| | | |
|---|---|---|
| K1MTR_MAP_U03 | is able to use basic computer modeling tools to develop a prototype of an integrated driving system with a control algorithm | T1A_U09<br>InzA_U02<br>T1A_U16<br>InzA_U08 |
| K1MTR_MAP_U04 | is able to develop and verify mathematical models of the systems and processes connected with mechatronics | T1A_U09<br>InzA_U02<br>T1A_U13<br>InzA_U05 |
| K1MTR_MAP_U05 | is able to choose appropriate algorithm for solving mathematical models of linear and nonlinear dynamic states | T1A_U14<br>InzA_U06<br>T1A_U16<br>InzA_U08 |
| K1MTR_MAP_U06 | is able to use modern computer tools for design of supplying and control systems in a building | T1A_U15<br>InzA_U07<br>T1A_U16<br>InzA_U08 |
| K1MTR_MAP_U07 | is able to obtain thin-films with desired electrical properties and assess the influence of technological parameters on the values of these properties | T1A_U15<br>InzA_U07<br>T1A_U16<br>InzA_U08 |
| K1MTR_MAP_U08 | is able to define a configuration of a microprocessor system for realization of engineering tasks concerning measurements and control and choose proper tools for the system programming | T1A_U14<br>InzA_U06 |

**Attachment no. 3 AREA OF GRAUDATION Mechatronic Microsystems**

| | | |
|---|---|---|
| **KNOWLEDGE** | | |
| K1MTR_MM_W01 | has ordered and theoretically grounded knowledge concerning materials, technology, structure as well as specific electrical properties and stability of classical and modern components and passive elements of electronic circuits in mechatronic systems | T1A_W01<br>T1A_W03 |
| K1MTR_MM_W02 | has ordered and theoretically grounded knowledge in the field of photonics, including the knowledge necessary to understand the physical basis of the operation of the components of an optical transmission path and knows the areas of application of photonic systems, especially in automotive industry, electric power engineering and microsystems | T1A_W01<br>T1A_W03<br>T1A_W04 |
| K1MTR_MM_W03 | knows and understands technological processes associated with the fabrication of micro- and nano-devices used in mechatronics; is familiar with the current state and developing trends in micro- and nano electronic technologies | T1A_W03<br>T1A_W04 |
| K1MTR_MM_W04 | has basic, ordered and theoretically grounded knowledge concerning numerical methods applied in engineering; the range of the knowledge comprises error analysis, methods of numerical differentiation and integration, solving of linear and nonlinear systems of equations, approximation and interpolation methods, algorithms for single- and multiple criteria optimization and the methods of experiment design; has also basic knowledge in the field of modeling and simulation of continuous and discrete phenomena related to macro, micro and mesa scale | T1A_W02<br>T1A_W07<br>InzA_W02 |
| K1MTR_MM_W05 | has basic, ordered and theoretically grounded knowledge concerning the methods and materials used in modern electronics bonding, microsystems and photonics; the range of the knowledge comprises, among the others, basic bonding methods (i.e. wire bonding, surface bonding and flip-chip bonding), substrates intended for bonding with different scale of integration, applied solders (lead and leadless) electrically and thermally conductive resins; has knowledge about typical failures and bonds reliability | T1A_W03<br>T1A_W06<br>InzA_W01 |
| K1MTR_MM_W06 | has basic knowledge about principles of operation and handling external devices used in computer systems | T1A_W03<br>T1A_W07<br>InzA_W02 |
| **SKILLS** | | |

| | | |
|---|---|---|
| K1MTR_MM_U01 | is able to perform an analysis of the properties of components and passive elements, analysis of electrical circuits built of passive elements (DC, AC and transient analysis), is able to use proper methods and devices for measurement of basic quantities characterizing electronic components and systems | T1A_U07<br>T1A_U08<br>InzA_U01 |
| K1MTR_MM_U02 | can use the recognized methods, mathematical models and computer simulations for analysis and evaluation of the operation of optoelectronic components and simple optical fiber systems; can use proper methods and instruments to measure the basic quantities characteristic of these elements and optoelectronic systems; is able to prepare technical documentation on realization of an engineering task and arrange a report containing results of the task | T1A_U03<br>T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02 |
| K1MTR_MM_U03 | is able to design a technological process of fabrication of an electronic device, taking into account desired functional and economic criteria, using proper methods, techniques, tools and materials; applies industrial safety rules and is familiar with the principles of working in laboratory and industrial environment | T1A_U11<br>T1A_U12<br>InzA_U04<br>T1A_U16<br>InzA_U08 |
| K1MTR_MM_U04 | is able to choose and apply in practice proper tools, programs, numerical methods and algorithms to solve typical problems from the field of computer aided design in engineering; furthermore, is able to interpret the obtained results and use appropriate methods of their verification; correctly identifies and defines priorities for accomplishment the undertaken engineering task from the field of computer aided design | T1A_U08<br>InzA_U01<br>T1A_U09<br>InzA_U02<br>T1A_U15<br>InzA_U07 |
| K1MTR_MM_U05 | correctly analyzes, chooses and applies proper materials used for bonding in contemporary electronics; is able by himself/herself to perform simple activities connected with realization of simple electrical connections and bonding or debonding of elements on printed boards; is prepared to use the knowledge both in electronic industry and small professional service firms | T1A_U12<br>InzA_U04<br>T1A_U16<br>InzA_U08 |
| K1MTR_MM_U06 | is able design and develop software for computer measurement systems with different communication interfaces; is able to use catalogue cards and application notes to select appropriate components of designed circuit or electronic system; is able to prepare documentation on realization of an engineering task and arrange a report containing an analysis of results of the task | T1A_U01<br>T1A_U03<br>T1A_U07<br>T1A_U10<br>InzA_U03<br>T1A_U16<br>InzA_U08 |

**Attachment no. 2 to Programme of Education**

# PROGRAMME OF STUDIES

## 1. Description

| | |
|---|---|
| *Number of semesters:*<br>***7*** | *Number of ECTS points necessary to obtain qualifications:*<br>***210*** |
| *Prerequisites:*<br>***The basis for admission to study is the ENROLMENT INDEX. Its value is determined by selected results of the secondary school-leaving examination. The ENROLMENT INDEX is the sum of the points scored in the qualifying subjects (mathematics, physics, the Polish language, a modern foreign language), calculated in accordance with the applicant admission rules passed by the Senate. The enrolment index threshold value is set depending on the number of applicants.*** | *Upon completion of studies graduate obtains*<br>*professional degree of:* ***engineer***<br>*1-st level qualifications* |
| *Possibility of continuing of the studies:*<br>***The graduate is prepared to undertake study at the second level*** | *Graduate profile, employability:*<br>***The 1st-level-studies main-field-of-study MTR graduate has skills in: using the acquired knowledge in her/his professional life, communicating with the workplace milieu, actively participating in team work, managing her/his subordinates, undertaking independent business activity and dealing with legal and economic problems. The Mechatronics graduate has knowledge of mechanics, electrotechnics and electronics, information science, metrology, automation and robotics, and control theory and engineering. This wide, specific to main field of study Mechatronics, education area, forms a nationally unique profile of the graduate as a comprehensively educated engineer prepared to take up challenges in practically any field of present-day science and technology. The graduate has the skill to exploit the acquired knowledge in the design, manufacture, implementation and operation of mechatronic devices. The graduate is prepared to work in:***<br>***the electrical machinery industry, the automotive industry, the aircraft industry, the machine tool industry, the domestic appliances industry, the medical equipment industry, scientific-research institutions, R&D centres, design-construction centres, health-care*** |

| | |
|---|---|
| | ***institutions (medical and diagnostic equipment operation) and service and testing stations. The graduate is prepared to undertake 2nd level studies.*** |
| *Indication of the connection with University's mission and its development strategy:*<br>*the knowledge acquired in the course of the studies is not only to bear fruit in the graduate's future professional career, but also to shape an enterprising and creative person ready to face new challenges.* | |

**2. Fields of science and scientific disciplines to which educational effects apply:**

***Area: technical sciences***

***Discipline: electronics (main discipline), automatic control and robotics, information science***

**Concise analysis of consistency between assumed educational effects and labor market needs**

*The education effects apply to not only the broadly understood mechanics, electrotechnics and electronics, automation and robotics, but also, because of the demands of the modern engineering and technology used in industry today, to microprocessor engineering, control theory and engineering, information science and management and marketing techniques. Having achieved the assumed educational effects, the graduate will be able to find an attractive and interesting job in all the branches of industry and to set up her/his own business. The educational effects were reported and discussed at meetings of the Electrical Engineering Faculty Council whose members include representatives of industrial plants from Poland, especially from Lower Silesia and the neighboring provinces.*

## 4. List of education modules

### 4.1. List of obligatory modules

#### 4.1.1. List of general education modules

##### 4.1.1.1. *Liberal-managerial subjects* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCM031006W | Management Essentials | 1 | | | | | K1MTR_W04 K1MTR_W28 | 15 | 30 | 1 | 0.6 | T | Z | | | KO | Ob. |
| 2. | MCM036006W | Project Management | 1 | | | | | K1MTR_W28 | 15 | 30 | 1 | 0.6 | T | Z | | | KO | Ob. |
| | | Total | 2 | 0 | 0 | 0 | 0 | | 30 | 60 | 2 | 1.2 | | | | | | |

##### 4.1.1.2. *Foreign languages* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

##### 4.1.1.3. *Sporting classes* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

### 4.1.1.4. *Information Technologies* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCM031007W | Information Technology | 1 | | | | | K1MTR_W01 K1MTR_W02 | 15 | 30 | 1 | 0.6 | T | Z | | | KO | Ob. |
| 2. | MCM031007L | Information Technology | | | 1 | | | K1MTR_U19 | 15 | 30 | 1 | 0.7 | T | Z | | P | KO | Ob. |
| | | Total | 1 | 0 | 1 | 0 | 0 | | 30 | 60 | 2 | 1.3 | | | | | | |

### Altogether for general education modules:

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 3 | 0 | 1 | 0 | 0 | 60 | 120 | 4 | 2.5 |

### 4.1.2. List of basic sciences modules

#### 4.1.2.1. *Mathematics* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MAT001402W | Algebra and Analytic Geometry | 2 | | | | | K1MTR_W01 | 30 | 60 | 2 | 1.5 | T | E | O | | PD | Ob. |
| 2. | MAT001402C | Algebra and Analytic Geometry | | 1 | | | | K1MTR_U01 K1MTR_K01 | 15 | 60 | 2 | 1.0 | T | Z | O | P | PD | Ob. |
| 3. | MAT001412W | Mathematical Analysis 1.1 A | 2 | | | | | K1MTR_W01 | 30 | 150 | 5 | 3.0 | T | E | O | | PD | Ob. |
| 4. | MAT001412C | Mathematical Analysis 1.1 A | | 2 | | | | K1MTR_U01 | 30 | 90 | 3 | 2.0 | T | Z | O | P | PD | Ob. |
| 5. | MAT001422W | Mathematical Analysis 2.1 A | 2 | | | | | K1MTR_W01 | 30 | 120 | 4 | 3 | T | E | O | | PD | Ob. |
| 6. | MAT001422C | Mathematical Analysis 2.1 A | | 2 | | | | K1MTR_U01 | 30 | 90 | 3 | 2 | T | Z | O | P | PD | Ob. |
| 7. | MAT001452W | Ordinary Differential Equations | 1 | | | | | K1MTR_W01 | 15 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| 8. | MAT001452C | Ordinary Differential Equations | | 1 | | | | K1MTR_U01 K1MTR_K01 | 15 | 60 | 2 | 1.4 | T | Z | | P | PD | Ob. |
| 9. | MCD033002W | Statistics for Engineers | 1 | | | | | K1MTR_W26 | 15 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| 10. | MCD033002C | Statistics for Engineers | | 1 | | | | K1MTR_U30 | 15 | 60 | 2 | 1.4 | T | Z | | P | PD | Ob. |
| | | Total | 8 | 7 | 0 | 0 | 0 | | 225 | 810 | 27 | 17.7 | | | | | | |

#### 4.1.2.2. *Physics* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | FZP001058W | Physics 1.2 | 2 | | | | | K1MTR_W01 K1MTR_W02 K1MTR_W12 K1MTR_K01 K1MTR_K02 K1MTR_K07 K1MTR_K12 | 30 | 120 | 4 | 4 | T | E | O | | PD | Ob. |
| 2. | FZP001058C | Physics 1.2 | | 2 | | | | K1MTR_U01 K1MTR_U02 K1MTR_U12 K1MTR_U24 K1MTR_K01 K1MTR_K02 K1MTR_K07 K1MTR_K12 | 30 | 60 | 2 | 2 | T | Z | O | P | PD | Ob. |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3. | FZP003002W | Physics 2.8 | 1 | | | | | K1MTR_W01<br>K1MTR_W02<br>K1MTR_W07<br>K1MTR_W13<br>K1MTR_W14<br>K1MTR_W25 | 15 | 60 | 2 | 2 | T | E | O | | PD | Ob. |
| 4. | FZP003002L | Physics 2.8 | | | 1 | | | K1MTR_U01<br>K1MTR_U24<br>K1MTR_U25<br>K1MTR_K02<br>K1MTR_K11 | 15 | 60 | 2 | 2 | T | Z | O | P | PD | Ob. |
| | | Total | 3 | 2 | 1 | 0 | 0 | | 90 | 300 | 10 | 10 | | | | | | |

### 4.1.2.3. *Chemistry* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCD031001W | Chemisty | 2 | | | | | K1MTR_W07 | 30 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| | | Total | 2 | 0 | 0 | 0 | 0 | | 30 | 60 | 2 | 1.2 | | | | | | |

### 4.1.2.4. *Informatics* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCM033005W | Software Engineering and UML | 1 | | | | | K1MTR_W19<br>K1MTR_W32 | 15 | 30 | 1 | 0.6 | T | Z | | | PD | Ob. |
| | | Total | 1 | 0 | 0 | 0 | 0 | | 15 | 30 | 1 | 0.6 | | | | | | |

### 4.1.2.5. *Informatics* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCM032004W | Material Science I | 2 | | | | | K1MTR_W02 K1MTR_W07 | 30 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| 2. | MCM032004L | Material Science I | | | 1 | | | K1MTR_U07 | 15 | 30 | 1 | 0.7 | T | Z | | P | PD | Ob. |
| 3. | MCR033102W | Material Science II | 1 | | | | | K1MTR_W07 | 15 | 60 | 2 | 1.2 | T | E | | | PD | Ob. |
| 4. | MCR033102L | Material Science II | | | 1 | | | K1MTR_U03 | 15 | 30 | 1 | 0.7 | T | Z | | P | PD | Ob. |
| | | Total | 3 | 0 | 2 | 0 | 0 | | 75 | 180 | 6 | 3,8 | | | | | | |

### Altogether for basic sciences modules:

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 17 | 9 | 3 | 0 | 0 | 435 | 1380 | 46 | 33.3 |

### 4.1.3. List of main-field-of-study modules

#### 4.1.3.1. *Obligatory main-field-of-study* modules

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCR031101W | Metrology principles | 1 | | | | | K1MTR_W03 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 2. | MCM031005W | Engineering Graphics | 1 | | | | | K1MTR_W06 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 3. | MCM031005L | Engineering Graphics | | | 2 | | | K1MTR_U05<br>K1MTR_U09<br>K1MTR_U29 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 4. | MCM031008W | Introduction to Mechatronics | 2 | | | | | K1MTR_W10<br>K1MTR_W15<br>K1MTR_W16<br>K1MTR_W19<br>K1MTR_W22<br>K1MTR_W23<br>K1MTR_W26 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 5. | MCR032102W | Fundamentals of Electrotechnics | 2 | | | | | K1MTR_W13 | 30 | 90 | 3 | 1.8 | T | E | | | K | Ob. |
| 6. | MCR032102C | Fundamentals of Electrotechnics | | 1 | | | | K1MTR_U13 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 7. | MCM032005W | Mechanics I (Statics) | 2 | | | | | K1MTR_W01<br>K1MTR_W02<br>K1MTR_W08 | 30 | 90 | 3 | 1.8 | T | Z | | | K | Ob. |
| 8. | MCM032005C | Mechanics I (Statics) | | 2 | | | | K1MTR_U08 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 9. | MCD032001W | Electronic Components and Circuits | 2 | | | | | K1MTR_W14<br>K1MTR_W29 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 10. | MCR033231W | Electrical installations and supply systems | 1 | | | | | K1MTR_W10 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 11. | MCR033231C | Electrical installations and supply systems | | 1 | | | | K1MTR_U01<br>K1MTR_U02<br>K1MTR_U03<br>K1MTR_U04<br>K1MTR_U05<br>K1MTR_K01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 12. | MCM033006W | Mechanics II (Dynamics) | 2 | | | | | K1MTR_W09 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 13. | MCM033006C | Mechanics II (Dynamics) | | 1 | | | | K1MTR_U01<br>K1MTR_U02 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 14. | MCM033007W | Strength of materials, Mechanics of engineering materials | 2 | | | | | K1MTR_W07 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 15. | MCM033007C | Strength of materials, Mechanics of engineering materials | | 2 | | | | K1MTR_U01<br>K1MTR_U02<br>K1MTR_U09 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 16. | MCM033008W | Fundamentals of manufacturing | 2 | | | | | K1MTR_W04 | 30 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. | MCD033001L | Electronic Components and Circuits | | | 2 | | | K1MTR_U32<br>K1MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 18. | MCR034103W | Electrical metrology | 1 | | | | | K1MTR_W03 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 19. | MCR034103L | Electrical metrology | | | 1 | | | K1MTR_U03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 20. | MCR034211W | Fundamentals of control engineering | 2 | | | | | K1MTR_W17 | 30 | 90 | 3 | 1.8 | T | E | | | K | Ob. |
| 21. | MCM034005W | Analysis and Synthesis of Kinematic Systems | 2 | | | | | K1MTR_W09 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 22. | MCM034005P | Analysis and Synthesis of Kinematic Systems | | | | 2 | | K1MTR_U09 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 23. | MCM032006W | Metrology of geometrical quantites | 1 | | | | | K1MTR_W03 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 24. | MCM032006L | Metrology of geometrical quantites | | | 1 | | | K1MTR_U29<br>K1MTR_K03<br>K1MTR_K04<br>K1MTR_K09 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 25. | MCM034006L | Fundamentals of manufacturing | | | 3 | | | K1MTR_U03<br>K1MTR_U11<br>K1MTR_U29<br>K1MTR_K01<br>K1MTR_K05<br>K1MTR_K08 | 45 | 90 | 3 | 2.1 | T | Z | | P | K | Ob. |
| 26. | MCM034007W | Systems for Manufacturing and Assembly | 2 | | | | | K1MTR_W08<br>K1MTR_W11<br>K1MTR_W18 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 27. | MCM034007L | Systems for Manufacturing and Assembly | | | 1 | | | K1MTR_U11<br>K1MTR_U18<br>K1MTR_K03<br>K1MTR_K04<br>K1MTR_K06 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 28. | MCD034002W | Principles of microprocessor technology | 1 | | | | | K1MTR_W16 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 29. | MCD034002L | Principles of microprocessor technology | | | 2 | | | K1MTR_U16 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 30. | MCR035241W | Safety in electrical engineering | 1 | | | | | K1MTR_W27 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 31. | MCR035241L | Safety in electrical engineering | | | 1 | | | K1MTR_U31<br>K1MTR_K13 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 32. | MCR035301W | Electrical Drives | 2 | | | | | K1MTR_W10 | 30 | 90 | 3 | 1.8 | T | E | | | K | Ob. |
| 33. | MCR035301L | Electrical Drives | | | 2 | | | K1MTR_U02<br>K1MTR_U10 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 34. | MCR035211L | Fundamentals of control engineering | | | 1 | | | K1MTR_U17<br>K1MTR_K03 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 35. | MCR035212W | Elements of control engineering | 1 | | | | | K1MTR_W17 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 36. | MCR035212L | Elements of control engineering | | | 1 | | | K1MTR_U17<br>K1MTR_K01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 37. | MCM035003W | Fundamentals of machine elements design | 2 | | | | | K1MTR_W07<br>K1MTR_W09<br>K1MTR_W10 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38. | MCM035003P | Fundamentals of machine elements design | | | | 2 | | K1MTR_U05<br>K1MTR_U09<br>K1MTR_U23<br>K1MTR_K02<br>K1MTR_K04 | 30 | 90 | 3 | 2.1 | T | Z | | P | K | Ob. |
| 39. | MCM035004W | Drive systems, hydraulic components and pneumatic components | 2 | | | | | K1MTR_W10<br>K1MTR_W24 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 40. | MCM035004L | Drive systems, hydraulic components and pneumatic components | | | 1 | | | K1MTR_U10<br>K1MTR_U23<br>K1MTR_K04 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 41. | MCD035001W | Fundamentals of Electronic Design | 1 | | | | | K1MTR_W31 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 42. | MCD035002W | Applications of optoelectronics | 1 | | | | | K1MTR_W30 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 43. | MCD035002L | Applications of optoelectronics | | | 2 | | | K1MTR_U33 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 44. | MCM036004W | Basics of mechatronical design of systems | 1 | | | | | K1MTR_W24 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 45. | MCM036004P | Basics of mechatronical design of systems | | | | 2 | | K1MTR_U23<br>K1MTR_K02 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 46. | MCM036005W | Industrial robots | 2 | | | | | K1MTR_W09<br>1MTR_W10<br>1MTR_W15<br>K1MTR_W23 | 30 | 30 | 1 | 0.6 | T | E | | | K | Ob. |
| 47. | MCM036005L | Industrial robots | | | 1 | | | K1MTR_U09<br>K1MTR_U24<br>K1MTR_U29 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 48. | MCD036001W | Microsystems (MEMS) | 2 | | | | | K1MTR_W15 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 49. | MCD036001L | Microsystems (MEMS) | | | 1 | | | K1MTR_U15<br>K1MTR_K03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 50. | MCD036002P | Fundamentals of Electronic Design | | | | 2 | | K1MTR_U34<br>K1MTR_U32<br>K1MTR_K03<br>K1MTR_K04 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| | | Total | 41 | 7 | 22 | 8 | 0 | | 1170 | 2580 | 86 | 55.6 | | | | | | |

## Altogether for main-field-of-study modules:

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 41 | 7 | 22 | 8 | 0 | 1170 | 2580 | 86 | 55.6 |

### 4.1.3. List of specialization modules

#### 4.1.3.1. *Obligatory specialization subjects* modules

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

**Altogether for specialization modules:**

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| | | | | | | | | |

### 4.2. List of optional modules

### 4.2.1. List of general education modules

#### 4.2.1.1. *Liberal-managerial subjects* modules

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | HMH100035BK | Block of humanistic courses | 1 | | | | | K1MTR_W25 K1MTR_K02 K1MTR_K07 | 15 | 30 | 1 | 0.6 | T | Z | O | | KO | W |
| 2. | HMH100035BK | Block of humanistic courses | 1 | | | | | K1MTR_W05 K1MTR_K09 | 15 | 30 | 1 | 0.6 | T | Z | O | | KO | W |
| 3. | HMH100035BK | Block of humanistic courses | | | | | 1 | K1MTR_U25 K1MTR_K15 | 15 | 60 | 2 | 1.4 | T | Z | O | P | KO | W |
| | | Total | 2 | 0 | 0 | 0 | 1 | | 45 | 120 | 4 | 2.6 | | | | | | |

### 4.2.1.2. *Foreign languages* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | JZL100707BK | Foreign Languages B2 or C1 | | 4 | | | | K1MTR_U06, K1MTR_K01 | 60 | 60 | 2 | 1.5 | T | Z | O | P | KO | W |
| 2. | JZL100708BK | Foreign Languages B2 or C1 | | 4 | | | | K1MTR_U06, K1MTR_K01 | 60 | 90 | 3 | 2.5 | T | Z | O | P | KO | W |
| | | Total | 0 | 8 | 0 | 0 | 0 | | 120 | 150 | 5 | 4 | | | | | | |

### 4.2.1.3. *Sporting classes* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | WFW000000BK | Block of Sports Activities | | 2 | | | | K1MTR_K03 K1MTR_K11 | 30 | 30 | 1 | 1 | T | Z | O | P | KO | W |
| | | Total | 0 | 2 | 0 | 0 | 0 | | 30 | 30 | 1 | 1 | | | | | | |

### 4.2.1.4. *Information Technologies module*

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

**Altogether for general education modules:**

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 2 | 10 | 0 | 0 | 1 | 195 | 300 | 10 | 7.6 |

### 4.2.2. List of basic sciences modules

#### 4.2.2.1. *Mathematics* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

#### 4.2.2.2. *Physics* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

### 4.2.2.3. Chemistry module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

### 4.2.2.4. Informatics module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | **MCM032101BK** | **Optional courses: Informatics** | **2** | | | | | | 30 | 30 | 1 | 0.6 | T | Z | | | PD | W |
| | | | | | **2** | | | | 30 | 30 | 1 | 0.7 | T | Z | | P | PD | W |
| 1. | MCR032251W | Introduction to programming | 2 | | | | | K1MTR_W19 | | | | | | | | | | |
| 2. | MCR032251L | Introduction to programming | | | 2 | | | K1MTR_U19 | | | | | | | | | | |
| 3. | MCM032102W | Introduction to programming | 2 | | | | | K1MTR_W19 | | | | | | | | | | |
| 4. | MCM032102L | Introduction to programming | | | 2 | | | K1MTR_U19<br>K1MTR_K03 | | | | | | | | | | |
| 5. | MCD032101W | Fundamentals of Computer Science | 2 | | | | | K1MTR_W19 | | | | | | | | | | |
| 6. | MCD032101L | Fundamentals of Computer Science | | | 2 | | | K1MTR_U19 | | | | | | | | | | |
| | **MCM033101BK** | **Optional courses: Procedural Programming** | | | **2** | | | | 30 | 90 | 3 | 2.1 | T | Z | | P | PD | W |
| 7. | MCR033251L | Programming in Matlab | | | 2 | | | K1MTR_U19 | | | | | | | | | | |
| 8. | MCM033102L | C Programming | | | 2 | | | K1MTR_U19<br>K1MTR_K01 | | | | | | | | | | |
| 9. | MCD033101L | The Practice of Programming in C | | | 2 | | | K1MTR_U19<br>K1MTR_K03<br>K1MTR_K04 | | | | | | | | | | |
| | **MCM034101BK** | **Optional courses: Network communication** | **1** | | | | | | 15 | 60 | 2 | 1.2 | T | Z | | | PD | W |
| | | | | | **1** | | | | 15 | 30 | 1 | 0.7 | T | Z | | P | PD | W |
| 10. | MCR034104W | Components of computer networks | 1 | | | | | K1MTR_W19<br>K1MTR_W20 | | | | | | | | | | |
| 11. | MCR034104L | Components of computer networks | | | 1 | | | K1MTR_U19<br>K1MTR_U20 | | | | | | | | | | |
| 12. | MCM034103W | Industrial networks | 1 | | | | | K1MTR_W20 | | | | | | | | | | |
| 13. | MCM034103L | Industrial networks | | | 1 | | | K1MTR_U20 | | | | | | | | | | |
| 14. | MCD034103W | Introduction to Computer Networks | 1 | | | | | K1MTR_W20 | | | | | | | | | | |
| 15. | MCD034103L | Introduction to Computer Networks | | | 1 | | | K1MTR_U20 | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **MCM034102BK** | **Optional courses: Object Oriented Programming** | | | **2** | | | | 30 | 90 | 3 | 2.1 | T | Z | | P | PD | W |
| 16. | MCR034251L | MATLAB Object Oriented Programming | | | 2 | | | K1MTR_U19<br>K1MTR_U37<br>K1MTR_K01 | | | | | | | | | | |
| 17. | MCM034104L | C++ Programming | | | 2 | | | K1MTR_U19<br>K1MTR_U35<br>K1MTR_K01 | | | | | | | | | | |
| 18. | MCD034102L | Object Oriented Programming | | | 2 | | | K1MTR_U19<br>K1MTR_U35<br>K1MTR_K01 | | | | | | | | | | |
| | **MCM036101BK** | **Optional courses: CAD 3D-FEM** | | | **2** | | | K1MTR_U19<br>K1MTR_U35<br>K1MTR_K01 | 30 | 60 | 2 | 1.4 | T | Z | | P | PD | W |
| 19. | MCR036303L | FEM modelling in mechatronics | | | 2 | | | K1MTR_U01<br>K1MTR_U02<br>K1MTR_U13<br>K1MTR_K03 | | | | | | | | | | |
| 20. | MCM036106L | CAD/FEM | | | 2 | | | K1MTR_U22 | | | | | | | | | | |
| 21. | MCD036101L | Numerical prototyping of microelectronic structures | | | 2 | | | K1MTR_U22<br>K1MTR_K04<br>K1MTR_K05 | | | | | | | | | | |
| | | Total | 12 | 0 | 36 | 0 | 0 | | 180 | 390 | 13 | 8.8 | | | | | | |

## Altogether for basic sciences modules:

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 12 | 0 | 36 | 0 | 0 | 180 | 390 | 13 | 8.8 |

### 4.2.3. List of main-field of science modules

#### 4.2.3.1. *Optional main-field-of-study* modules

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | **MCR035101BK** | **Optional courses:** | **1** | | | | | | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| | | **Sensing** | | | **2** | | | | 30 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 1. | MCR035103W | Sensors – properties and applications | 1 | | | | | K1MTR_W15 | | | | | | | | | | |
| 2. | MCR035103L | Sensors – properties and applications | | | 2 | | | K1MTR_U15 | | | | | | | | | | |
| 3. | MCM035105W | Sensory w systemacha wytwórczych | 1 | | | | | K1MTR_W03<br>K1MTR_W15<br>K1MTR_W16 | | | | | | | | | | |
| 4. | MCM035105L | Sensory w systemacha wytwórczych | | | 2 | | | K1MTR_U03<br>K1MTR_U10<br>K1MTR_U15 | | | | | | | | | | |
| 5. | MCM035106W | Sensors in the machine and vehicle construction | 1 | | | | | K1MTR_W03<br>K1MTR_W15<br>K1MTR_W16 | | | | | | | | | | |
| 6. | MCM035106L | Sensors in the machine and vehicle construction | | | 2 | | | K1MTR_U03<br>K1MTR_U10<br>K1MTR_U15 | | | | | | | | | | |
| 7. | MCD035101W | Sensors and actuators | 1 | | | | | K1MTR_W15 | | | | | | | | | | |
| 8. | MCD035101L | Sensors and actuators | | | 2 | | | K1MTR_U15 | | | | | | | | | | |
| | **MCM035102BK** | **Optional courses:** | **1** | | | | | | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| | | **Logical Systems** | | | **1** | | | | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 9. | MCR035303W | Programming of distributed control systems based on PLC | 1 | | | | | K1MTR_W10<br>K1MTR_W17<br>K1MTR_W33 | | | | | | | | | | |
| 10. | MCR035303L | Programming of distributed control systems based on PLC | | | 1 | | | K1MTR_U15<br>K1MTR_U20<br>K1MTR_U36 | | | | | | | | | | |
| 11. | MCM035104W | Programmable Logic Controllers | 1 | | | | | K1MTR_W10<br>K1MTR_W33 | | | | | | | | | | |
| 12. | MCM035104L | Programmable Logic Controllers | | | 1 | | | K1MTR_U16<br>K1MTR_U36 | | | | | | | | | | |
| 13. | MCD035102W | Logic Circuits Modeling | 1 | | | | | K1MTR_W16<br>K1MTR_W19 | | | | | | | | | | |
| 14. | MCD035102L | Logic Circuits Modeling | | | 1 | | | K1MTR_U19<br>K1MTR_U22 | | | | | | | | | | |
| | **MCM036102BK** | **Optional courses: Interdisciplinary Team Project** | | | | **2** | | | 30 | 90 | 3 | 2.1 | T | Z | | P | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15. | MCR036103P, 6231, 6302 | Interdisciplinary Team Project | | | | 2 | | K1MTR_U04<br>K1MTR_U30<br>K1MTR_K03<br>K1MTR_K06 | | | | | | | | | | |
| 16. | MCM036107P | Interdisciplinary Team Project | | | | 2 | | K1MTR_U04<br>K1MTR_U30<br>K1MTR_K03<br>K1MTR_K06 | | | | | | | | | | |
| 17. | MCD036102P | Interdisciplinary Team Project | | | | 2 | | K1MTR_U04<br>K1MTR_U30<br>K1MTR_K03<br>K1MTR_K06 | | | | | | | | | | |
| | **MCM036103BK** | **Optional courses:** | **1** | | | | | | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| | | **Signal Processing** | | | **1** | | | | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 18. | MCR036106W | Digital signal processing | 1 | | | | | K1MTR_W21 | | | | | | | | | | |
| 19. | MCR036106L | Digital signal processing | | | 1 | | | K1MTR_U21<br>K1MTR_U22 | | | | | | | | | | |
| 20. | MCM036108W | Signal Processing | 1 | | | | | K1MTR_W16 | | | | | | | | | | |
| 21. | MCM036108L | Signal Processing | | | 1 | | | K1MTR_U19<br>K1MTR_U21 | | | | | | | | | | |
| 22. | MCD036103W | Methods of Signal Processing | 1 | | | | | K1MTR_W21 | | | | | | | | | | |
| 23. | MCD036103L | Methods of Signal Processing | | | 1 | | | K1MTR_U01<br>K1MTR_K06 | | | | | | | | | | |
| | **MCM036104BK** | **Optional courses:** | **2** | | | | | | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| | | **Applications of Microsystems** | | | **2** | | | | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 24. | MCR036304W | Microsystems in measurements | 1 | | | | | K1MTR_W16 | | | | | | | | | | |
| 25. | MCR036304L | Microsystems in measurements | | | 1 | | | K1MTR_U15<br>K1MTR_U16 | | | | | | | | | | |
| 26. | MCR036305W | Microsystems in control | 1 | | | | | K1MTR_W21 | | | | | | | | | | |
| 27. | MCR036305L | Microsystems in control | | | 1 | | | K1MTR_U15<br>K1MTR_U16 | | | | | | | | | | |
| 28. | MCM036109W | Mechatronics in Medicine | 1 | | | | | K1MTR_M_W03<br>K1MTR_W08<br>K1MTR_W23<br>K1MTR_W09<br>K1MTR_W26 | | | | | | | | | | |
| 29. | MCM036109L | Mechatronics in Medicine | | | 1 | | | K1MTR_U02<br>K1MTR_U03<br>K1MTR_U21<br>K1MTR_K01<br>K1MTR_K07 | | | | | | | | | | |
| 30. | MCM036110W | Mechatronic systems in manufacturing technologies | 1 | | | | | K1MTR_W09<br>K1MTR_W15<br>K1MTR_W23 | | | | | | | | | | |
| 31. | MCM036110L | Mechatronic systems in manufacturing technologies | | | 1 | | | K1MTR_U03<br>K1MTR_U11<br>K1MTR_U15 | | | | | | | | | | |
| 32. | MCD036104W | Microsystems in medicine | 1 | | | | | K1MTR_W15 | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33. | MCD036104L | Microsystems in medicine | | | 1 | | | K1MTR_U15<br>K1MTR_K03 | | | | | | | | | | |
| 34. | MCD036105W | Automotive microsystems | 1 | | | | | K1MTR_W15 | | | | | | | | | | |
| 35. | MCD036105L | Automotive microsystems | | | 1 | | | K1MTR_U15<br>K1MTR_K03 | | | | | | | | | | |
| | | Total | 21 | 0 | 26 | 8 | 0 | | 195 | 450 | 15 | 10 | | | | | | |

### 4.2.3.2. *Degree Profile* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| **Degree Profile: - Mechatronics in Automation and Measurements** | | | | | | | | | | | | | | | | | | |
| 1. | MCR035302W | Power Electronics | 2 | | | | | K1MTR_MAP_W01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 2. | MCR035302L | Power Electronics | | | 1 | | | K1MTR_MAP_U01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 3. | MCR036102W | Active materials | 1 | | | | | K1MTR_MAP_W02<br>K1MTR_W02 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 4. | MCR036102L | Active materials | | | 1 | | | K1MTR_MAP_U02<br>K1MTR_U02<br>K1MTR_U03<br>K1MTR_U22<br>K1MTR_U24 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 5. | MCR036211W | System modelling | 1 | | | | | K1MTR_MAP_W05<br>K1MTR_MAP_W04 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 6. | MCR036211L | System modelling | | | 1 | | | K1MTR_MAP_U04<br>K1MTR_MAP_U05 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 7. | MCR036301L | Control Systems Prototyping | | | 1 | | | K1MTR_U19 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 8. | MCR037231W | Building automation | 1 | | | | | K1MTR_MAP_W06 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 9. | MCR037231P | Building automation | | | | 2 | | K1MTR_MAP_U06<br>K1MTR_K06 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 10. | MCR037101P | Numerical methods | | | | 1 | | K1MTR_U01<br>K1MTR_K04<br>K1MTR_K06 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 11. | MCR037102W | Thin-layer technologies | 1 | | | | | K1MTR_W02<br>K1MTR_W18<br>K1MTR_MAP_W07 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 12. | MCR037102L | Thin-layer technologies | | | 2 | | | K1MTR_U02<br>K1MTR_U03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13. | MCR037301S<br>MCR037201S<br>MCR037103S | Diploma seminar | | | | | 2 | K1MTR_MAP_U01<br>K1MTR_MAP_U02<br>K1MTR_MAP_U03<br>K1MTR_MAP_U04<br>K1MTR_MAP_U05<br>K1MTR_MAP_U06<br>K1MTR_MAP_U07<br>K1MTR_MAP_U08<br>K1MTR_K04,<br>K1MTR_K06 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| **Degree Profile: - Mechatronics in Machine Building and Vehicles** | | | | | | | | | | | | | | | | | | |
| 14. | MCM035203W | Ecology in industrial manufacturing | 1 | | | | | K1MTR_M_W05 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 15. | MCM035204W | Technological designe processes | 1 | | | | | K1MTR_W06<br>K1MTR_W11 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 16. | MCM035204P | Technological designe processes | | | | 1 | | K1MTR_M_U03<br>K1MTR_M_U06 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 17. | MCM036203W | Manufacturing automation | 2 | | | | | K1MTR_M_W01<br>K1MTR_M_W02 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 18. | MCM036203L | Manufacturing automation | | | 1 | | | K1MTR_M_U02 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 19. | MCM036204W | Design of mechanical assemblies | 1 | | | | | K1MTR_W07<br>K1MTR_W09<br>K1MTR_W10 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 20. | MCM036204P | Design of mechanical assemblies | | | | 1 | | K1MTR_M_U01<br>K1MTR_U09<br>K1MTR_U22<br>K1MTR_U23<br>K1MTR_U24<br>K1MTR_K02<br>K1MTR_K04 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 21. | MCM037205W | Monitoring of machines and processes | 1 | | | | | K1MTR_W03<br>K1MTR_W11<br>K1MTR_W15<br>K1MTR_W17 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 22. | MCM037205L | Monitoring of machines and processes | | | 1 | | | K1MTR_U02<br>K1MTR_U03<br>K1MTR_U17<br>K1MTR_U21<br>K1MTR_U19<br>K1MTR_K01<br>K1MTR_K02<br>K1MTR_K04<br>K1MTR_K05<br>K1MTR_K06<br>K1MTR_K07<br>K1MTR_K08<br>K1MTR_K09 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 23. | MCM037206P | Numerical methods | | | | 1 | | K1MTR_U21<br>K1MTR_U03<br>K1MTR_K03<br>K1MTR_K04 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 24. | MCM037207W | Programing of machine numerical controled | 2 | | | | | K1MTR_M_W04<br>K1MTR_W11 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25. | MCM037207P | Programing of machine numerical controled | | | | 1 | | K1MTR_M_U05 K1MTR_M_U06 K1MTR_U24 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 26. | MCM037208W | SCADA i HMI | 1 | | | | | K1MTR_W19 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 27. | MCM037001S | Diploma seminar | | | | | 2 | K1MTR_U24 K1MTR_K01 K1MTR_K03 K1MTR_K04 K1MTR_K06 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| **Degree Profile: - Mechatronic Systems** | | | | | | | | | | | | | | | | | | |
| 28. | MCD035201W | Electronic Components | 2 | | | | | K1MTR_MM_W01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 29. | MCD035201L | Electronic Components | | | 1 | | | K1MTR_MM_U01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 30. | MCD036201W | Photonics | 1 | | | | | K1MTR_MM_W02 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 31. | MCD036201L | Photonics | | | 2 | | | K1MTR_MM_U02 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 32. | MCD036202W | Micro- and Nanoelectronics | 2 | | | | | K1MTR_MM_W01 K1MTR_MM_W03 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 33. | MCD037201L | Laboratory on micro- and nanoelectronics | | | 1 | | | K1MTR_MM_U03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 34. | MCD037202L | Numerical methods | | | 1 | | | K1MTR_MM_W04 K1MTR_MM_U04 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 35. | MCD037203W | Packaging of Electronic and Photonics Systems | 1 | | | | | K1MTR_W18 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 36. | MCD037203L | Packaging of Electronic and Photonics Systems | | | 1 | | | K1MTR_U18 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 37. | MCD037204W | Peripheral Devices in Computer Systems | 2 | | | | | K1MTR_MM_W02 K1MTR_MM_W06 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 38. | MCD037204L | Peripheral Devices in Computer Systems | | | 1 | | | K1MTR_MM_U02 K1MTR_K03 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 39. | MCD037001S | Diploma seminar | | | | | 2 | K1MTR_MM_W05 K1MTR_MM_U01- K1MTR_MM_U06 K1MTR_U02- K1MTR_U31 K1MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| | | Total | 23 | 0 | 15 | 7 | 6 | | 765 | 1800 | 60 | 39.3 | | | | | | |

### 4.2.3.3. *Training* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | **MCM037003BK** | **Training** | | | | | | | 0 | 120 | 4 | 4 | T | Z | | P | K | W |
| **Degree Profile: Mechatronics in Automation and Measurements** | | | | | | | | | | | | | | | | | | |
| 1. | MCR037001Q | Practice | | | | | | K1MTR_U29 | | | | | | | | | | |
| **Degree Profile: Mechatronics in Machine Building and Vehicles** | | | | | | | | | | | | | | | | | | |
| 2. | MCM070003Q | Practice | | | | | | K1MTR_U29 | | | | | | | | | | |
| **Degree Profile: Mechatronic Systems** | | | | | | | | | | | | | | | | | | |
| 3. | MCD030002Q | Practice | | | | | | K1MTR_U04<br>K1MTR_U29<br>K1MTR_K02<br>K1MTR_K03 | | | | | | | | | | |
| | | Total | 0 | 0 | 0 | 0 | 0 | | 0 | 120 | 4 | 4 | | | | | | |

### 4.2.3.4. *Diploma dissertation* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | **MCR037002BK** | **Diploma thesis** | | | | **2** | | | 30 | 360 | 12 | 12 | T | Z | | P | K | W |
| **Degree Profile: Mechatronics in Automation and Measurements** | | | | | | | | | | | | | | | | | | |
| 1. | MCR037100D<br>MCR037200D<br>MCR037300D | Diploma thesis | | | | 2 | | K1MTR_U24<br>K1MTR_K01<br>K1MTR_K04<br>K1MTR_K06 | | | | | | | | | | |
| **Degree Profile: Mechatronics in Machine Building and Vehicles** | | | | | | | | | | | | | | | | | | |
| 2. | MCM037002D | Diploma thesis | | | | 2 | | K1MTR_U24<br>K1MTR_K01<br>K1MTR_K04<br>K1MTR_K06 | | | | | | | | | | |
| **Degree Profile: Mechatronic Systems** | | | | | | | | | | | | | | | | | | |
| 3. | MCD037002D | Diploma thesis | | | | 2 | | K1MTR_MM_U01-<br>K1MTR_MM_U06<br>K1MTR_U01-<br>K1MTR_U33<br>K1MTR_K03<br>K1MTR_K10 | | | | | | | | | | |
| | | Total | 0 | 0 | 0 | 2 | 0 | | 30 | 360 | 12 | 12 | | | | | | |

**Altogether for main-field-of-study modules:**

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 44 | 0 | 41 | 17 | 6 | 990 | 2730 | 91 | 65.3 |

### 4.2.4 List of specialization modules

#### 4.2.4.1. *Optional specialization subjects modules*

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

#### 4.2.4.2. *Diploma dissertation* module

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | | | | | | | | | | | | | | | | | | |
| | | Total | | | | | | | | | | | | | | | | |

**Altogether for specialization modules:**

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| | | | | | | | | |

## 4.2 Training module

| Name of training | | Training | |
|---|---|---|---|
| **Number of ECTS points** | **Number of ECTS points for BK classes1** | **Training crediting mode** | **Code** |
| **6** | **4** | report | **MCR037001Q (W05)**<br>**MCM037003Q (W10)**<br>**MCD030002Q (W12)** |

| Training duration | Training objective |
|---|---|
| **4 weeks** | The aim of the work placement is for the student to gain industrial experience, familiarize herself/himself with the basic technical and technological equipment and with the work of the plant's technical supervisors, and in particular to:<br>• broaden the knowledge gained in her/his studies and develop the skills of using it,<br>• familiarize herself/himself with the peculiarities of the professional environment,<br>• develop specific professional skills directly connected with the work placement venue,<br>• hone the skills of effective communication,<br>• familiarize herself/himself with the principles of work organization and division of competences, the procedures, the work planning process and the control,<br>• improve her/his skills of organizing her/his own work and teamwork and effectively managing time as well as develop conscientiousness and responsibility for the entrusted tasks,<br>• hone the skill of using a foreign language in professional situations.<br>Through the free choice of the work placement venue, e.g. through her/his choice of the "firm", the student can pursue her/his professional interests. This may help her/him to formulate the topic of her/his engineering diploma work. The student's first professional work often takes place in the work placement venue. |

### 4.3 Diploma dissertation module

| Type of diploma dissertation | engineering | |
|---|---|---|
| **Number of semesters of diploma dissertation** | **Number of ECTS points** | **Code** |
| **1** | **12** | **MCR037100, 7200, 7300 MCM037002, MCD037002** |
| **Character of diploma dissertation** | | |
| The engineering diploma dissertation has a character useful for engineering practice. Its subject is, in particular, a solution of a problem relating to: design, a measurement experiment, the development of a computer program and an analysis of a part or the totality of processes having a technical, organizational-technical and economic-technical character. The dissertation has no solely descriptive character, and clearly includes a part being the student's own contribution. | | |
| **Number of BK1 ECTS points** | | |

### 5. Ways of verifying assumed educational effects

| Type of classes | Ways of verifying assumed educational effects |
|---|---|
| lecture | *examination, semi final wrtitten test, short test, oral answer, presence, test, written test* |
| class | *semi final wrtitten test, short test, oral answer, activity in problem discussions, test, report, activity* |
| laboratory | *short test, oral answer, activity in problem discussions, pass, activity, average lab. assessment, report, paper presentation,* |
| project | *semi final wrtitten test, short test, oral answer, activity in problem discussions, pass, activity, project preparation, report, project defense, presence, presentation,* |
| seminar | *oral answer, activity in problem discussions, activity, presentation, problem work out* |
| training | *report from training* |
| diploma dissertation | *prepared diploma dissertation* |

6. **Total number of ECTS points, which student has to obtain from classes requiring direct academic teacher-student contact** (enter total of ECTS points for courses/groups of courses denoted with code BK1)

   **189.1 ECTS**

7. **Total number of ECTS points, which student has to obtain from basic sciences classes**

| | |
|---|---|
| Number of ECTS points for obligatory subjects | 46 |
| Number of ECTS points for optional subjects | 0 |
| Total number of ECTS points | 46 |

8. **Total number of ECTS points, which student has to obtain from practical classes, including laboratory classes** (enter total number of ECTS points for courses/group of courses denoted with code P)

| | |
|---|---|
| Number of ECTS points for obligatory subjects | 59 |
| Number of ECTS points for optional subjects | MiAaM - 56<br>MiMBaV - 54<br>MM - 55 |
| Total number of ECTS points | MiAaM - 115<br>MiMBaV - 113<br>MM - 114 |

9. **Minimum number of ECTS points, which student has to obtain doing education modules offered as part of university-wide classes or other main field of study** (enter number of ECTS points for courses/groups of courses denoted with code O)
   **39 ECTS**

10. **Total number of ECTS points, which student may obtain doing optional modules (min. 30% of total number of ECTS points)**
    **74 ECTS**

**11. Range of diploma examination**

The diploma examination problems, divided into thematic blocks, are available on the Faculty website.

**12. Requirements concerning deadlines for crediting courses/groups of courses for all courses in particular modules**

| *No.* | *Course code* | *Name of course* | *Crediting by deadline (number of semester)* |
|---|---|---|---|
| | | | |

**13. Plan of studies (attachment no. 1)**

Opinion of the Student Council of the Faculty

..... .....

Date Name, surname and signature of the student's representative

..... .....

Date Dean's signature

**Attachment no. 1 to Programme of Studies**

# PLAN OF STUDIES

**FACULTIES: Electrical Engineering, Mechanical Engineering, Microsystem Electronics and Photonics**

**MAIN FIELD OF STUDY:** ***Mechatronics***

**EDUCATION LEVEL:** ***1-st level engineering study***

**FORM OF STUDIES*: full-time***

**PROFILE:** ***general academic***

**SPECIALIZATION**:

**LANGUAGE OF STUDY:** ***Polish***

Microsystem Electronics and Photonics Faculty Council resolution no. ***9/1/2016-2020*** of **21.09.2016**

In effect since ***01.10.2016***

Faculty: **Microsystem Electronics and Photonics**
Field of study: **Mechatronics**
Degree profile: **Mechatronic microsystems**
Study: **1-st level, full-time**

Faculty Council resolution from: **21.09.2016**
In effect from: **01.10.2016**

# POINT AND HOUR LAYOUT OF THE PLAN OF STUDIES

| | 23 | I | 30 | 25 | II | 30 | 26 | III | 30 | 27 | IV | 30 | 28 | V | 30 | 27 | VI | 30 | 12 | VII | 30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | | | | | | | | | | | | | MCD035201 **2W + 1L** 20100<br>Electronic components | | | | | | | | | 28 |
| 27 | | | | | | | | | | MCM034101BK **2W + 1L** 10100<br>Optional block:<br>Network communication | | | | | | MCD036201 **1W + 2L** 10200<br>Photonics | | | | | | 27 |
| 26 | | | | | | | MCM033101BK **3L** 00200<br>Optional block:<br>Procedural programming | | | | | | | | | | | | | | | | 26 |
| 25 | | | | MCM032101BK **1W + 1L** 20200<br>Optional block: Informatics | | | MCR033231 **1W + 1C** 11000<br>Electrical installations and supply systems | | | MCM034102BK **3L** 00200<br>Optional block:<br>Object oriented programming | | | MCR035241 **1W + 1L** 10100<br>Safety in electrical engineering | | | | | | | | | | 25 |
| 24 | | | | | | | | | | | | | | | | MCD036202 **2W** 20000<br>Micro- and nanoelectronics | | | | | | 24 |
| 23 | MCR031101 **1W** 10000<br>Metrology principles | | | | | | | | | MCR034103 **1W + 2L** 10100<br>Electrical metrology | | | MCM035101BK **1W + 1L** 10200<br>Optional block:<br>Sensing | | | MCM036101BK **2L** 00200<br>Optional block:<br>CAD 3D – FEM | | | | | | 23 |
| 22 | MCM031005 **1W + 2L** 20100<br>Engineering graphics | | | MCR032102 **3W + 1C** 21000**E**<br>Fundamentals of electrical engineering | | | MCM033102 **2W + 1L** 10100**E**<br>Material science II | | | | | | | | | | | | | | | 22 |
| 21 | | | | | | | | | | MCR034211 **2W** 20000**E**<br>Fundamentals of control engineering | | | | | | | | | | | | 21 |
| 20 | | | | | | | MCM033005 **1W** 10000<br>Software engineering and UML | | | | | | MCM035102BK **1W + 2L** 10100<br>Optional block:<br>Logical systems | | | MCM036102BK **3P** 00020<br>Optional block:<br>Interdisciplinary team project | | | | | | 20 |
| 19 | MCM031006 **1W** 10000<br>Management essentials | | | | | | | | | | | | | | | | | | | | | 19 |
| 18 | MCM031007 **1W + 1L** 10100<br>Information technology | | | MCM032006 **1W + 1L** 10100<br>Metrology of geometrical quantities | | | MCM033006 **2W + 2C** 21000**E**<br>Mechanics II (dynamics) | | | MCM034005 **2W + 2P** 20020**E**<br>Analysis and synthesis of kinematic systems | | | MCR035301 **3W + 2L** 20200**E**<br>Electrical drives | | | MCM036103BK **1W + 2L** 10100<br>Optional block:<br>Signal processing | | | | | | 18 |
| 17 | | | | | | | | | | | | | | | | | | | | | | 17 |
| 16 | MCM031008 **2W** 20000<br>Introduction to Mechatronics | | | MCM032004 **2W + 1L** 20100<br>Material science I | | | MCM033007 **2W + 2C** 22000<br>Strength of materials, mechanics of engineering materials | | | | | | | | | MCM036104BK **2W + 2L** 20200<br>Optional block:<br>Applications of microsystems | | | | | | 16 |
| 15 | | | | | | | | | | MCM034006 **3L** 00300<br>Fundamentals of manufacturing | | | | | | | | | | | | 15 |
| 14 | MCD031001 **2W** 20000<br>Chemistry | | | | | | | | | | | | MCR035211 **1L** 00100 | | | | | | | | | 14 |
| 13 | | | | | | | | | | | | | MCR035212 **2W + 1L** 10100<br>Elements of control engineering | | | | | | | | | 13 |
| 12 | MAT001402 **2W + 2C** 21000**E**<br>Algebra and analytic geometry | | | MCM032005 **3W + 2C** 22000<br>Mechanics I (statics) | | | MCM033008 **1W** 20000<br>Fundamentals of manufacturing | | | MCM034007 **2W + 1L** 20100**E**<br>Systems for manufacturing and assembly | | | | | | MCM036004 **2W + 2P** 10020<br>Basics of mechatronical design of systems | | | MCD037201 **2L** 00100<br>Laboratory of micro- and nanoelectronics | | | 12 |
| 11 | | | | | | | | | | | | | MCM035003 **2W + 3P** 20020<br>Fundamentals of machine elements design | | | | | | MCD037202 **2L** 00100<br>Numerical methods | | | 11 |
| 10 | | | | | | | MCD033001 **2L** 00200<br>Electronic components and circuits | | | | | | | | | | | | MCD037203 **2W + 1L** 10100<br>Packaging of electronic and photonic systems | | | 10 |
| 9 | MAT001412 **5W + 3C** 22000**E**<br>Mathematical analysis 1.1A | | | MCD032001 **2W** 20000<br>Electronic components and circuits | | | | | | MCD034002 **2W + 2L** 10200<br>Principles of microprocessor technology | | | | | | MCM036005 **1W + 2L** 20100**E**<br>Industrial robots | | | | | | 9 |
| 8 | | | | | | | MAT001452 **2W + 2C** 11000<br>Ordinary differential equations | | | | | | | | | | | | MCD037204 **2W + 1L** 20100<br>Peripheral devices in computer systems | | | 8 |
| 7 | | | | MAT001422 **4W + 3C** 22000**E**<br>Mathematical analysis 2.1A | | | | | | | | | MCM035004 **2W + 1L** 20100**E**<br>Drive systems, hydraulic components and pneumatic components | | | | | | | | | 7 |
| 6 | | | | | | | MCD033002 **2W + 2C** 11000<br>Engineering statistics | | | WFW000000BK **1C** 02000<br>Sport activities | | | | | | MCM036006 **1W** 10000<br>Project management | | | | | | 6 |
| 5 | FZP001058 **4W + 2C** 22000**E**<br>Physics 1.2 | | | | | | | | | | | | MCD035001 **1W** 10000<br>Fundamentals of electronic design | | | MCD036001 **2W + 2L** 20100**E**<br>Microsystems (MEMS) | | | HMH100035BK **2W** 10000<br>Humanities block (autopresentation) | | | 5 |
| 4 | | | | | | | JZL100707 **2C** 04000<br>Foreign language B2 or C1 | | | JZL100708 **3C** 04000**E**<br>Foreign language B2 or C1 | | | | | | | | | MCD037001 **2S** 00002<br>Diploma seminar | | | 4 |
| 3 | | | | FZP003002 **2W + 2L** 10100**E**<br>Physics 2.8 | | | | | | | | | MCD035002 **1W + 1L** 10200<br>Applications of optoelectronics | | | | | | | | | 3 |
| 2 | | | | | | | | | | | | | | | | MCM036002 **1P** 00020<br>Fundamentals of electronic design | | | MCD037002 12 ECTS<br>Diploma thesis | | | 2 |
| 1 | HMH100035BK **1W** 10000<br>Humanities block (philosophy and ethics) | | | HMH100035BK **1W** 10000<br>Humanities block (copyright law) | | | | | | | | | | | | | | | | | | 1 |
| | $d_I$=13 | | | $d_{II}$=13 | | | $d_{III}$=13 | | | $d_{IV}$=10 | | | $d_V$=7 | | | $d_{VI}$=5 | | | $d_{VII}$=0 | | | |

## OPTIONAL BLOCKS

**MCM032101BK: Informatics**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR032251 | Introduction to programming | 20200 | 1W + 1L | W-5 |
| MCM032102 | Introduction to computer science | 20200 | 1W + 1L | W-10 |
| MCD032101 | Fundamentals of computer science | 20200 | 1W + 1L | W-12 |

**MCM033101BK: Procedural programming**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR033251 | Programming in Matlab | 00200 | 3L | W-5 |
| MCM033102 | C programming | 00200 | 3L | W-10 |
| MCD033101 | The practice of programming in C | 00200 | 3L | W-12 |

**MCM034101BK: Network communication**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR034104 | Components of computer networks | 10100 | 2W + 1L | W-5 |
| MCM034103 | Industrial networks | 10100 | 2W + 1L | W-10 |
| MCD034103 | Introduction to computer networks | 10100 | 2W + 1L | W-12 |

**MCM034102BK: Object oriented programming**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR034251 | Matlab object oriented programming | 00200 | 3L | W-5 |
| MCM034104 | C++ object oriented programming | 00200 | 3L | W-10 |
| MCD034102 | Object oriented programming | 00200 | 3L | W-12 |

**MCM035101BK: Sensing**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR035103 | Sensors – properties and applications | 10200 | 1W + 1L | W-5 |
| MCM035105 | Sensors in manufacturing systems | 10200 | 1W + 1L | W-10 |
| MCM035106 | Sensors in machine and vehicle construction | 10200 | 1W + 1L | W-10 |
| MCD035101 | Sensors and actuators | 10200 | 1W + 1L | W-12 |

**MCM035102BK: Logical systems**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR035303 | Programming of distributed control systems based on PLC | 10100 | 1W + 2L | W-5 |
| MCM035104 | Programmable logic controllers | 10100 | 1W + 2L | W-10 |
| MCD035102 | Logic circuits modelling | 10100 | 1W + 2L | W-12 |

**MCM036101BK: CAD 3D – FEM**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR036303 | FEM modelling in mechatronics | 00200 | 2L | W-5 |
| MCM036106 | CAD/FEM | 00200 | 2L | W-10 |
| MCD036101 | Numerical prototyping of microelectronic structures | 00200 | 2L | W-12 |

**MCM036102BK: Interdisciplinary team project**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR036103 | Interdisciplinary team project | 00020 | 3P | W-5 |
| MCM036107 | Interdisciplinary team project | 00020 | 3P | W-10 |
| MCD036102 | Interdisciplinary team project | 00020 | 3P | W-12 |

**MCM036103BK: Signal processing**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR036106 | Digital signal processing | 10100 | 1W + 2L | W-5 |
| MCM036108 | Signal processing | 10100 | 1W + 2L | W-10 |
| MCD036103 | Methods of signal processing | 10100 | 1W + 2L | W-12 |

**MCM036104BK: Applications of microsystems**

| COURSE CODE | COURSE NAME | NUMBER OF HOURS | POINTS | SUPERVISOR |
|---|---|---|---|---|
| MCR036304 | Microsystems in measurements | 10100 | 1W + 1L | W-5 |
| MCR036305 | Microsystems in control | 10100 | 1W + 1L | W-5 |
| MCM036109 | Mechatronics in medicine | 10100 | 1W + 1L | W-10 |
| MCM036110 | Mechatronic systems in manufacturing technologies | 10100 | 1W + 1L | W-10 |
| MCD036104 | Microsystems in medicine | 10100 | 1W + 1L | W-12 |
| MCD036105 | Automotive microsystems | 10100 | 1W + 1L | W-12 |

**Legend**

| | |
|---|---|
| Basic science courses | |
| University-wide courses | |
| Main field of study courses | |
| Specialization courses | |
| Obligatory courses | |
| Optional courses | MCD |

## 1. Set of obligatory and optional courses and groups of courses in semester arrangement

# Semester 1

### Obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCR031101W | Metrology principles | 1 | | | | | K1MTR_W03 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 2. | MCM031005W | Engineering Graphics | 1 | | | | | K1MTR_W06 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 3. | MCM031005L | Engineering Graphics | | | 2 | | | K1MTR_U05<br>K1MTR_U09<br>K1MTR_U29 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 4. | MCM031006W | Management Essentials | 1 | | | | | K1MTR_W04<br>K1MTR_W28 | 15 | 30 | 1 | 0.6 | T | Z | | | KO | Ob. |
| 5. | MCM031007W | Information Technology | 1 | | | | | K1MTR_W01<br>K1MTR_W02 | 15 | 30 | 1 | 0.6 | T | Z | | | KO | Ob. |
| 6. | MCM031007L | Information Technology | | | 1 | | | K1MTR_U19 | 15 | 30 | 1 | 0.7 | T | Z | | P | KO | Ob. |
| 7. | MCM031008W | Introduction to Mechatronics | 2 | | | | | K1MTR_W10<br>K1MTR_W15<br>K1MTR_W16<br>K1MTR_W19<br>K1MTR_W22<br>K1MTR_W23<br>K1MTR_W26 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 8. | MCD031001W | Chemisty | 2 | | | | | K1MTR_W07 | 30 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| 9. | MAT001402W | Algebra and Analytic Geometry | 2 | | | | | K1MTR_W01 | 30 | 60 | 2 | 1.5 | T | E | O | | PD | Ob. |
| 10. | MAT001402C | Algebra and Analytic Geometry | | 1 | | | | K1MTR_U01<br>K1MTR_K01 | 15 | 60 | 2 | 1.0 | T | Z | O | P | PD | Ob. |
| 11. | MAT001412W | Mathematical Analysis 1.1 A | 2 | | | | | K1MTR_W01 | 30 | 150 | 5 | 3.0 | T | E | O | | PD | Ob. |
| 12. | MAT001412C | Mathematical Analysis 1.1 A | | 2 | | | | K1MTR_U01 | 30 | 90 | 3 | 2.0 | T | Z | O | P | PD | Ob. |
| 13. | FZP001058W | Physics 1.2 | 2 | | | | | K1MTR_W01<br>K1MTR_W02<br>K1MTR_W12<br>K1MTR_K01<br>K1MTR_K02<br>K1MTR_K07<br>K1MTR_K12 | 30 | 120 | 4 | 4.0 | T | E | O | | PD | Ob. |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14. | FZP001058C | Physics 1.2 | | 2 | | | | K1MTR_U01<br>K1MTR_U02<br>K1MTR_U12<br>K1MTR_U24<br>K1MTR_K01<br>K1MTR_K02<br>K1MTR_K07<br>K1MTR_K12 | 30 | 60 | 2 | 2.0 | T | Z | O | P | PD | Ob. |
| | | Total | 14 | 5 | 3 | 0 | 0 | | 330 | 870 | 29 | 20.4 | | | | | | |

## Optional courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | HMH100035BK | Block of humanistic courses | 1 | | | | | K1MTR_W25<br>K1MTR_K02<br>K1MTR_K07 | 15 | 30 | 1 | 0.6 | T | Z | O | | KO | W |
| | | Total | 1 | 0 | 0 | 0 | 0 | | 15 | 30 | 1 | 0.6 | | | | | | |

## Altogether in semester

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 15 | 5 | 3 | 0 | 0 | 345 | 900 | 30 | 21 |

# Semester 2

## Obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCR032102W | Fundamentals of Electrotechnics | 2 | | | | | K1MTR_W13 | 30 | 90 | 3 | 1.8 | T | E | | | K | Ob. |
| 2. | MCR032102C | Fundamentals of Electrotechnics | | 1 | | | | K1MTR_U13 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 3. | MCM032006W | Metrology of geometrical quantites | 1 | | | | | K1MTR_W03 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 4. | MCM032006L | Metrology of geometrical quantites | | | 1 | | | K1MTR_U29<br>K1MTR_K03<br>K1MTR_K04<br>K1MTR_K09 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 5. | MCM032004W | Material Science I | 2 | | | | | K1MTR_W02<br>K1MTR_W07 | 30 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| 6. | MCM032004L | Material Science I | | | 1 | | | K1MTR_U07 | 15 | 30 | 1 | 0.7 | T | Z | | P | PD | Ob. |
| 7. | MCM032005W | Mechanics I (Statics) | 2 | | | | | K1MTR_W01<br>K1MTR_W02<br>K1MTR_W08 | 30 | 90 | 3 | 1.8 | T | Z | | | K | Ob. |
| 8. | MCM032005C | Mechanics I (Statics) | | 2 | | | | K1MTR_U08 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 9. | MCD032001W | Electronic Components and Circuits | 2 | | | | | K1MTR_W14<br>K1MTR_W29 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 10. | MAT001422W | Mathematical Analysis 2.1 A | 2 | | | | | K1MTR_W01 | 30 | 120 | 4 | 3.0 | T | E | O | | PD | Ob. |
| 11. | MAT001422C | Mathematical Analysis 2.1 A | | 2 | | | | K1MTR_U01 | 30 | 90 | 3 | 2.0 | T | Z | O | P | PD | Ob. |
| 12. | FZP003002W | Physics 2.8 | 1 | | | | | K1MTR_W01<br>K1MTR_W02<br>K1MTR_W07<br>K1MTR_W13<br>K1MTR_W14<br>K1MTR_W25 | 15 | 60 | 2 | 2.0 | T | E | O | | PD | Ob. |
| 13. | FZP003002L | Physics 2.8 | | | 1 | | | K1MTR_U01<br>K1MTR_U24<br>K1MTR_U25<br>K1MTR_K02<br>K1MTR_K11 | 15 | 60 | 2 | 2.0 | T | Z | O | P | PD | Ob. |
| | | Total | 12 | 5 | 3 | 0 | 0 | | 300 | 810 | 27 | 19.1 | | | | | | |

## Optional courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | HMH100035BK | Block of humanistic courses | 1 | | | | | K1MTR_W05 K1MTR_K09 | 15 | 30 | 1 | 0.6 | T | Z | O | | KO | W |
| | **MCM032101BK** | **Optional courses:** | **2** | | | | | | 30 | 30 | 1 | 0.6 | T | Z | | | PD | W |
| | | **Informatics** | | | **2** | | | | 30 | 30 | 1 | 0.7 | T | Z | | P | PD | W |
| 2. | MCR032251W | Introduction to programming | 2 | | | | | K1MTR_W19 | | | | | | | | | | |
| 3. | MCR032251L | Introduction to programming | | | 2 | | | K1MTR_U19 | | | | | | | | | | |
| 4. | MCM032102W | Introduction to programming | 2 | | | | | K1MTR_W19 | | | | | | | | | | |
| 5. | MCM032102L | Introduction to programming | | | 2 | | | K1MTR_U19 K1MTR_K03 | | | | | | | | | | |
| 6. | MCD032101W | Fundamentals of Computer Science | 2 | | | | | K1MTR_W19 | | | | | | | | | | |
| 7. | MCD032101L | Fundamentals of Computer Science | | | 2 | | | K1MTR_U19 | | | | | | | | | | |
| | | Total | 3 | 0 | 2 | 0 | 0 | | 75 | 90 | 3 | 1,9 | | | | | | |

## Altogether in semester

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 15 | 5 | 5 | 0 | 0 | 375 | 900 | 30 | 21 |

# Semester 3

## Obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCR033231W | Electrical installations and supply systems | 1 | | | | | K1MTR_W10 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 2. | MCR033231C | Electrical installations and supply systems | | 1 | | | | K1MTR_U01 K1MTR_U02 K1MTR_U03 K1MTR_U04 K1MTR_U05 K1MTR_K01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 3. | MCR033102W | Material Science II | 1 | | | | | K1MTR_W07 | 15 | 60 | 2 | 1.2 | T | E | | | PD | Ob. |
| 4. | MCR033102L | Material Science II | | | 1 | | | K1MTR_U03 | 15 | 30 | 1 | 0.7 | T | Z | | P | PD | Ob. |
| 5. | MCM033005W | Software Engineering and UML | 1 | | | | | K1MTR_W19 K1MTR_W32 | 15 | 30 | 1 | 0.6 | T | Z | | | PD | Ob. |
| 6. | MCM033006W | Mechanics II (Dynamics) | 2 | | | | | K1MTR_W09 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 7. | MCM033006C | Mechanics II (Dynamics) | | 1 | | | | K1MTR_U01 K1MTR_U02 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 8. | MCM033007W | Strength of materials, Mechanics of engineering materials | 2 | | | | | K1MTR_W07 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 9. | MCM033007C | Strength of materials, Mechanics of engineering materials | | 2 | | | | K1MTR_U01 K1MTR_U02 K1MTR_U09 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 10. | MCM033008W | Fundamentals of manufacturing | 2 | | | | | K1MTR_W04 | 30 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 11. | MCD033001L | Electronic Components and Circuits | | | 2 | | | K1MTR_U32 K1MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 12. | MAT001452W | Ordinary differential equations | 1 | | | | | K1MTR_W01 | 15 | 60 | 2 | 1.0 | T | Z | | | PD | Ob. |
| 13. | MAT001452C | Ordinary differential equations | | 1 | | | | K1MTR_U01 K1MTR_K01 | 15 | 60 | 2 | 1.0 | T | Z | | P | PD | Ob. |
| 14. | MCD033002W | Statistics for Engineers | 1 | | | | | K1MTR_W26 | 15 | 60 | 2 | 1.2 | T | Z | | | PD | Ob. |
| 15. | MCD033002C | Statistics for Engineers | | 1 | | | | K1MTR_U30 | 15 | 60 | 2 | 1.4 | T | Z | | P | PD | Ob. |
| | | Total | 11 | 6 | 3 | 0 | 0 | | 300 | 750 | 25 | 15.6 | | | | | | |

## Optional courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | JZL100707BK | Foreign Languages B2 or C1 | | **4** | | | | K1MTR_U06<br>K1MTR_K01 | 60 | 60 | 2 | 1.5 | T | Z | O | P | KO | W |
| | **MCM033101BK** | **Optional courses:**<br>**Procedural Programming** | | | **2** | | | | 30 | 90 | 3 | 2.1 | T | Z | | P | PD | W |
| 2. | MCR033251L | Programming in Matlab | | | 2 | | | K1MTR_U19 | | | | | | | | | | |
| 3. | MCM033102L | C Programming | | | 2 | | | K1MTR_U19<br>K1MTR_K01 | | | | | | | | | | |
| 4. | MCD033101L | The Practice of Programming in C | | | 2 | | | K1MTR_U19<br>K1MTR_K03<br>K1MTR_K04 | | | | | | | | | | |
| 1. | JZL100707BK | Foreign Languages B2 or C1 | | **4** | | | | K1MTR_U06<br>K1MTR_K01 | 60 | 60 | 2 | 1.5 | T | Z | O | P | KO | W |
| | | Total | 0 | 4 | 2 | 0 | 0 | | 90 | 150 | 5 | 3.6 | | | | | | |

## Altogether in semester

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 11 | 10 | 5 | 0 | 0 | 390 | 900 | 30 | 19.2 |

# Semester 4

## Obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCR034103W | Electrical metrology | 1 | | | | | K1MTR_W03 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 2. | MCR034103L | Electrical metrology | | | 1 | | | K1MTR_U03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 3. | MCR034211W | Fundamentals of control engineering | 2 | | | | | K1MTR_W17 | 30 | 90 | 3 | 1.8 | T | E | | | K | Ob. |
| 4. | MCM034005W | Analysis and Synthesis of Kinematic Systems | 2 | | | | | K1MTR_W09 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 5. | MCM034005P | Analysis and Synthesis of Kinematic Systems | | | | 2 | | K1MTR_U09 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 6. | MCM034006L | Fundamentals of manufacturing | | | 3 | | | K1MTR_U03<br>K1MTR_U11<br>K1MTR_U29<br>K1MTR_K01<br>K1MTR_K05<br>K1MTR_K08 | 45 | 90 | 3 | 2.1 | T | Z | | P | K | Ob. |
| 7. | MCM034007W | Systems for Manufacturing and Assembly | 2 | | | | | K1MTR_W08<br>K1MTR_W11<br>K1MTR_W18 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 8. | MCM034007L | Systems for Manufacturing and Assembly | | | 1 | | | K1MTR_U11<br>K1MTR_U18<br>K1MTR_K03<br>K1MTR_K04<br>K1MTR_K06 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 9. | MCD034002W | Principles of microprocessor technology | 1 | | | | | K1MTR_W16 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 10. | MCD034002L | Principles of microprocessor technology | | | 2 | | | K1MTR_U16 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| | | Total | 8 | 0 | 7 | 2 | 0 | | 255 | 600 | 20 | 13 | | | | | | |

## Optional courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | JZL100708BK | Foreign Languages B2 or C1 | | **4** | | | | K1MTR_U06<br>K1MTR_K01 | 60 | 90 | 3 | 2.5 | T | Z | O | P | KO | W |
| 2. | WFW000000BK | Block of Sports Activities | | **2** | | | | K1MTR_K03<br>K1MTR_K11<br>K1MTR_K14 | 30 | 30 | 1 | 1 | T | Z | O | P | KO | W |
| | **MCM034101BK** | **Optional courses:** | **1** | | | | | | 15 | 60 | 2 | 1.2 | T | Z | | | PD | W |
| | | **Network communication** | | | **1** | | | | 15 | 30 | 1 | 0.7 | T | Z | | P | PD | W |
| 3. | MCR034104W | Components of computer networks | 1 | | | | | K1MTR_W19<br>K1MTR_W20 | | | | | | | | | | |
| 4. | MCR034104L | Components of computer networks | | | 1 | | | K1MTR_U19<br>K1MTR_U20 | | | | | | | | | | |
| 5. | MCM034103W | Industrial networks | 1 | | | | | K1MTR_W20 | | | | | | | | | | |
| 6. | MCM034103L | Industrial networks | | | 1 | | | K1MTR_U20 | | | | | | | | | | |
| 7. | MCD034103W | Introduction to Computer Networks | 1 | | | | | K1MTR_W20 | | | | | | | | | | |
| 8. | MCD034103L | Introduction to Computer Networks | | | 1 | | | K1MTR_U20 | | | | | | | | | | |
| | **MCM034102BK** | **Optional courses:**<br>**Object Oriented Programming** | | | **2** | | | | 30 | 90 | 3 | 2.1 | T | Z | | P | PD | W |
| 9. | MCR034251L | MATLAB Object Oriented Programming | | | 2 | | | K1MTR_U19<br>K1MTR_U35<br>K1MTR_K01 | | | | | | | | | | |
| 10. | MCM034104L | C++ Programming | | | 2 | | | K1MTR_U19<br>K1MTR_U35<br>K1MTR_K01 | | | | | | | | | | |
| 11. | MCD034102L | Object Oriented Programming | | | 2 | | | K1MTR_U19<br>K1MTR_U35<br>K1MTR_K01 | | | | | | | | | | |
| | | Total | 1 | 4 | 3 | 0 | 0 | | 150 | 300 | 10 | 7,5 | | | | | | |

## Altogether in semester

| Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|
| lec | c | lab | p | s | | | | |
| 9 | 4 | 10 | 2 | 0 | 405 | 900 | 30 | 20.5 |

# Semester 5

## Obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCR035241W | Safety in electrical engineering | 1 | | | | | K1MTR_W27 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 2. | MCR035241L | Safety in electrical engineering | | | 1 | | | K1MTR_U31<br>K1MTR_K13 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 3. | MCR035301W | Electrical Drives | 2 | | | | | K1MTR_W10 | 30 | 90 | 3 | 1.8 | T | E | | | K | Ob. |
| 4. | MCR035301L | Electrical Drives | | | 2 | | | K1MTR_U02<br>K1MTR_U10 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 5. | MCR035211L | Fundamentals of control engineering | | | 1 | | | K1MTR_U17<br>K1MTR_K03 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 6. | MCR035212W | Elements of control engineering | 1 | | | | | K1MTR_W17 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 7. | MCR035212L | Elements of control engineering | | | 1 | | | K1MTR_U17<br>K1MTR_K01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 8. | MCM035003W | Fundamentals of machine elements design | 2 | | | | | K1MTR_W07<br>K1MTR_W09<br>K1MTR_W10 | 30 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 9. | MCM035003P | Fundamentals of machine elements design | | | | 2 | | K1MTR_U05<br>K1MTR_U09<br>K1MTR_U23<br>K1MTR_K02<br>K1MTR_K04 | 30 | 90 | 3 | 2.1 | T | Z | | P | K | Ob. |
| 10. | MCM035004W | Drive systems, hydraulic components and pneumatic components | 2 | | | | | K1MTR_W10<br>K1MTR_W24 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 11. | MCM035004L | Drive systems, hydraulic components and pneumatic components | | | 1 | | | K1MTR_U10<br>K1MTR_U23<br>K1MTR_K04 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| 12. | MCD035001W | Fundamentals of Electronic Design | 1 | | | | | K1MTR_W31 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 13. | MCD035002W | Applications of optoelectronics | 1 | | | | | K1MTR_W30 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob. |
| 14. | MCD035002L | Applications of optoelectronics | | | 2 | | | K1MTR_U33 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| | | Total | 10 | 0 | 8 | 2 | 0 | | 300 | 660 | 22 | 14.2 | | | | | | |

## Group of obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | **MCM035101BK** | **Optional courses:** | **1** | | | | | | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| | | **Sensing** | | | **2** | | | | 30 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 1. | MCR035103W | Sensors – properties and applications | 1 | | | | | K1MTR_W15 | | | | | | | | | | |
| 2. | MCR035103L | Sensors – properties and applications | | | 2 | | | K1MTR_U15 | | | | | | | | | | |
| 3. | MCM035105W | Sensory w systemacha wytwórczych | 1 | | | | | K1MTR_W03<br>K1MTR_W15<br>K1MTR_W16 | | | | | | | | | | |
| 4. | MCM035105L | Sensory w systemacha wytwórczych | | | 2 | | | K1MTR_U03<br>K1MTR_U10<br>K1MTR_U15 | | | | | | | | | | |
| | **MCM035102BK** | **Optional courses:** | **1** | | | | | | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| | | **Logical Systems** | | | **1** | | | | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 7. | MCR035303W | Programming of distributed control systems based on PLC | 1 | | | | | K1MTR_W10<br>K1MTR_W17<br>K1MTR_W33 | | | | | | | | | | |
| 8. | MCR035303L | Programming of distributed control systems based on PLC | | | 1 | | | K1MTR_U15<br>K1MTR_U20<br>K1MTR_U36 | | | | | | | | | | |
| 9. | MCM035104W | Programmable Logic Controllers | 1 | | | | | K1MTR_W10<br>K1MTR_W33 | | | | | | | | | | |
| 10. | MCM035104L | Programmable Logic Controllers | | | 1 | | | K1MTR_U16<br>K1MTR_U36 | | | | | | | | | | |
| 11. | MCD035102W | Logic Circuits Modeling | 1 | | | | | K1MTR_W16<br>K1MTR_W19 | | | | | | | | | | |
| 12. | MCD035102L | Logic Circuits Modeling | | | 1 | | | K1MTR_U19<br>K1MTR_U22 | | | | | | | | | | |
| | **MCR035201BK** | **Degree Profile** | | | | | | | | | | | | | | | | |
| **Degree Profile: Mechatronics in Automation and Measurements** | | | | | | | | | | | | | | | | | | |
| 13. | MCR035302W | Power Electronics | 2 | | | | | K1MTR_MAP_W01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 14. | MCR035302L | Power Electronics | | | 1 | | | K1MTR_MAP_U01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| **Degree Profile: Mechatronics in Machine Building and Vehicles** | | | | | | | | | | | | | | | | | | |
| 15. | MCM035203W | Ecology in industrial manufacturing | 1 | | | | | K1MTR_M_W05 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 16. | MCM035204W | Technological designe processes | 1 | | | | | K1MTR_W06<br>K1MTR_W11 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. | MCM035204P | Technological designe processes | | | | 1 | | K1MTR_M_U03<br>K1MTR_M_U06 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| **Degree Profile: Mechatronic Systems** | | | | | | | | | | | | | | | | | | |
| 18. | MCD035201W | Electronic Components | 2 | | | | | K1MTR_MM_W01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 19. | MCD035201L | Electronic Components | | | 1 | | | K1MTR_MM_U01 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| | | **Degree Profile: MiAaM** | 4 | 0 | 4 | 0 | 0 | | 120 | 240 | 8 | 5.2 | | | | | | |
| | | **Degree Profile: MiBaV** | 4 | 0 | 3 | 1 | 0 | | 120 | 240 | 8 | 5.2 | | | | | | |
| | | **Degree Profile: MS** | 4 | 0 | 4 | 0 | 0 | | 120 | 240 | 8 | 5.2 | | | | | | |

## Altogether in semester

| | Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|---|
| | lec | c | lab | p | s | | | | |
| Degree Profile: MiAaM | 14 | 0 | 12 | 2 | 0 | 420 | 900 | 30 | 19.4 |
| Degree Profile:MiBaV | 14 | 0 | 11 | 3 | 0 | 420 | 900 | 30 | 19.4 |
| Degree Profile: MS | 14 | 0 | 12 | 2 | 0 | 420 | 900 | 30 | 19.4 |

# Semester 6

## Obligatory courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | MCM036004W | Basics of mechatronical design of systems | 1 | | | | | K1MTR_W24 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob. |
| 2. | MCM036004P | Basics of mechatronical design of systems | | | | 2 | | K1MTR_U23 K1MTR_K02 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 3. | MCM036005W | Industrial robots | 2 | | | | | K1MTR_W09 1MTR_W10 1MTR_W15 K1MTR_W23 | 30 | 30 | 1 | 0.6 | T | E | | | K | Ob. |
| 4. | MCM036005L | Industrial robots | | | 1 | | | K1MTR_U09 K1MTR_U24 K1MTR_U29 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 5. | MCM036006W | Project Management | 1 | | | | | K1MTR_W28 | 15 | 30 | 1 | 0.6 | T | Z | | | KO | Ob. |
| 6. | MCD036001W | Microsystems (MEMS) | 2 | | | | | K1MTR_W15 | 30 | 60 | 2 | 1.2 | T | E | | | K | Ob. |
| 7. | MCD036001L | Microsystems (MEMS) | | | 1 | | | K1MTR_U15 K1MTR_K03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob. |
| 8. | MCD036002P | Fundamentals of Electronic Design | | | | 2 | | K1MTR_U34 K1MTR_U32 K1MTR_K03 K1MTR_K04 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | Ob. |
| | | Total | 6 | 0 | 2 | 4 | 0 | | 180 | 390 | 13 | 8.5 | | | | | | |

## Optional courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol**)** | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| | **MCM036101BK** | **Optional courses: CAD 3D-FEM** | | | **2** | | | | 30 | 60 | 2 | 1.4 | T | Z | | P | PD | W |
| 1. | MCR036303L | FEM modelling in mechatronics | | | 2 | | | K1MTR_U01 K1MTR_U02 K1MTR_U13 K1MTR_K03 | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. | MCM036106L | CAD/FEM | | | 2 | | | K1MTR_U22 | | | | | | | | | | |
| 3. | MCD036101L | Numerical prototyping of microelectronic structures | | | 2 | | | K1MTR_U22<br>K1MTR_K04<br>K1MTR_K05 | | | | | | | | | | |
| | **MCM036102BK** | **Optional courses:<br>Interdisciplinary Team Project** | | | | **2** | | | 30 | 90 | 3 | 2.1 | T | Z | | P | K | W |
| 4. | MCR036103P, 6231, 6302 | Interdisciplinary Team Project | | | | 2 | | K1MTR_U04<br>K1MTR_U30<br>K1MTR_K03<br>K1MTR_K06 | | | | | | | | | | |
| 5. | MCM036107P | Interdisciplinary Team Project | | | | 2 | | K1MTR_U04<br>K1MTR_U30<br>K1MTR_K03<br>K1MTR_K06 | | | | | | | | | | |
| 6. | MCD036102P | Interdisciplinary Team Project | | | | 2 | | K1MTR_U04<br>K1MTR_U30<br>K1MTR_K03<br>K1MTR_K06 | | | | | | | | | | |
| | **MCM036103BK** | **Optional courses:** | **1** | | | | | | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| | | **Signal Processing** | | | **1** | | | | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 7. | MCR036106W | Digital signal processing | 1 | | | | | K1MTR_W21 | | | | | | | | | | |
| 8. | MCR036106L | Digital signal processing | | | 1 | | | K1MTR_U21<br>K1MTR_U22 | | | | | | | | | | |
| 9. | MCM036108W | Signal Processing | 1 | | | | | K1MTR_W16 | | | | | | | | | | |
| 10. | MCM036108L | Signal Processing | | | 1 | | | K1MTR_U19<br>K1MTR_U21 | | | | | | | | | | |
| 11. | MCD036103W | Methods of Signal Processing | 1 | | | | | K1MTR_W21 | | | | | | | | | | |
| 12. | MCD036103L | Methods of Signal Processing | | | 1 | | | K1MTR_U01<br>K1MTR_K06 | | | | | | | | | | |
| | **MCM036104BK** | **Optional courses:** | **2** | | | | | | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| | | **Applications of Microsystems** | | | **2** | | | | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 13. | MCR036304W | Microsystems in measurements | 1 | | | | | K1MTR_W16 | | | | | | | | | | |
| 14. | MCR036304L | Microsystems in measurements | | | 1 | | | K1MTR_U15<br>K1MTR_U16 | | | | | | | | | | |
| 15. | MCR036305W | Microsystems in control | 1 | | | | | K1MTR_W21 | | | | | | | | | | |
| 16. | MCR036305L | Microsystems in control | | | 1 | | | K1MTR_U15<br>K1MTR_U16 | | | | | | | | | | |
| 17. | MCM036109W | Mechatronics in Medicine | 1 | | | | | K1MTR_M_W03<br>K1MTR_W08<br>K1MTR_W23<br>K1MTR_W09<br>K1MTR_W26 | | | | | | | | | | |
| 18. | MCM036109L | Mechatronics in Medicine | | | 1 | | | K1MTR_U02<br>K1MTR_U03<br>K1MTR_U21<br>K1MTR_K01<br>K1MTR_K07 | | | | | | | | | | |
| 19. | MCM036110W | Mechatronic systems in manufacturing technologies | 1 | | | | | K1MTR_W09<br>K1MTR_W15<br>K1MTR_W23 | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20. | MCM036110L | Mechatronic systems in manufacturing technologies | | | 1 | | | K1MTR_U03<br>K1MTR_U11<br>K1MTR_U15 | | | | | | | | | | |
| 21. | MCD036104W | Microsystems in medicine | 1 | | | | | K1MTR_W15 | | | | | | | | | | |
| 22. | MCD036104L | Microsystems in medicine | | | 1 | | | K1MTR_U15<br>K1MTR_K03 | | | | | | | | | | |
| 23. | MCD036105W | Automotive microsystems | 1 | | | | | K1MTR_W15 | | | | | | | | | | |
| 24. | MCD036105L | Automotive microsystems | | | 1 | | | K1MTR_U15<br>K1MTR_K03 | | | | | | | | | | |
| | **MCR036201BK** | **Degree Profile** | | | | | | | | | | | | | | | | |
| **Degree Profile: Mechatronics in Automation and Measurements** | | | | | | | | | | | | | | | | | | |
| 25. | MCR036102W | Active materials | 1 | | | | | K1MTR_MAP_W02<br>K1MTR_W02 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 26. | MCR036102L | Active materials | | | 1 | | | K1MTR_MAP_U02<br>K1MTR_U02<br>K1MTR_U03<br>K1MTR_U22<br>K1MTR_U24 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 27. | MCR036211W | System modelling | 1 | | | | | K1MTR_MAP_W05<br>K1MTR_MAP_W04 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 28. | MCR036211L | System modelling | | | 1 | | | K1MTR_MAP_U04<br>K1MTR_MAP_U05 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| **Degree Profile: Mechatronics in Machine Building and Vehicles** | | | | | | | | | | | | | | | | | | |
| 30. | MCM036203W | Manufacturing automation | 2 | | | | | K1MTR_M_W01<br>K1MTR_M_W02 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 31. | MCM036203L | Manufacturing automation | | | 1 | | | K1MTR_M_U02 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 32. | MCM036204W | Design of mechanical assemblies | 1 | | | | | K1MTR_W07<br>K1MTR_W09<br>K1MTR_W10 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 33. | MCM036204P | Design of mechanical assemblies | | | | 1 | | K1MTR_M_U01<br>K1MTR_U09<br>K1MTR_U22<br>K1MTR_U23<br>K1MTR_U24<br>K1MTR_K02<br>K1MTR_K04 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| **Degree Profile: Mechatronic Systems** | | | | | | | | | | | | | | | | | | |
| 34. | MCD036201W | Photonics | 1 | | | | | K1MTR_MM_W02 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 35. | MCD036201L | Photonics | | | 2 | | | K1MTR_MM_U02 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 36. | MCD036202W | Micro- and Nanoelectronics | 2 | | | | | K1MTR_MM_W01<br>K1MTR_MM_W03 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| | | **Degree Profile: MiAaM** | 5 | 0 | 8 | 2 | 0 | | 225 | 510 | 17 | 11.4 | | | | | | |
| | | **Degree Profile: MiBaV** | 6 | 0 | 6 | 3 | 0 | | 225 | 510 | 17 | 11.3 | | | | | | |
| | | **Degree Profile: MS** | 6 | 0 | 7 | 2 | 0 | | 225 | 510 | 17 | 11.3 | | | | | | |

## Altogether in semester

| | Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|---|
| | lec | c | lab | p | s | | | | |
| **Degree Profile: MiAaM** | 11 | 0 | 10 | 6 | 0 | 405 | 900 | 30 | 19.9 |
| **Degree Profile:MiBaV** | 12 | 0 | 8 | 7 | 0 | 405 | 900 | 30 | 19.8 |
| **Degree Profile: MS** | 12 | 0 | 9 | 6 | 0 | 405 | 900 | 30 | 19.8 |

# Semester 7

## Optional courses

| No. | Course/group of courses code | Name of course/group of courses (denote the group of courses with **GK** symbol) | Weekly number of hours | | | | | Field of study educational effect symbol | Number of hours | | Number of ECTS | | Form[2] of course/ group of courses | Way[3] of crediting | Course/group of courses | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lec | c | lab | p | s | | ZZU | CNPS | total | BK[1] classes | | | university-wide[4] | practical[5] | kind[6] | type[7] |
| 1. | HMH100035BK | Block of humanistic courses | | | | | 1 | K1MTR_U25<br>K1MTR_K15 | 15 | 60 | 2 | 1.4 | T | Z | O | P | KO | W |
| | **MCR037201BK** | **Degree Profile** | | | | | | | | | | | | | | | | |
| **Degree Profile: Mechatronics in Automation and Measurements** | | | | | | | | | | | | | | | | | | |
| 2. | MCR037301S<br>MCR037201S<br>MCR037103S | Diploma seminar | | | | | 2 | K1MTR_MAP_U01<br>K1MTR_MAP_U02<br>K1MTR_MAP_U03<br>K1MTR_MAP_U04<br>K1MTR_MAP_U05<br>K1MTR_MAP_U06<br>K1MTR_MAP_U07<br>K1MTR_MAP_U08<br>K1MTR_K04<br>K1MTR_K06 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 3. | MCR037100D<br>MCR037200D<br>MCR037300D | Diploma thesis | | | | 2 | | K1MTR_U24<br>K1MTR_K01<br>K1MTR_K04<br>K1MTR_K06 | 30 | 360 | 12 | 12 | T | Z | | P | K | W |
| 4. | MCR037001Q | Practice | | | | | | K1MTR_U29 | 0 | 120 | 4 | 4 | T | Z | | P | K | W |
| 5. | MCR037231W | Building automation | 1 | | | | | K1MTR_MAP_W06 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 6. | MCR037231P | Building automation | | | | 2 | | K1MTR_MAP_U06<br>K1MTR_K06 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 7. | MCR037101P | Numerical methods | | | | 1 | | K1MTR_U01<br>K1MTR_K04<br>K1MTR_K06 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 8. | MCR037102W | Thin-layer technologies | 1 | | | | | K1MTR_W02<br>K1MTR_W18<br>K1MTR_MAP_W07 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 9. | MCR037102L | Thin-layer technologies | | | 2 | | | K1MTR_U02<br>K1MTR_U03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| **Degree Profile: Mechatronics in Machine Building and Vehicles** | | | | | | | | | | | | | | | | | | |
| 10. | MCM037001S | Diploma seminar | | | | | 2 | K1MTR_U24<br>K1MTR_K01<br>K1MTR_K03<br>K1MTR_K04<br>K1MTR_K06 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 11. | MCM037002D | Diploma thesis | | | | 2 | | K1MTR_U24<br>K1MTR_K01<br>K1MTR_K04<br>K1MTR_K06 | 30 | 360 | 12 | 12 | T | Z | | P | K | W |
| 12. | MCM037003Q | Practice | | | | | | K1MTR_U29 | 0 | 120 | 4 | 4 | T | Z | | P | K | W |
| 13. | MCM037205W | Monitoring of machines and processes | 1 | | | | | K1MTR_W03<br>K1MTR_W11<br>K1MTR_W15<br>K1MTR_W17 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14. | MCM037205L | Monitoring of machines and processes | | | 1 | | | K1MTR_U02<br>K1MTR_U03<br>K1MTR_U17<br>K1MTR_U21<br>K1MTR_U19<br>K1MTR_K01<br>K1MTR_K02<br>K1MTR_K04<br>K1MTR_K05<br>K1MTR_K06<br>K1MTR_K07<br>K1MTR_K08<br>K1MTR_K09 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 15. | MCM037206P | Numerical methods | | | | 1 | | K1MTR_U21<br>K1MTR_U03<br>K1MTR_K03<br>K1MTR_K04 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 16. | MCM037207W | Programing of machine numerical controled | 2 | | | | | K1MTR_M_W04<br>K1MTR_W11 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 17. | MCM037207P | Programing of machine numerical controled | | | | 1 | | K1MTR_M_U05<br>K1MTR_M_U06<br>K1MTR_U24 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 18. | MCM037208W | SCADA i HMI | 1 | | | | | K1MTR_W19 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| **Degree Profile: Mechatronic Systems** | | | | | | | | | | | | | | | | | | |
| 19. | MCD037001S | Diploma seminar | | | | | 2 | K1MTR_MM_W05<br>K1MTR_MM_U01-<br>K1MTR_MM_U06<br>K1MTR_U02-<br>K1MTR_U31<br>K1MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 20. | MCD037002D | Diploma thesis | | | | 2 | | K1MTR_MM_U01-<br>K1MTR_MM_U06<br>K1MTR_U01-<br>K1MTR_U31<br>K1MTR_K03<br>K1MTR_K10 | 30 | 360 | 12 | 12 | T | Z | | P | K | W |
| 21. | MCD030002Q | Practice | | | | | | K1MTR_U04<br>K1MTR_U29<br>K1MTR_K02<br>K1MTR_K03 | 0 | 120 | 4 | 4 | T | Z | | P | K | W |
| 22. | MCD037201L | Laboratory on micro- and nanoelectronics | | | 1 | | | K1MTR_MM_U03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 23. | MCD037202L | Numerical methods | | | 1 | | | K1MTR_MM_W04<br>K1MTR_MM_U04 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 24. | MCD037203W | Packaging of Electronic and Photonics Systems | 1 | | | | | K1MTR_W18 | 15 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 25. | MCD037203L | Packaging of Electronic and Photonics Systems | | | 1 | | | K1MTR_U18 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 26. | MCD037204W | Peripheral Devices in Computer Systems | 2 | | | | | K1MTR_MM_W02<br>K1MTR_MM_W06 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 27. | MCD037204L | Peripheral Devices in Computer Systems | | | 1 | | | K1MTR_MM_U02<br>K1MTR_K03 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| | | **Degree Profile: MiAaM** | 2 | 0 | 2 | 5 | 3 | | 180 | 900 | 30 | 25.4 | | | | | | |
| | | **Degree Profile:MiBaV** | 4 | 0 | 1 | 4 | 3 | | 180 | 900 | 30 | 25.3 | | | | | | |
| | | **Degree Profile: MS** | 3 | 0 | 4 | 2 | 3 | | 180 | 900 | 30 | 25.4 | | | | | | |

**Altogether in semester**

| | Total number of hours | | | | | Total number of ZZU hours | Total number of CNPS hours | Total number of ECTS points | Number of ECTS points for BK[1] classes |
|---|---|---|---|---|---|---|---|---|---|
| | lec | c | lab | p | s | | | | |
| Degree Profile: MiAaM | 2 | 0 | 2 | 5 | 3 | 180 | 900 | 30 | 25.4 |
| Degree Profile:MiBaV | 4 | 0 | 1 | 4 | 3 | 180 | 900 | 30 | 25.3 |
| Degree Profile: MS | 3 | 0 | 4 | 2 | 3 | 180 | 900 | 30 | 25.4 |

## 2. Set of exams in semestral arrangement

| Course code | Name of course credited by examination | Semester |
|---|---|---|
| MAT001402W<br>MAT001412W<br>FZP001058W | 1. Algebra and Analytic Geometry<br>2. Mathematical Analysis1.1 A<br>3. Physics 1.2 | 1 |
| MCR032102W<br>MAT001422W<br>FZP003002W | 1. Fundamentals of Electrotechnics<br>2. Mathematical Analysis 2.1 A<br>3. Physics 2.8 | 2 |
| MCR033102W<br>MCM033006W | 1. Material Science II<br>2. Mechanics II (Dynamics) | 3 |
| MCR034211W<br>MCM034005W<br>MCM034007W | 1. Fundamentals of control engineering<br>2. Analysis and Synthesis of Kinematic Systems<br>3.Systems for Manufacturing and Assembly | 4 |
| MCR035301W<br>MCM035004W | 1. Electrical Drives<br>2. Drive systems, hydraulic components and pneumatic components | 5 |
| MCM036005W<br>MCD036001W | 1. Industrial robots<br>2. Microsystems (MEMS) | 6 |

## 3. Numbers of allowable deficit of ECTS points after particular semesters

| Semester | Allowable deficit of ECTS points after semester |
|---|---|
| 1 | 13 |
| 2 | 13 |
| 3 | 13 |
| 4 | 10 |
| 5 | 7 |
| 6 | 5 |

Opinion of the Student Council of the Faculty

..... .....

Date Name, surname and signature of the student's representative

..... .....

Date Dean's signature

| | | | |
|---|---|---|---|
| **Faculty:** | **Microsystem Electronics and Photonics** | **Faculty Council resolution from:** | **21.09.2016** |
| **Field of study:** | **Mechatronics** | **In effect from:** | **01.10.2016** |
| **Studies:** | **1st level, full-time** | | |

# COURSE CATALOG

**Subject cards for courses that are realized in the *Mechatronics* field of study and are supervised by the Faculty of Electrical Engineering and the Faculty of Mechanical Engineering, as well as the subject cards for humanities, management, sport and language courses are posted on the Wrocław University of Science and Technology ECTS information catalog (http://www.portal.pwr.wroc.pl/syllabus,241.dhtml).**

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Chemia** | |
| Name in English: | **Chemistry** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD031001** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | | | |
| Number of hours of total student workload (CNPS) | 60 | | | | |
| Form of crediting | Z | | | | |
| Number of ECTS points | 2 | | | | |
| Including number of ECTS points for practical (P) classes | 0 | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of chemistry required at high school level
2. Knowledge of mathematics required at high school level
3. Knowledge of physics required at high school level

## SUBJECT OBJECTIVES

C01 To acquaint students with the basis of chemistry in the field of study, particularly in an atomic and compounds structure, crystallography

C02 To acquaint students with the kinetics of chemical reactions and factors influencing on rate and direction of chemical reactions

C03 To acquaint students with the chemistry and metal electrochemistry including chemical and electrochemical corrosion

C04 To acquaint students with significant elements of organic chemistry and classification of organic compounds

C05 To acquaint students with chemistry of polymers

C06 Preliminary preparation to carry out the researches in fields related to micro- and nanoelectronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has knowledge in basis of chemistry, particularly in crystallography and physicochemical properties of inorganic and organic materials - understand the relationship between their properties and structure from the perspective of materials science

PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Student can identify and describe the chemical and electrochemical phenomena. Moreover can determine the chemical properties of basic chemicals and to determine their behavior under various conditions

PEK_U02 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

**Relating to social competences**

PEK_K01 Student understands the need and knows the possibility of lifelong learning (studies II and III degree, postgraduate courses) - increase professional, personal and social competence

PEK_K02 Student is aware of the importance and understanding of non-technical aspects and impacts of engineering, including its impact on the environment, and the related responsibility for decisions

PEK_K03 The student is able to think and act in an entrepreneurial way

## PROGRAMME CONTENT

| | **Form of classes - Lecture** | Quantity |
|---|---|---|
| Le_01 | Atom structure, the periodic table | 2 |
| Le_02 | Molecular structures | 2 |
| Le_03 | States of matter and its properties | 2 |
| Le_04 | Crystallographic elements | 2 |
| Le_05 | The chemical reactions and chemical kinetics | 2 |
| Le_06 | Chemical equilibrium | 2 |
| Le_07 | Chemistry of solutions | 2 |
| Le_08 | Electrochemistry | 2 |
| Le_09 | Metal chemistry | 2 |
| Le_10 | Corrosion of metals | 2 |
| Le_11 | Non-metal chemistry | 2 |
| Le_12 | Nanomaterial properties | 2 |
| Le_13 | Introduction to organic chemistry | 2 |
| Le_14 | Polymers chemistry | 2 |
| Le_15 | Test | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Traditional lecture with presentation and discussion
ND_02 Consultations
ND_03 Preparation of selected problems raised during the lecture
ND_04 Individual work – self-study and preparation for test

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Discussion, final test |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. I. Barycka, K. Skudlarski, Podstawy chemii, Oficyna Wydawnicza Politechniki Wrocławskiej, 2001
2. Group work under supervision of Jacek Banaś and Wojciech Stolarski, Chemia dla inżynierów, AGH Kraków, 2008

**Secondary literature**

1. F. A. Otton, G. Wilkinson, P.L. Gaus, Chemia nieorganiczna, WNT, 1995
2. L. Pauling, P. Pauling, Chemia, WNT, 1997

## SUBJECT SUPERVISOR

**Helena.Teterycz@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Chemistry**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W07 | C01-C05 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_W02 | InzA_W02 | C01-C06 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_U01 (skills) | K1MTR_U02 | C01-C05 | Le_01-Le_14 | ND_02-ND_04 |
| PEK_U02 | InzA_U01 | C01-C06 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_K01 (competences) | K1MTR_K01 | C01 | Le_01-Le_14 | ND_01-ND_04 |
| PEK_K02 | K1MTR_K02 | C01, C02, C05 | Le_01-Le_14 | ND_01-ND_04 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Elementy i układy elektroniczne** | |
| Name in English: | **Electronic Elements and Devices** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD032001** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | | | |
| Number of hours of total student workload (CNPS) | 60 | | | | |
| Form of crediting | Z | | | | |
| Number of ECTS points | 2 | | | | |
| Including number of ECTS points for practical (P) classes | 0 | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic physics - Electricity and Magnetism

## SUBJECT OBJECTIVES

C01 To learn basic physical properties and operation of semiconductor devices
C02 To learn parameters and characteristics of electronic components
C03 To learn how to choose proper electronic device for circuit design
C04 To gain ability to define priorities in engineering tasks
C05 To provide background in scientific research competence in the areas of micro- and nanoelectronics and passive and active electronic components

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Understands basic physics of semiconductors, operation of semiconductor devices and their applications

PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Can use electronic component data sheets. Have skill of using semiconductor elements in electronic circuits.

PEK_U02 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

**Relating to social competences**

PEK_K01 Have ability to set-up priorities in engineering tasks

## PROGRAMME CONTENT

| | **Form of classes - Lecture** | Quantity |
|---|---|---|
| Le_01 | Introduction. Basic electric circuit laws. R, L, C components | 2 |
| Le_02 | Properties of semiconductors. Energy band model | 2 |
| Le_03 | Influence of temperature, light and magnetic field on semiconductors | 2 |
| Le_04 | The p-n junction. Types of diodes and applications | 2 |
| Le_05 | Rectifying and voltage regulator circuits | 2 |
| Le_06 | Bipolar transistor: principle of operation, dc bias | 2 |
| Le_07 | Midterm test | 2 |
| Le_08 | Bipolar transistor characteristics and parameters. Equivalent circuits | 2 |
| Le_09 | Transistor amplifier circuits | 2 |
| Le_10 | Field effect transistors - JFET, MESFET, MOSFET | 2 |
| Le_11 | Switching devices: thyristors, triacs, IGBT | 2 |
| Le_12 | Optoelectronic components | 2 |
| Le_13 | Introduction to analog ICs, OP-AMP applications | 2 |
| Le_14 | Digital TTL and CMOS circuits | 2 |
| Le_15 | Final test | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Lecture with slide presentation and discussion
ND_02 Office hours – tutorials
ND_03 Individual study with lecture material
ND_04 Student work - preparation to the class tests

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02, PEK_U01, PEK_U02, PEK_K01 | Tests, discussions |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Świt, J. Pułtorak, Przyrządy półprzewodnikowe, WNT, 1988
2. B. Boratyński, Notatki z wykładu, kopie (pliki .pdf) materiałów wykładowcy, 2011
3. W. Marciniak, Przyrządy półprzewodnikowe i układy scalone, WNT, 1984


**Secondary literature**


1. A. Guziński, Liniowe elektroniczne układy analogowe, WNT, 1983
2. G. Rizzoni, Fundamentals of Electrical Engineering, McGraw-Hill, 2010


## SUBJECT SUPERVISOR


**Boguslaw.Boratynski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Electronic Elements and Devices**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_MM_W02, K1MTR_MM_W14 | C01-C03 | Le_01-Le_14 | ND_01-ND_04 |
| PEK_W02 | InzA_W02 | C01-C03, C05 | Le_01-Le_14 | ND_01-ND_04 |
| PEK_U01 (skills) | K1MTR_MM_U03, K1MTR_MM_U14 | C01-C03 | Le_01-Le_14 | ND_01-ND_04 |
| PEK_U02 | InzA_U01 | C01-C03, C05 | Le_01-Le_14 | ND_01-ND_04 |
| PEK_K01 (competences) | K1MTR_K04 | C04 | Le_01-Le_14 | ND_01-ND_04 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Podstawy informatyki** | |
| Name in English: | **Fundamentals of Computer Science** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD032101** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | 30 | | |
| Number of hours of total student workload (CNPS) | 30 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completed the course material: Information technology

## SUBJECT OBJECTIVES

C01 Gaining theoretical knowledge about C and C++ languages referred to in Le_01-Le_14
C02 Gaining practical skills (programming C and C++ applications) through laboratory tasks La_01-La_14

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 He knows the basics of C/C++

**Relating to skills**

PEK_U01 He can develop a simple application in C/C++ implementing the selected algorithm

**Relating to social competences**

PEK_K01 Able to interact and work in a group of laboratory, taking in the different roles

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Encoding information. Character encodings: ASCII, ISO 8859-2, UNICODE. Representation of integers in the U1, U2, + N, BCD, BCD+3. The IEEE 754 and the limits of calculation accuracy | 2 |
| Le_02 | Portability of code and data: code reuse across platforms, data exchange between different systems and processors of different architectures | 2 |
| Le_03 | Single- and multi-dimensional arrays. Pointers and pointer arithmetic. Conditions and loops | 2 |
| Le_04 | Dynamic memory allocation. Exceptions | 2 |
| Le_05 | Binary and text files. Introduction to the data serialization | 2 |
| Le_06 | Structures, unions, organization of fields of structures in memory | 2 |
| Le_07 | Functions, function parameters, recursion. Error prevention against stack overflow. Different conventions for function calls and their impact on performance and code portability | 2 |
| Le_08 | Data processing: sorting algorithms. The use of function pointers | 2 |
| Le_09 | Classes in C++ as a smart structures | 2 |
| Le_10 | Operator overloading. Defining custom data types | 2 |
| Le_11 | Polymorphism and paradigms of object-oriented programming | 2 |
| Le_12 | Features of C# and Java as object-oriented languages | 2 |
| Le_13 | Basics of programming TCP/IP | 2 |
| Le_14 | Communication and data exchange between Java and C++ applications. Using 16-bit big-endian and 32-bit little-endian processor and data portability. | 2 |
| Le_15 | Final test | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Configuration of the Integrated Development Environment | 2 |
| La_02 | Basic data types. Standard input-output. Operations on numeric variables | 2 |
| La_03 | Debugger. Type conversions | 2 |
| La_04 | Strings, arrays, files | 2 |
| La_05 | Selected algorithms for processing strings in C | 2 |
| La_06 | Local, global, static variables. Functions | 2 |
| La_07 | Conditional statements and multiple-choice switch case instruction | 2 |
| La_08 | Dynamic allocation of memory and pointer arithmetics | 2 |
| La_09 | Introduction to classes and objects | 2 |
| La_10 | Object-oriented I/O in C++ | 2 |
| La_11 | Sorting algorithms and complexity of algorithms | 2 |
| La_12 | Applications of function pointers | 2 |
| La_13 | Completion of the final project (application in C) | 2 |
| La_14 | Presentation of successful completion of the final project | 2 |
| La_15 | Additional (spare) classes | 2 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 The traditional lecture with presentations and discussion |
| ND_02 Program completion quizzes to verify the current curriculum |
| ND_03 Consultation |
| ND_04 Self study - preparation of selected topics in the lecture |
| ND_05 Self study - preparation of selected topics in the laboratory |
| ND_06 Laboratories |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01 | Discussions and final test |
| P2 = F2 (lab) | PEK_U01, PEK_K01 | Partial tests and quizzes, lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Prata, S., Język C. Szkoła programowania. Wydanie V, Helion, 2006
2. Kerningham B. W., Ritchie D. M., Język ANSI C, WNT, 2001
3. Kuczmarski, Karol, Kurs C++, http://avocado.risp.pl, 2012


**Secondary literature**


1. Bartlet, Jonathan, Programming from the Ground Up, http://www.bartlettpublishing.com/, 2012
2. Stroustrup, Bjarne, The C++ programming language, ADDISON-WESLEY PUBL. CO., 1991


## SUBJECT SUPERVISOR


**Krzysztof.Urbanski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Fundamentals of Computer Science**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W19 | C01 | Le_01-Le_14 | ND_01-ND_04 |
| PEK_U01 (skills) | K1MTR_U19, K1MTR_U21 | C02 | La_01-La_14 | ND_02, ND_03, ND_05, ND_06 |

| | | | | |
|---|---|---|---|---|
| PEK_K01 (competences) | K1MTR_K03 | C02 | La_01-La_14 | ND_05, ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Elementy i układy elektroniczne** | |
| Name in English: | **Electronic Elements and Devices** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD033001** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | 30 | | |
| Number of hours of total student workload (CNPS) | | | 60 | | |
| Form of crediting | | | Z | | |
| Number of ECTS points | | | 2 | | |
| Including number of ECTS points for practical (P) classes | | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic physics - Electricity and Magnetism
2. Lecture: Electronic Elements and Circuits

## SUBJECT OBJECTIVES

C01 To learn basic physical properties of semiconductors
C02 To learn parameters and characteristics of diodes, transistors and integrated circuits
C03 To learn how to choose proper electronic device for circuit design
C04 To learn how to analyse simple electronic circuits
C05 Team work skill development
C06 To provide background in scientific research competence in the areas of micro- and nanoelectronics and passive and active electronic components

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Understanding of basic physics of semiconductors, operation of semiconductor devices and their applications

PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Ability to use data sheets to choose proper electronic component for specific application. Skill of using semiconductor elements in electronic circuits.

PEK_U02 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

**Relating to social competences**

PEK_K01 Independent and team work ability in laboratory experiments

## PROGRAMME CONTENT

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Introduction to the Laboratory | 3 |
| La_02 | The p-n junction characteristics | 3 |
| La_03 | Rectifying diodes and circuits | 3 |
| La_04 | Voltage regulator with a Zener diode | 3 |
| La_05 | Bipolar transistor characteristics | 3 |
| La_06 | Bipolar transistor amplifier | 3 |
| La_07 | MOSFET characteristics and application | 3 |
| La_08 | Bipolar transistor characteristics and parameters. Equivalent circuits | 3 |
| La_09 | CMOS gates | 3 |
| La_10 | Make-up lab meeting | 3 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Oral introduction to the experiments, 10-minute quizzes
ND_02 Office hours – tutorials
ND_03 Individual study -preparation for lab experiment

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lab) | PEK_W01, PEK_W02, PEK_U01, PEK_U02 | Short tests and oral quizes |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Świt, J. Pułtorak, Przyrządy półprzewodnikowe, WNT, 1988
2. B. Boratyński, Notatki z wykładu, kopie (pliki .pdf) materiałów wykładowcy, 2010
3. B. Streetman, Przyrządy półprzewodnikowe, WNT, 1984
4. W. Marciniak, Przyrządy półprzewodnikowe i układy scalone, WNT, 1984
5. Group work, Instructions to laboratory exercises (.pdf files), 2012


**Secondary literature**


1. A. Guziński, Liniowe elektroniczne układy analogowe, WNT, 1983
2. G. Rizzoni, Fundamentals of Electrical Engineering, McGraw-Hill, 2010


## SUBJECT SUPERVISOR


**Boguslaw.Boratynski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Electronic Elements and Devices**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_MM_W02 | C01-C03 | La_01-La_10 | ND_01-ND_03 |
| PEK_W02 | InzA_W02 | C01-C03, C06 | La_01-La_10 | ND_01-ND_03 |
| PEK_U01 (skills) | K1MTR_MM_U03 | C01-C03 | La_01-La_10 | ND_01-ND_03 |
| PEK_U02 | InzA_U01 | C01-C03, C06 | La_01-La_10 | ND_01-ND_03 |
| PEK_K01 (competences) | K1MTR_K03 | C04, C05 | La_01-La_10 | ND_01-ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Statystyka inżynierska** | |
| Name in English: | **Engineering Statistics** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD033002** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | 15 | | | |
| Number of hours of total student workload (CNPS) | 60 | 60 | | | |
| Form of crediting | Z | Z | | | |
| Number of ECTS points | 2 | 2 | | | |
| Including number of ECTS points for practical (P) classes | 0 | 2 | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | 1.4 | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows the elements of probability corresponding to high school at the primary level

## SUBJECT OBJECTIVES

C01 Acquisition of knowledge of basic probability distributions, their properties and applications
C02 Acquisition of knowledge on the role of statistical methods in engineering activities; data collection methods, descriptive analysis and graphical presentation of experimental data
C03 Acquisition of skills solve problems independently from the application of probabilistic models and statistical methods in engineering practice
C04 Consolidation of student awareness regarding the need to use statistical methods in engineering activities

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has knowledge of basic probabilistic models, methods of data collection and presentation of statistical data, he knows the basic methods of statistical data analysis

**Relating to skills**

PEK_U01 Is able to select and use appropriate tools to solve selected problems of statistical data analysis, is able to draw conclusions on the basis of their analysis

**Relating to social competences**

PEK_K01 Can work as a team member to solve engineering problems using statistical methods

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction. Rules. Probability and the role of statistics in engineering. Collection of empirical data | 1 |
| Le_02 | Geometric probability, independent events, conditional probability, Bayes' theorem. Random variables. Moments of random variables, distribution function | 2 |
| Le_03 | Distributions of functions of random variables (binomial, geometric, Poisson, exponential, tables of normal distribution, standardization, random variable, Student-t distribution, chi-square) | 2 |
| Le_04 | Moments of trial, Descriptive statistics (stem and leaf, quantile of the trial, histogram, box plots, graphs timelines) | 2 |
| Le_05 | Approximation of distributions of discrete normal distribution. Independence of random variables. Covariance and correlation. Central limit theorem. Estimators and their properties | 2 |
| Le_06 | Estimation methods. Confidence intervals | 2 |
| Le_07 | Selected statistical tests | 2 |
| Le_08 | Passing test | 2 |
| | **TOTAL** | 15 |

| Form of classes - Classes | | Quantity |
|---|---|---|
| Cl_01 | Introductory exercises, range of exercises, principles of assessment | 1 |
| Cl_02 | Solving basic tasks in the field of probability, calculation of moments | 2 |
| Cl_03 | Solving the scope of the selected probability distributions | 2 |
| Cl_04 | The use of descriptive statistics in data analysis - problem solving | 2 |
| Cl_05 | The use of descriptive statistics in data analysis - problem solving | 2 |
| Cl_06 | Central limit theorem – solving selected examples | 2 |
| Cl_07 | Estimation methods – solving selected examples | 2 |
| Cl_08 | Selected statistical tests – solving examples | 2 |
| | **Total** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Traditional lectures using multimedia presentations and discussion |
| ND_02 Consultation |
| ND_03 Self - preparation for the lecture inflicted issues |
| ND_04 Self - preparation for exercise |
| ND_05 Self - self-inflicted solving problems during exercise |
| ND_06 Exercises: a short, 15-minute tests at the beginning of classes |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01 | Writing test |
| P2 = F2 (classes) | PEK_U01, PEK_K01 | Solving exercises, discussions, short test during classes |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. W. Krysicki et al., Rachunek prawdopodobieństwa i statystyka matematyczna w zadaniach, PWN, Warszawa 1995
2. W. Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna. Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław 2003


**Secondary literature**


1. D.C. Montgomery, G.C. Runger, Applied Statistics and probability for engineers; Students solutions Manual, Wiley&Sons, 2006, 4th Ed.,
2. Roman Nowak, Statystyka dla fizyków, PWN, 2002
3. R. Lyman Ott, Michael Longnecker, An introduction to statistical methods and data analysis, Brooks/Cole Cemgage Learning, 6th, Ed., 2010
4. Dr. Graham Currell, Dr. Antony Dowman, Essential Mathematics and Statistics for Science, 2nd Edition, Wiley, 2009


## SUBJECT SUPERVISOR


**Jaroslaw.Domaradzki@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Engineering Statistics**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01 | C01, C02 | Le_01-Le_08 | ND_01-ND_03 |

| | | | | |
|---|---|---|---|---|
| PEK_U01 (skills) | K1MTR_U01 | C03 | Cl_01-Cl_08 | ND_04-ND_06 |
| PEK_K01 (competences) | K1MTR_K03 | C04 | Cl_01-Cl_08 | ND_01-ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Praktyka programowania w języku C** | |
| Name in English: | **The Practice of Programming in C** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD033101** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | 30 | | |
| Number of hours of total student workload (CNPS) | | | 90 | | |
| Form of crediting | | | Z | | |
| Number of ECTS points | | | 3 | | |
| Including number of ECTS points for practical (P) classes | | | 3 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | 2.1 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completed the course material: Information technology
2. Completed the course material: Introduction to computer science

## SUBJECT OBJECTIVES

C01 Ability to program microcontroller based devices in C language

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Gaining theoretical knowledge referred to in La_01-La_09

**Relating to skills**

PEK_U01 Gaining practical skills through laboratory tasks La_01-La_09

**Relating to social competences**

PEK_K01 Gaining experience working in a development team

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Laboratory** | | Quantity |
| La_01 | Introduction to the chosen IDE for microcontrollers | 3 |
| La_02 | Software implementation of OSI layers 2-4. Using the Ethernet interface. Synthesis and decoding of IP/UDP packets in network microcontrollers | 3 |
| La_03 | Extensions for C in microcontrollers and standard ANSI C | 3 |
| La_04 | Boot sequences of selected microcontrollers - from power-on to the main() function | 3 |
| La_05 | Servicing interrupts in C. UART programming | 3 |
| La_06 | AT command support - software communication with GSM / GPRS | 3 |
| La_07 | Floating-point arithmetic and other mathematical operations a microcontroller, or how to live without FPU. When we use fixed-point arithmetic instead of floating point | 3 |
| La_08 | RF - OOK: transmitting the data, synthesis of bitstream with NRZ coding | 3 |
| La_09 | RF - OOK: receiving and decoding the bit-oriented data (state machine of a decoder) | 3 |
| La_10 | Additional (spare) classes | 3 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Program completion quizzes to verify the current curriculum<br>ND_02 Consultation<br>ND_03 Self study - preparation of selected topics in the laboratory<br>ND_04 Laboratory exercises using microcontrollers |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lab) | PEK_W01, PEK_U01, PEK_K01 | Program completion quizzes, lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Kernighan, Brian W., Lekcja programowania: najlepsze praktyki, Helion, 2011
2. King, K. N., Język C: nowoczesne programowanie, Helion, 2011


**Secondary literature**


1. Krzysztof Urbański, Laboratory instructions, 2012


## SUBJECT SUPERVISOR


**Krzysztof.Urbanski@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**The Practice of Programming in C**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W19 | C01 | La_01-La_09 | ND_01-ND_04 |
| PEK_U01 (skills) | K1MTR_U16, K1MTR_U24 | C01 | La_01-La_09 | ND_02-ND_04 |
| PEK_K01 (competences) | K1MTR_K03 | C01 | La_01-La_09 | ND_04 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Podstawy techniki mikroprocesorowej** | |
| Name in English: | **Basics in Microprocessor Engineering** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD034002** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 30 | | |
| Number of hours of total student workload (CNPS) | 60 | | 60 | | |
| Form of crediting | E | | Z | | |
| Number of ECTS points | 2 | | 2 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge in the field of electronic components and circuits
2. Basic knowledge in the field of computer programming

## SUBJECT OBJECTIVES

C01 Gaining the knowledge of the design and operation of microprocessors
C02 Gaining the knowledge of the microcontroller peripherals
C03 Gaining experience in programming of microprocessors and their peripherals
C04 Preliminary preparation to carry out the researches in fields related to digital electronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knowledge about the architecture and operation of microprocessors
PEK_W02 Knowledge of peripheral devices in single-chip microcontrollers
PEK_W03 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Ability to microprocessors low-level programming
PEK_U02 Ability to use microcontroller peripherals
PEK_U03 The student is able to identify and formulate a specification of simple and practical engineering tasks, characteristic for the studied field of study

**Relating to social competences**

PEK_K01 The student is aware of the importance and understands the non-technical aspects and results of engineering activity, including its impact on the environment, and the associated responsibility for made decisions

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Architecture of the RISC processor basing on the ATMEGA8535 as an example | 2 |
| Le_02 | ATMEGA8535 microcontroller instruction set | 2 |
| Le_03 | Peripherals - handling with I/O ports, analog to digital converter | 2 |
| Le_04 | Interrupts - mechanism and programming | 2 |
| Le_05 | Peripherals - programmable timers/counters | 2 |
| Le_06 | Styles of low-level programming | 2 |
| Le_07 | Peripherals - serial interfaces SPI, UART, I2C | 2 |
| Le_08 | Summary | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Introduction - how to handle with programming tools and educational kits | 4 |
| La_02 | Programming of ports, loops, jumps and procedures | 4 |
| La_03 | Interrups, use of the analog to digital converter, cooperation of the peripheral devices - design of the microprocessor voltmeter | 4 |
| La_04 | Driving of stepper motors,counters - counting of external pulses and timing | 4 |
| La_05 | Counters - generation of rectangular waveform with variable duty factor | 4 |
| La_06 | SPI interface, programming the 7-segment displays drivers, programming of text information | 4 |
| La_07 | Programming the EEPROM, communication with RAM, controlling the LCD display | 4 |
| La_08 | Additional term | 2 |
| | **TOTAL** | 30 |

**TEACHING TOOLS USED**

ND_01 Traditional lecture supported by multimedia presentation
ND_02 Own work - preparation for classes and exam
ND_03 Exercises
ND_04 Own work - preparation for laboratory.

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W03 | Written exam |
| P2 = F2 (lab) | PEK_U01-PEK_U03 | Evaluation of laboratory exercises |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Hitachi HD44780 LCD Controller, technical documentation
2. Maxim MAX7219/MAX7221, technical documentation
3. Atmel ATMega8535, technical documentation


**Secondary literature**


1. R. Baranowski, Mikrokontrolery AVR ATmega w praktyce, BTC, 2005


## SUBJECT SUPERVISOR


**Artur.Wiatrowski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Basics in Microprocessor Engineering**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W16 | C01, C02 | Le_01-Le_08 | ND_01, ND_02, ND_04 |
| PEK_W02 | K1MTR_W16 | C01, C02 | Le_01-Le_08 | ND_01, ND_02, ND_04 |
| PEK_W03 | InzA_W02 | C02-C04 | Le_01-Le_08 | ND_01, ND_02, ND_04 |
| PEK_U01 (skills) | K1MTR_U16 | C03 | La_01-La_15 | ND_03 |
| PEK_U02 | K1MTR_U16 | C03 | La_01-La_15 | ND_03 |
| PEK_U03 | InzA_U06 | C01-C04 | Le_01-Le_08 | ND_03 |
| PEK_K01 (competences) | InzA_K01 | C01-C04 | Le_01-Le_08 | ND_01, ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Programowanie obiektowe** | |
| Name in English: | **Object Oriented Programming** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD034102** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | 30 | | |
| Number of hours of total student workload (CNPS) | | | 90 | | |
| Form of crediting | | | Z | | |
| Number of ECTS points | | | 3 | | |
| Including number of ECTS points for practical (P) classes | | | 3 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | 2.1 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completed the course material: Introduction to computer science

## SUBJECT OBJECTIVES

C01 The ability to design and implementation of applications in object-oriented programming language

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Gaining theoretical knowledge referred to in La_01-La_07

**Relating to skills**

PEK_U01 Gaining practical skills through laboratory tasks La_01-La_07

**Relating to social competences**

PEK_K01 Gaining experience working in a development team

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Laboratory** | | Quantity |
| La_01 | Introduction to .NET and C # language. Discussion of the objectives of the project target (robot or machine controller) | 4 |
| La_02 | Introduction to UML. Design target driver functions in groups | 4 |
| La_03 | Development of diagrams: use case and activity classes for the driver. User Interface Design | 4 |
| La_04 | Principles of good GUI design. Designing of the user interface for controller | 4 |
| La_05 | Gaining knowledge about the class that realizes UDP network communication. Design your own application testing its operation | 4 |
| La_06 | The implementation of application implementing the assumption of La_02 | 4 |
| La_07 | Functional tests and add exception handling (optional) | 4 |
| La_08 | Additional (spare) classes | 2 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED | |
|---|---|
| ND_01 | Quizzes to master the material needed to verify the current curriculum |
| ND_02 | Consultation |
| ND_03 | Self study - preparation of selected topics in the laboratory |
| ND_04 | Laboratories |
| ND_05 | Giving the knowledge necessary to carry out laboratory activities |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lab) | PEK_W01, PEK_U1, PEK_K01 | Program completion quizzes, lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Rasheed, Faraz, Programmer-s Heaven C# School Book, http://www.programmersheaven.com/ebooks/csharp_ebook.pdf, 2012
2. Petzold, Charles, Programming Microsoft Windows with C#, Microsoft Press, 2001
3. Kubik, Tomasz, UML and service description languages : information systems modelling, PRINTPAP, 2011


## SUBJECT SUPERVISOR


**Krzysztof.Urbanski@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Object Oriented Programming**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W19 | C01 | La_01-La_07 | ND_02, ND_03, ND_05 |
| PEK_U01 (skills) | K1MTR_U19,K1MTR_U21 | C01 | La_01-La_07 | ND_04 |
| PEK_K01 (competences) | K1MTR_K03 | C01 | La_01-La_07 | ND_01-ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Wprowadzenie do sieci komputerowych** | |
| Name in English: | **Introduction to Computer Networks** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD034103** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 30 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completed the course material: Information technology
2. Completed the course material: Introduction to computer science

## SUBJECT OBJECTIVES

C01 Gaining theoretical knowledge referred to in La_01-La_07
C02 Gaining practical skills through laboratory tasks La_01-La_07
C03 Gaining theoretical knowledge referred to in Le_01-Le_07

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 He knows the principles of operation of computer networks and their security aspects
PEK_W02 He knows the rules of designing network solutions and their programming

**Relating to skills**

PEK_U01 The ability to design simple and secure computer networks, including the safety aspects

| | |
|---|---|
| PEK_U02 | The ability to practical application of network technology, and to communicate with the measuring systems and devices |

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | Is aware of the need for ethical and legal standards relating to such with access to private and sensitive data processed in computer networks |
| PEK_K02 | Is able to interact and work in a group of laboratory, taking in the different roles |

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Introduction: ISO / OSI model, network topologies, protocols | 2 |
| Le_02 | The ARP protocol. Static and dynamic ARP table entries. Prevention of attacks carried out on the basis of the ARP protocol. Example implementation of the ARP protocol using networked microcontroller | 2 |
| Le_03 | The IP protocol. Route selection. Address Translation. Overview of the TCP, UDP, ICMP | 2 |
| Le_04 | High-level network programming: client-server architecture. Portability of data on the network | 2 |
| Le_05 | Safety: traffic monitoring, attack detection, firewalls, data encryption, certificates, privacy | 2 |
| Le_06 | Selected network services: DNS, FTP, HTTP. Configuring and securing devices against selected attacks | 2 |
| Le_07 | Wireless Networks. Bluetooth, Wi-Fi. Configuration, range, safety | 2 |
| Le_08 | Final test | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | What is the Internet? The most important protocols. Getting familiar with tool WireShark | 2 |
| La_02 | The principle of operation of L2 and L3 switch. The ARP protocol. MAC spoofing and certain types of attacks | 2 |
| La_03 | TCP and UDP applications. Client-server architecture. Network programming using the BSD sockets. Multi-threaded server application | 2 |
| La_04 | Implementation of embedded web server and TCP stack in single chip microcontroller. Remote device control and data acquisition using a Web browser | 2 |
| La_05 | The HTTP protocol and the DNS system. Configuration of http server, including support for multiple domains | 2 |
| La_06 | Principle of operation of NAT. Setting up Windows ICS and NAT devices. Port mapping | 2 |
| La_07 | Setting up and running the SSH and RDP services allow remote access to the computer located behind NAT | 2 |
| La_08 | Additional (spare) classes | 1 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED | |
|---|---|
| ND_01 | Program completion quizzes to verify the current curriculum |
| ND_02 | Consultation |
| ND_03 | Self study - preparation of selected topics in the lecture and laboratory |
| ND_04 | Specialized software to perform the tasks of laboratory |
| ND_05 | Educational kits with networked microcontrollers |
| ND_06 | Giving the knowledge necessary to carry out laboratory activities |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Final test |
| P2 = F2 (lab) | PEK_U01, PEK_U02, PEK_K01, PEK_K02 | Program completion quizzes, lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Stevens W. R., Programowanie zastosowań sieciowych w systemie Unix, Helion, 2010
2. Tanenbaum, Andrew S. , Sieci komputerowe, Helion, 2004
3. Schneier, Bruce, Kryptografia dla praktyków: protokoły i programy źródłowe w języku C, WNT, 2002


**Secondary literature**


1. Danowski, Bartosz, Wi-Fi : domowe sieci bezprzewodowe, Helion, 2010
2. Park, John, Practical data communications for instrumentation and control, Elsevier, 2003


## SUBJECT SUPERVISOR


**Krzysztof.Urbanski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Introduction to Computer Networks**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W20 | C01 | Le_01-Le_07 | ND_01, ND_03, ND_04 |
| PEK_W02 | K1MTR_W20 | C01 | Le_01-Le_07 | ND_01- ND_06 |
| PEK_U01 (skills) | K1MTR_U20 | C02 | La_01-La_07 | ND_02, ND_03, ND_05, ND_06 |
| PEK_U02 | K1MTR_U20 | C02 | La_01-La_07 | ND_02, ND_03, ND_05, ND_06 |
| PEK_K01 (competences) | K1MTR_K02, K1MTR_K05 | C01 | La_01-La_07 | ND_03, ND_06 |
| PEK_K02 | K1MTR_K03 | C02 | La_01-La_07 | ND_03, ND_06 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Podstawy projektowania układów elektronicznych** |
| Name in English: | **Fundamentals of Electronic Design** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **I level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD035001** |
| Group of courses: | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | | | |
| Number of hours of total student workload (CNPS) | 30 | | | | |
| Form of crediting | Z | | | | |
| Number of ECTS points | 1 | | | | |
| Including number of ECTS points for practical (P) classes | 0 | 0 | 0 | 0 | 0 |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | 0 | 0 | 0 | 0 |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of electrical engineering and analog technique
2. Basic knowledge of issues related to semiconductor devices

## SUBJECT OBJECTIVES

C01 To acquaint students with basic electronic systems, properties and applications of electronic circuits
C02 To acquaint students with basics of analog and digital circuits design
C03 Preliminary preparation to carry out the researches in fields related to micro- and nanoelectronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Students have systematic and theoretically founded knowledge of basic digital and analogue circuits
PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Student are able to analyse basic parameters and characteristics of measurement and control electronics |
| PEK_U02 | The student is able to identify and formulate a specification of simple and practical engineering tasks, characteristic for the studied field of study |

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | Student are able to identify priorities needed to realise defined engineering task, connected with design, analysis and measurement of basic parameters of analog and digital circuits |
| PEK_K02 | Student are able to identify which tasks are to realize individually or in group |
| PEK_K03 | The student is able to think and act in an entrepreneurial way |

## PROGRAMME CONTENT

| | **Form of classes - Lecture** | Quantity |
|---|---|---|
| Le_01 | Properties and characteristics of operational amplifiers | 2 |
| Le_02 | Linear and nonlinear circuits designed with operational amplifiers | 2 |
| Le_03 | Properties and characteristics of instrumental and differentia amplifiers | 2 |
| Le_04 | Circuits for acquisition of photodetector signals | 2 |
| Le_05 | Current and voltage sources | 2 |
| Le_06 | Digital to analog and analog to digital converters | 2 |
| Le_07 | Input and output circuits for analog to digital and digital to analog converters | 2 |
| Le_08 | Test in writing | 1 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Traditional lecture with discussion
ND_02 Multimedia lecture with discussion
ND_03 Consultations
ND_04 Individual work – preparation of selected topics of the lecture
ND_05 Individual work – preparation for test

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Test in writing |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J. Baranowski, G. Czajkowski, Układy analogowe nieliniowe i impulsowe, WNT, 2004
2. P. Górecki, Wzmacniacze operacyjne, Wydawnictwo BCT, 2004
3. S. Kuta, Układy elektroniczne, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 1995


**Secondary literature**


1. P. Horowitz, W. Hill, Sztuka elektroniki, Wydawnictwo Komunikacji i Łączności, 2009
2. S. Kuta, Elementy i układy elektroniczne cz.2, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 2000

| **SUBJECT SUPERVISOR** |
|---|
| **Teodor.Gotszalk@pwr.wroc.pl** |

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Fundamentals of Electronic Design**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W16 | C01 | Le_01-Le_08 | ND_01-ND_05 |
| PEK_W02 | InzA_W02 | C01, C03 | Le_01-Le_08 | ND_01- ND_05 |
| PEK_U01 (skills) | K1MTR_MM_U01 | C02 | Le_01-Le_08 | ND_03, ND_04 |
| PEK_U02 | InzA_U06 | C02, C03 | Le_01-Le_08 | ND_01-ND_05 |
| PEK_K01 (competences) | K1MTR_K03 | C02 | Le_01-Le_08 | ND_03 |
| PEK_K02 | K1MTR_K04 | C02 | Le_01-Le_08 | ND_03 |
| PEK_K03 | InzA_K02 | C02, C03 | Le_01-Le_08 | ND_01-ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Zastosowanie optoelektroniki** | |
| Name in English: | **The Use of Optoelectronics** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD036201** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 30 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of physics (including geometric optics) and foundations of solid state physics
2. Completion of Fundamentals of Electrical Engineering course
3. Completion of Electronics Elements and Devices course

## SUBJECT OBJECTIVES

C01 To familiarize students with the basic optical phenomena in semiconductors, including the transmission of light in semiconductors and optical fiber
C02 Students become acquainted with the structure, parameters and conditions of optoelectronic components
C03 Persisting the ability to work in a group
C04 Preparing to conduct research with applications using fiber optics, light emitters and detectors

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has ordered in terms of theoretical knowledge of photonics, including the knowledge necessary to understand the physical basis of optical components telecommunications track and knows areas of photonic systems application in particular in the automotive, energy and microsystems

PEK_W02 The student has a basic knowledge of the life cycle of the technical equipment, facilities, and systems

**Relating to skills**

PEK_U01 Student can use optical fiber systems and simple elements known in engineering practice

PEK_U02 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

**Relating to social competences**

PEK_K01 Student is able to interact and work in laboratory group, taking in her different roles

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Introduction to optoelectronics | 1 |
| Le_02 | The basics of optical phenomena in semiconductors | 2 |
| Le_03 | Optical fiber technique | 3 |
| Le_04 | Light sources | 2 |
| Le_05 | Photodetectors | 2 |
| Le_06 | Basics of the solar cells | 1 |
| Le_07 | Areas of application of optoelectronic devices | 3 |
| Le_08 | Test | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Attenuation of a multisegment optical fiber transmission system measurement | 2 |
| La_02 | Study of the attenuation of optical fibers | 2 |
| La_03 | Testing of optical polarizer | 2 |
| La_04 | Investigation of spectrum characteristics of light sources | 2 |
| La_05 | Investigation of matching efficiency of optical connectors in different transmission optical windows | 2 |
| La_06 | Machine Vision for manufacturing quality assurance | 2 |
| La_07 | Optical microscope and interferometry measurements for 2D/3D | 2 |
| La_08 | Measurement of surface scattering and photometric light characteristics | 2 |
| La_09 | Industrial laser technologies | 2 |
| La_10 | Methods of laser beam measurement and process monitoring | 2 |
| La_11 | Panels and solar cells | 2 |
| La_12 | Optical fiber sensors | 2 |
| La_13 | Optotelecommunication track | 2 |

| | | |
|---|---|---|
| La_14 | Optical fiber connection technology (welding of fiber optics, measurement of the geometry of the optical fiber) | 2 |
| La_15 | Semiconductor lighting systems | 2 |
| | **TOTAL** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Traditional lecture with presentations and discussion |
| ND_02 Self work – independent studies and preparing for the test |
| ND_03 Tutorials |
| ND_04 Self study – preparation for laboratory class |
| ND_05 A brief test at the beginning of the laboratory activities |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Discussions, test |
| P2 = F2 (lab) | PEK_U01, PEK_U02, PEK_K01 | Test at the beginning of the exercises, laboratory reports, evaluation class implementation exercises |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. B. Mroziewicz, M. Bugajski, Wł. Nakwaski, Lasery półprzewodnikowe, WNT, 1985
2. B. Ziętek, Optoelektronika, Wyd. UMK, 2004
3. J. E. Midwinder, Y. L. Guo, Optoelektronika i technika światłowodowa, WKŁ, 1995
4. J. I. Pankove, Zjawiska optyczne w półprzewodnikach, WNT, 1984
5. J. Piotrowski, A. Rogalski, Półprzewodnikowe detektory podczerwieni, WNT, 1985
6. Z. Bielecki, A. Rogalski, Detekcja sygnałów optycznych, WNT, 2001


**Secondary literature**


1. A. Smoliński, Optoelektronika światłowodowa, WKŁ, 1985
2. G. Einarsson, Podstawy telekomunikacji światłowodowej, WKŁ, 1983
3. J. Godlewski, Generacja i detekcja promieniowania optycznego, PWN, 1974
4. J. Hennel, Podstawy elektroniki półprzewodnikowej, WNT, 1986
5. J. Siuzdak, Wstęp do współczesnej telekomunikacji światłowodowej, WKŁ, 1997
6. K. Booth, S. Hill, Optoelektronika, WKŁ, 2001
7. M. Marciniak, Łączność światłowodowa, WKŁ, 1998


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**The Use of Optoelectronics**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W30 | C01, C02, C04 | Le_01-Le_07 | ND_01-ND_03 |
| PEK_W02 | InzA_W01 | C01, C02, C04 | Le_01-Le_07 | ND_01-ND_03 |
| PEK_U01 (skills) | K1MTR_U35 | C02, C04 | La_01-La_15 | ND_01-ND_05 |
| PEK_U02 | InzA_U01 | C02, C04 | La_01-La_15 | ND_01-ND_05 |
| PEK_K01 (competences) | K1MTR_K03 | C03 | La_01-La_15 | ND_02, ND_04 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Sensory i aktuatory** | |
| Name in English: | **Sensors and Actuators** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD035101** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | 30 | | |
| Number of hours of total student workload (CNPS) | 30 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. No requirements

## SUBJECT OBJECTIVES

C01 Organization of knowledge in the fields of micromechanic sensors and actuators
C02 To familiarize oneself with basic properties of micromechanic sensors
C03 To familiarize oneself with methods and algorithms of analog and digital conditioning of signals from micromechanic sensors
C04 Preliminary preparation to conduct research in areas related to the integration and use of sensor systems using MEMS sensors

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has knowledge in the field of sensor techniques, knowledge necessary to understand physical and mechanical principles of operation of micromechanical sensors and actuators, knows dependencies between operation parameters and the construction, has knowledge of technology of micromechanical sensors

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Is able to select and apply proper sensors to measure different physical parameters, and to apply the sensors in various measurement systems. Is able to present principle of operation and apply selected microsystems and sensor. Is able to verify proper operation of the sensor |
| PEK_U02 | Is able to plan measurement experiment, to choose proper measurement devices and circuits, to estimate measurement errors and to work out results of experiment |
| PEK_U03 | The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions |
| PEK_U04 | The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks |
| PEK_U05 | The student is able to see system and non-technical aspects of engineering tasks during their formulating and solving |

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | Realizes the significance and understands non-technical aspects and consequences of engineering activity and especially its influence on the natural environment and the related responsibility for decisions |
| PEK_K02 | Is able to cooperate and work in a group, taking up different roles |
| PEK_K03 | The student is aware of the importance and understands the non-technical aspects and results of engineering activity, including its impact on the environment, and the associated responsibility for made decisions |

| **PROGRAMME CONTENT** | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Review of chosen methods of actuation and sensing utilized with MEMS | 3 |
| Le_02 | Introduction to fundamental mechanics of microstructures, bending, tensing in various micromechanic structures | 2 |
| Le_03 | Piezoresitive pressure sensor – principle of operation, construction | 2 |
| Le_04 | Piezoresitive pressure sensor – parameters, conditioning of electric signal, examples of realizations | 2 |
| Le_05 | Acceleration sensors, gyroscopes – principles of operation, construction, parameters and examples of realizations | 2 |
| Le_06 | Micromachines as devices with various sensors and actuators | 2 |
| Le_07 | Final colloquium | 2 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Piezoresitsive pressure sensor | 3 |
| La_02 | Barometric altitude meter | 3 |
| La_03 | XYZ accelerometer | 3 |
| La_04 | E-compas | 3 |
| La_05 | Simulation and optimization of the silicon membrane of the pressure sensor | 3 |
| | **TOTAL** | 15 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Lecture<br>ND_02 Laboratory exercises |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01 | Discussions and final test |
| P2 = F2 (lab) | PEK_U01- PEK_U05, PEK_K01, PEK_K02 | Partial tests and quizzes, lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. M. Bao, Analysis and Design Principles of MEMS Devices, Elsevier, 2005

## SUBJECT SUPERVISOR

**Rafal.Walczak@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Sensors and Actuators**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W15 | C01-C03 | Le_01-Le_06 | ND_01 |
| PEK_U01 (skills) | K1MTR_U03 | C01-C03 | La_01-La_05 | ND_02 |
| PEK_U01 | K1MTR_U15 | C01-C03 | La_01-La_05 | ND_02 |
| PEK_U02 | InzA_01 | C01-C04 | La_01-La_05 | ND_02 |
| PEK_U03 | InzA_02 | C01-C04 | La_01-La_05 | ND_02 |
| PEK_U04 | InzA_03 | C01-C04 | La_01-La_05 | ND_02 |
| PEK_U05 | K1MTR_K02 | C01-C03 | Le_01-Le_06, La_01-La_05 | ND_01, ND_02 |
| PEK_K01 (competences) | KIMTR_K03 | C01-C03 | Le_01-Le_06, La_01-La_05 | ND_01, ND_02 |
| PEK_K02 | InzA_K01 | C01-C03 | Le_01-Le_06, La_01-La_05 | ND_01, ND_02 |
| PEK_K03 | K1MTR_W15 | C01-C03 | Le_01-Le_06 | ND_01 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Modelowanie układów logicznych** | |
| Name in English: | **Logic Circuits Modelling** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD035102** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 30 | | 60 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 2 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

## SUBJECT OBJECTIVES

C01 Understanding of logic circuits
C02 Gaining the skill of logic circuits modeling

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knowledge of the logic circuits
PEK_W02 The student knows the area of logic circuits application and know how to model them
PEK_W03 The student knows the basic method, techniques, tools and materials used in solving simple engineering problems from the studied field of study
PEK_W04 The student knows the typical engineering technologies in the area of studied field of study

**Relating to skills**

PEK_U01 Fundamental skill of logic circuits modeling
PEK_U02 Fundamental skill of coding in VHDL
PEK_U03 The student is able to select and properly use development tools to model logic circuits
PEK_U04 The student is able to identify and formulate a specification of simple and practical engineering tasks, characteristic for the studied field of study

**Relating to social competences**

PEK_K01 The student can interact and work in a group of laboratory

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Introduction to VLSI digital technology | 2 |
| Le_02 | VHDL basics | 2 |
| Le_03 | Modeling of combinational circuits | 2 |
| Le_04 | Introduction to digital sequential circuits | 2 |
| Le_05 | Modeling sequential circuits | 2 |
| Le_06 | State machines | 2 |
| Le_07 | Serial-to-parallel interface | 2 |
| Le_08 | Final test | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Introduction to VLSI digital technology | 2 |
| La_02 | VHDL basics | 2 |
| La_03 | Modeling of combinational circuits | 2 |
| La_04 | Introduction to digital sequential circuits | 2 |
| La_05 | Modeling sequential circuits | 2 |
| La_06 | State machines | 2 |
| La_07 | Serial-to-parallel interface | 1 |
| La_08 | Final test | 2 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Lecture with discussion |
| ND_02 Self - preparation for final test |
| ND_03 computer laboratory |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W04 | Final test |
| P2 = F2 (lab) | PEK_U01-PEK_U04 | Evaluation of the laboratory program implementation |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. M. Zwoliński, Projektowanie układów cyfrowych z wykorzystaniem języka VHDL, WKŁ, 2007

## SUBJECT SUPERVISOR

**Tomasz.Falat@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Logic Circuits Modelling**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W16, K1MTR_W24 | C01, C02 | Le_01-Le_08 | ND_01, ND_02 |
| PEK_W02 | K1MTR_W16, K1MTR_W24 | C01, C02 | Le_01-Le_08 | ND_01, ND_02 |
| PEK_W03 | InzA_W02 | C01, C02 | Le_01-Le_08 | ND_01, ND_02 |
| PEK_W04 | InzA_W05 | C01, C02 | Le_01-Le_08 | ND_01, ND_02 |
| PEK_U01 (skills) | K1MTR_U14, K1MTR_U16 | C01, C02 | Le_03-Le_05, La_01-La_08 | ND_01, ND_03 |
| PEK_U02 | K1MTR_U14, K1MTR_U16 | C01, C02 | Le_02-Le_07, La_01-La_08 | ND_01, ND_03 |
| PEK_U03 | K1MTR_U14, K1MTR_U16 | C01, C02 | Le_02-Le_07, La_01-La_08 | ND_01, ND_03 |
| PEK_U04 | InzA_U08 | C01, C02 | Le_02-Le_07, La_01-La_08 | ND_01, ND_03 |
| PEK_K01 (competences) | K1MTR_K03 | C01, C02 | La_01-La_08 | ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Mikrosystemy (MEMS)** | |
| Name in English: | **Microsystems (MEMS)** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD036001** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | 15 | | |
| Number of hours of total student workload (CNPS) | 60 | | 60 | | |
| Form of crediting | E | | Z | | |
| Number of ECTS points | 2 | | 2 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

## SUBJECT OBJECTIVES

C01 Familiarizing students with the basics of micromachines technology with elements of nanotechnology, the basics of design and application of the modern microsensors, microsystems MEMS, MEOMS, microactuators and micromachines, also chosen solutions micro- and nanorobots

C02 Acquiring skills in working with selected microsystems

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has structured and theoretically founded knowledge of the operation, construction and basic parameters of the micromechanical actuators, sensors and certain mechanical and electrical microsystems

**Relating to skills**

PEK_U01 The student is able to formulate the principle of operation of selected micro, select and apply appropriate sensors to measure various physical quantities and use them in systems of measurement, monitoring, control

PEK_U02 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

PEK_U03 The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks

PEK_U04 The student is able to see system and non-technical aspects of engineering tasks during their formulating and solving

**Relating to social competences**

PEK_K01 Able to interact and work in a group, taking in the different roles

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | The scope of the lecture, the history of microsystems, the role and position in the market.Materials and technological basics: a review of the planar procedures | 2 |
| Le_02 | Materials and technological basics: a review of the planar procedures | 2 |
| Le_03 | Technological basics cont.: a review of procedures of the deep silicon micromechanics | 2 |
| Le_04 | 3D silicon structures: the use in the construction of micro-sensors and actuators | 2 |
| Le_05 | Technological basics: LIGA and non-photolithographic methods microforming 3D | 2 |
| Le_06 | Pressure sensors from a chip to encapsulated sensor: design, parameters, types, technical | 2 |
| Le_07 | Movement in a microscale: static and dynamic microstructures | 2 |
| Le_08 | The accelerometers, sensors of vibration, force, displacement, construction and usage | 2 |
| Le_09 | Complex systems MEMS, MEOMS | 2 |
| Le_10 | Basics of microfluidics, micromechanical components for the control and flow measurement; dispensers, mixers, micropumps, valves, etc. | 2 |
| Le_11 | From microreactors to bio/med lab-chips and point-of-care systems | 2 |
| Le_12 | The use of microsystems in technics: automotive, aviation, military technology, household appliances, etc. | 2 |
| Le_13 | Micromachines; from simple static micro constructions to micro robots | 2 |
| Le_14 | Nanosystems; technological base, examples of solutions, nanoelectronics 3D | 2 |
| Le_15 | Summary, the development in the next 10 years. Test | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | The piezoresistive pressure sensor: modeling of silicon membranes, the basic element piezoresistive pressure sensor | 3 |
| La_02 | The piezoresistive pressure sensor: measuring the deflection of the membrane of silicon using a fiber optic meter distance | 3 |
| La_03 | The piezoresistive pressure sensor: measurement and determination of metrological parameters of the sensor and pressure sensor | 3 |
| La_04 | Microscale flow management: gas micropump | 3 |
| La_05 | Fiber optical MEMS switch | 3 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Lecture with presentation and discussion.<br>ND_02 Prepare for laboratory, short test the knowledge<br>ND_03 Consultation<br>ND_04 Own work - prepare for the test and the exam<br>ND_05 Analysis of the results and prepare of the report |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (lecture) | PEK_W01 | Test |
| F2 | PEK_W01 | Exam |
| F3 (lab) | PEK_U01-PEK_U04, PEK_K01 | Short tests at the beginning of the exercises, discussion. |
| F4 | PEK_U01-PEK_U04, PEK_K01 | Evaluation of the reports of the exercises. |
| P1 (lecture) = 0,5*(F1 + F2) | | |
| P2 (lab) = 0,5*(F3 + F4) | | |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J. Dziuban, Technologia i zastosowanie mikromechanicznych struktur krzemowych i krzemowo-szklanych w technice mikrosystemów, Oficyna Wydawnicza Politechniki Wrocławskiej, 2002


**Secondary literature**


1. Introduction to microsystem technology, Wiley, 2010
2. MacDouk, MEMS Handbook, MC, New York, 2009


## SUBJECT SUPERVISOR


**Anna.Gorecka-Drzazga@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Microsystems (MEMS)**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W15 | C01 | Le_01-Le_15 | ND_01, ND_03, ND_04 |
| PEK_U01 (skills) | K1MTR_U15 | C02 | La_01-La_05 | ND_02, ND_05 |
| PEK_U02 | InzA_U01 | C01, C02 | La_01-La_05 | ND_02, ND_05 |
| PEK_U03 | InzA_U02 | C02-C04 | La_01-La_05 | ND_02, ND_05 |
| PEK_U04 | InzA_U03 | C02-C04 | La_01-La_05 | ND_02, ND_05 |
| PEK_K01 (competences) | K1MTR_K03 | C02 | La_01-La_05 | ND_02, ND_05 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Podstawy projektowania układów elektronicznych** | |
| Name in English: | **Fundamentals of Electronic Design** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD036002** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | 30 | |
| Number of hours of total student workload (CNPS) | | | | 30 | |
| Form of crediting | | | | Z | |
| Number of ECTS points | | | | 1 | |
| Including number of ECTS points for practical (P) classes | | | | 1 | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | 0.7 | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of electrical engineering and analog technique
2. Basic knowledge of issues related to semiconductor devices

## SUBJECT OBJECTIVES

C01 To acquaint students with basic electronic systems, properties and applications of electronic circuits
C02 To educate students how to select components of electronic circuits to realize defined engineering task
C03 Preliminary preparation to carry out the researches in fields related to micro- and nanoelectronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Students have systematic and theoretically founded knowledge of basic digital and analogue circuits
PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Students are able to design electronic circuits responsible for measurement and acquisition of sensor signals and depending on the system complexity to conduct, test and characterize the fabricated analog and digital circuits

PEK_U02 The student is able to identify and formulate a specification of simple and practical engineering tasks, characteristic for the studied field of study

**Relating to social competences**

PEK_K01 Students are able to identify priorities needed to realise defined engineering task, connected with design, analysis and measurement of basic parameters of analog and digital circuits

PEK_K02 Students are able to identify which tasks are to realize individually or in group

PEK_K03 The student is able to think and act in an entrepreneurial way

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Project** | | Quantity |
| Pr_01 | Introduction, security training, regulations how to realise the project tasks, introduction to measurement experimental techniques | 2 |
| Pr_02 | Discussion and valuation of block diagram of the designed linear and or analog electronic circuit | 2 |
| Pr_03 | Design of schematic diagram of the constructed electronic circuit - Part I system supply and passive components | 2 |
| Pr_04 | Design of schematic diagram of the constructed electronic circuit - Part II active components | 2 |
| Pr_05 | Theoretical analysis of the designed circuit | 2 |
| Pr_06 | Simulation of the designed circuit | 2 |
| Pr_07 | Discussion and correction of mechanical setup of the designed electronic circuit | 2 |
| Pr_08 | Introduction of list of project | 2 |
| Pr_09 | Discussion on selected project tasks | 2 |
| Pr_10 | Design of dedicated printed circuit board-Part I supply and passive components | 2 |
| Pr_11 | Design of dedicated printed circuit board-Part II supply and active components | 2 |
| Pr_12 | Fabrication of printed circuit board | 2 |
| Pr_13 | Assembly of selected blocks of the designed electronic circuit | 2 |
| Pr_14 | Launching of the fabricated system | 2 |
| Pr_15 | Project presentation and defense | 2 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Multimedia presentation |
| ND_02 Consultations |
| ND_03 Individual work – analysis of indicated project tasks |
| ND_04 Individual work – study of project related issues |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (project) | PEK_U01, PEK_U02, PEK_K01-PEK_K03 | Written reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J. Baranowski, G. Czajkowski, Układy analogowe nieliniowe i impulsowe, WNT, 2004
2. P. Górecki, Wzmacniacze operacyjne, Wydawnictwo BCT, 2004
3. S. Kuta, Układy elektroniczne, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 1995


**Secondary literature**


1. P. Horowitz, W. Hill, Sztuka elektroniki, Wydawnictwo Komunikacji i Łączności, 2009
2. S. Kuta, Elementy i układy elektroniczne cz.2, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 2000


## SUBJECT SUPERVISOR


**Teodor.Gotszalk@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Fundamentals of Electronic Design**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W16 | C01 | Pr_01-Pr_04 | ND_01, ND_02 |
| PEK_W02 | InzA_W02 | C01, C03 | Pr_01-Pr_14 | ND_01-ND_04 |
| PEK_U01 (skills) | K1MTR_MM_U01 | C02 | Pr_01-Pr_14 | ND_02-ND_04 |
| PEK_U02 | InzA_U06 | C01, C03 | Pr_01-Pr_14 | ND_01-ND_04 |
| PEK_K01 (competences) | K1MTR_K03 | C01 | Pr_15 | ND_02, ND_04 |
| PEK_K02 | K1MTR_K04 | C01 | Pr_15 | ND_02, ND_04 |
| PEK_K03 | InzA_K02 | C02, C03 | Pr_01-Pr_14 | ND_01-ND_04 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Projektowanie numeryczne konstrukcji mikroelektronicznych** | |
| Name in English: | **Numerical Design of Microelectronic Structures** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036101** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | 30 | | |
| Number of hours of total student workload (CNPS) | | | 60 | | |
| Form of crediting | | | Z | | |
| Number of ECTS points | | | 2 | | |
| Including number of ECTS points for practical (P) classes | | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge on mathematics and physics
2. Basic knowledge on numerical methods
3. Basic computer skills and programming

## SUBJECT OBJECTIVES

C01 To acquaint students with methods used in numerical prototyping of microelectronic structures such as: optimization, design of experiments, etc., and to acquire professional skills in typical computer programs, eg. finite element method (FlexPDE, Ansys), optimization and design for quality (GNumeric, PSPP)

C02 Skills consolidation of self work as well as in collaboration with other people and with available educational materials

C03 Subject is associated with the research work in the area of numerical prototyping of microelectronic structures

C04 Student knows typical methods, techniques and software tools used in microelectronic structures prototyping

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has a basic, orderly and theoretically founded knowledge on techniques, methods and numerical computer tools in order to design microelectronic structures

PEK_W02 Student knows and understands the basic numerical methods and tools used for numerical modeling of simple engineering tasks in the field of microelectronic structures design

**Relating to skills**

PEK_U01 Student is able to select appropriate methods and tools for computer-aided engineering, as FlexPDE, AutoDesk, Gnumeric, in order to apply numerical design for microelectronic structures

PEK_U02 Student is capable in order to prototype microelectronic structures appropriate tools and methods, both analytical and simulation based

**Relating to social competences**

PEK_K01 Can appropriately define the priorities for implementation of specified tasks either by himself or other

PEK_K02 Can distinguish and understand the technical and non-technical aspects of contemporary engineering activities

## PROGRAMME CONTENT

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Introduction to numerical prototyping | 2 |
| La_02 | Introduction to numerical modelling in FlexPDE | 2 |
| La_03 | Functions and equations – gravitational field | 2 |
| La_04 | Electrostatic field - Poisson's / Laplace's equation | 2 |
| La_05 | Analysis of electrical resistance problem | 2 |
| La_06 | Analysis of stress and strain state | 2 |
| La_07 | Analysis of heat transfer | 2 |
| La_08 | Analysis of thermomechanical stresses and strains | 2 |
| La_09 | Laminar and turbulent flows | 2 |
| La_10 | Electromagnetic field | 2 |
| La_11 | Response surface modelling | 2 |
| La_12 | Optimization | 2 |
| La_13 | Sensitivity analysis | 2 |
| La_14 | Tolerance design | 2 |
| La_15 | Individual project / Assessment | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Laboratory: 5-minutes introduction and 5-minutes introductory tests
ND_02 Consultation
ND_03 Individual work: preparation for laboratories
ND_04 Individual work: laboratory reports

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (lab) | PEK_W01, PEK_W02 | Introductory laboratory tests |
| F2 | PEK_U01, PEK_U02, PEK_K01, PEK_K02 | Laboratory reports |
| P1 (laboratory) = 0,5*(F1 + F2) | | |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Kreyszig E., Advanced Engineering Mathematics, John Wiley and Sons, 2006
2. Thompson E., Introduction to the Finite Element Method, John Wiley and Sons, 2005
3. Zienkiewicz O.C., Taylor R.L., The Finite Element Method: Volumes 1-3, Butterworth-Heinemann, London, 2000


**Secondary literature**


1. Montgomery D., Design and Analysis of Experiments, John Wiley and Sons, 2005
2. Montgomery D., Runger G., Applied Statistics and Probability for Engineers, John Wiley and Sons, 2007
3. William D., Materials Science and Engineering an Introduction, John Wiley and Sons, 2007


## SUBJECT SUPERVISOR


**Artur.Wymyslowski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Numerical Design of Microelectronic Structures**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W22 | C01, C02 | La_01 | ND_01, ND_02 |
| PEK_W02 | InzA_W02 | C01, C02 | La_01 | ND_01, ND_02 |
| PEK_U01 (skills) | K1MTR_ U22 | C03 | La_02-La_12 | ND_03, ND_04 |
| PEK_U02 | InzA_U02 | C04 | La_02-La_12 | ND_03, ND_04 |
| PEK_K01 (competences) | K1MTR_K04, K1MTR_K05 | C03 | La_13-La_15 | ND_03, ND_04 |

| | | | | |
|---|---|---|---|---|
| PEK_K02 | InzA_K02 | C04 | La_13-La_15 | ND_03, ND_04 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Interdyscyplinarny projekt zespołowy** | |
| Name in English: | **Interdisciplinary team project** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036102** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | 30 | |
| Number of hours of total student workload (CNPS) | | | | 90 | |
| Form of crediting | | | | Z | |
| Number of ECTS points | | | | 3 | |
| Including number of ECTS points for practical (P) classes | | | | 3 | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | 2.1 | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completion of any course related to semiconductor devices and electronic circuits
2. Completion of any course related to programming of microcontrollers

## SUBJECT OBJECTIVES

C01 Acquiring skills of design, execution and measurements of analog electronic circuits
C02 Acquiring skills of programming and use of microprocessors and microcontrollers for engineering purposes
C03 Strengthening teamwork skills
C04 Preliminary preparation to carry out the researches in fields related to mechatronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to skills**

PEK_U01 The student is able to design, run, and test electronic analog circuits.
PEK_U02 The student is able to program a microcontroller and to evaluate its functionality
PEK_U03 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | The student is able to interact and work in a group , taking part in a variety of roles |
| PEK_K02 | The student is aware of the importance and understands the non-technical aspects and results of engineering activity, including its impact on the environment, and the associated responsibility for made decisions |

## PROGRAMME CONTENT

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Device project selection and development of the concept of its implementation | 6 |
| Pr_02 | Electronic circuit simulation in LTspice and design in Eagle | 4 |
| Pr_03 | Execution, commissioning and measurements of the electronic circuit | 6 |
| Pr_04 | Microcontroller programming | 4 |
| Pr_05 | Installation and commissioning of the complete mechatronic device | 6 |
| Pr_06 | Report elaboration | 4 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Own work - preparing for classes
ND_02 Report elaboration

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (project) | PEK_U01-PEK_U03, PEK_K01, PEK_K02 | Team work evaluation, final test of the device |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J. Izydorczyk, PSPICE, komputerowa symulacja układów elektronicznych, Helion, 1993
2. Atmel AVR XMEGA AU Manual – technical documentation


**Secondary literature**


1. Disscusion forum LTSpice, http://tech.groups.yahoo.com/group/LTspice/, Internet
2. Doliński J., Mikrokontrolery AVR w praktyce


## SUBJECT SUPERVISOR


**Janusz.Markowski@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Interdisciplinary team project**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_U01 (skills) | K1MTR_U23, K1MTR_U36 | C01, C02 | Pr_01-Pr_06 | ND_01, ND_02 |
| PEK_U02 | K1MTR_U16, K1MTR_U23 | C01, C02 | Pr_01-Pr_06 | ND_01, ND_02 |
| PEK_U03 | InzA_U01 | C01, C02, C04 | Pr_01-Pr_06 | ND_01, ND_02 |
| PEK_K01 (competences) | K1MTR_K03 | C03 | Pr_01-Pr_06 | ND_01, ND_02 |
| PEK_K02 | InzA_K01 | C03, C04 | Pr_01-Pr_06 | ND_01, ND_02 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Metody przetwarzania sygnałów** | |
| Name in English: | **Methods of Signal Processing** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036103** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 30 | | 60 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 2 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of mathematical analysis, linear algebra, probability and statistics

## SUBJECT OBJECTIVES

C01 Learning of basic techniques of signal processing and analysis
C02 Learning of implementation of basic digital signal processing algorithms with script languages (offline processing)
C03 Bringing the need for application of digital techniques of signal processing and analysis to attention of students

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Students will possess knowledge of processing and analysis of deterministic and stochastic signals in time and frequency domain
PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Using scripting languages, student can analyze signals by means of the Fourier transform, design digital, band, FIR and IIR filters

PEK_U02 The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks

**Relating to social competences**

PEK_K01 Student will understand the necessity of using of signal processing techniques in engineering. He can predict results of a processing in a given engineering problem.

PEK_K02 The student is able to think and act in an entrepreneurial way

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Potential applications of signal processing techniques. Basic terms and definitions in time domain | 2 |
| Le_02 | The family of Fourier transforms - representation of signals in frequency domain | 2 |
| Le_03 | Linear systems, superposition principle, properties in time and frequency domain | 2 |
| Le_04 | Test no. 1 | 2 |
| Le_05 | Laplace and Z transform in linear systems | 2 |
| Le_06 | Analog to digital and digital to analog conversion - sampling, quantization, reconstruction and properties of DACs and ADCs | 2 |
| Le_07 | Digital filtering - band filters design | 2 |
| Le_08 | Test no. 2 | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Introductory classes, familiarizing with a development environment | 3 |
| La_02 | Discrete Fourier Transform | 3 |
| La_03 | DFT properties | 3 |
| La_04 | Band finite impulse response filters (FIR) | 3 |
| La_05 | Band infinite impulse response filters (IIR) | 3 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED | |
|---|---|
| ND_01 | Presentation with audiovisual aids |
| ND_02 | Computer classes with scripting environment for engineering calculations |
| ND_03 | Office hours |
| ND_04 | Self-study - given issues preparation |
| ND_05 | Self-study - preparation for classes |
| ND_06 | Self-study and preparation for tests |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Tests no. 1 and 2 |
| P2 = F2 (lab) | PEK_U01, PEK_U02, PEK_K02, PEK_K02 | Assessment of preparations and work at the laboratory |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J. Szabatin, Podstawy teorii sygnałów, WKŁ Warszawa, 2007
2. R.G. Lyons, Wprowadzenie do cyfrowego przetwarzania sygnałów, WKŁ Warszawa, 2007
3. S. W. Smith, Cyfrowe przetwarzanie sygnałów - praktyczny poradnik dla inżynierów i naukowców, BTC Warszawa, 2007


**Secondary literature**


1. A. Papoulis, Probability, Random Variables and Stochastic Processes, MacGraw-Hill, 1991
2. R.N. Bracewell, The Fourier Transform and Its Applications, MacGraw-Hill, 2000
3. V. K. Madisetti, D.B. Williams, Digital Signal Processing Handbook, Chapman&Hall/CRC, 1999


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Methods of Signal Processing**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W21 | C01 | Le_01-Le_08 | ND_01, ND_03, ND_04, ND_06 |
| PEK_W02 | InzA_W02 | C01 | Le_01-Le_08 | ND_01, ND_03, ND_04, ND_06 |
| PEK_U01 (skills) | K1MTR_U01 | C02 | La_01-La_05 | ND_02, ND_05 |
| PEK_U02 | InzA_U02 | C02 | La_01-La_05 | ND_02, ND_05 |
| PEK_K01 (competences) | K1MTR_K06 | C03 | Le_01-Le_08, La_01-La_05 | ND_03, ND_04, ND_06 |
| PEK_K03 | InzA_K02 | C01-C03, C06 | Le_01-Le_08, La_01-La_05 | ND_03, ND_04, ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Mikrosystemy w medycynie** | |
| Name in English: | **Microsystems in Medicine** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036104** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 30 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

## SUBJECT OBJECTIVES

C01 Familiarizing students with the design and operation of selected microsystems and possibilities of their application in biology and medicine, as well as devices and apparatus microsystems for specific tasks
C02 Learning how to work with the selected microsystems for specific tasks in biology/medicine
C03 Fusing ability to work independently and in a team
C04 Preliminary preparation to conduct research on the use of microsystems in biology and medicine

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has a general knowledge of the structure and operation of the selected microsystem devices, and possibilities of their application in biology and medicine, he knows some devices and microsystem instruments for specific tasks in biology / medicine

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Student can work with selected microsystem devices and instruments designed for specific tasks in biology / medicine |
| PEK_U02 | Student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions |
| PEK_U03 | Student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks |
| PEK_U04 | The student is able to see system and non-technical aspects of engineering tasks during their formulating and solving |

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | Student is able to work independently and in laboratory group by adopting different roles |

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Microtechnologies in molecular genetics | 2 |
| Le_02 | Cardiac assist devices, artificial heart | 2 |
| Le_03 | Artificial sense organs: electronic hearing, bionic eye | 4 |
| Le_04 | Invasive and non-invasive microsystems for measuring blood pressure | 2 |
| Le_05 | Tonometer, sensors and microsystems for medical diagnosis | 1 |
| Le_06 | Lab-on-a-chips and biochips | 2 |
| Le_07 | Test | 2 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Flow and mixing of the liquids in the microchannels | 3 |
| La_02 | Dosing of micro- and nanovolumes with conductivity detection | 3 |
| La_03 | Droplet microfluidic system | 3 |
| La_04 | Microcytometer to study biological cells | 3 |
| La_05 | Microsystems for measuring blood pressure | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

| | |
|---|---|
| ND_01 | Traditional lecture with the use of slides, and discussion |
| ND_02 | Laboratory: short tests beginning laboratory |
| ND_03 | Consultations |
| ND_04 | Self study - preparation for laboratory exercises |
| ND_05 | Self study - independent studies and prepare for test |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01 | Test |
| P2 = F2 (lab) | PEK_U01-PEK_U04, PEK_K01 | Short tests at the beginning of the laboratory classes, laboratory reports and participation in discussions |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Manz, H. Becker, Microsystem technology in chemistry and life sciences, Springer-Verlag, 1999
2. James D. Watson & Francis Crick, Molecular structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid, Nature, 1953
3. M. Sładek, Pediatria Współczesna, Gastroenterologia, Hepatologia i Ż ywienie Dziecka , 2008
4. Paul Berg, Maxine Singer, Język genów. Poznawanie zasad dziedziczenia, Prószyński i S-ka, 1997


**Secondary literature**


1. Journals: Sensors and Actuators, Journal of Micromechanics and Microengineering
2. A. Górecka-Drzazga, lecture notes


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Microsystems in Medicine**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W15 | C01 | Wy_01-Wy_07 | ND_01, ND_03, ND_05 |
| PEK_U01 (skills) | K1MTR_U15 | C02, C03 | La_01-La_05 | ND_02, ND_04 |
| PEK_U02 | InzA_U01 | C02-C04 | La_01-La_05 | ND_02, ND_04 |
| PEK_U03 | InzA_U02 | C02-C04 | La_01-La_05 | ND_02, ND_04 |
| PEK_U04 | InzA_U03 | C02-C04 | La_01-La_05 | ND_02, ND_04 |
| PEK_K01 (competences) | K1MTR_K03 | C03 | La_01-La_05 | ND_04 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Mikrosystemy w motoryzacji** | |
| Name in English: | **Automotive Microsystems** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036105** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 30 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It is recommended to listen courses in semiconductor devices, electronics systems and metrology

## SUBJECT OBJECTIVES

C01 To familiarize students with the basic microsystems (sensor systems), used in automotive engineering
C02 Introduction to the structure, working conditions and measurement of the main parameters used in the above-mentioned sensor systems
C03 Strengthening teamwork skills
C04 Preliminary preparation to carry out the researches in fields related to mechatronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has the basic knowledge of the operation, construction, properties and characteristics of sensor systems and sensors (including intelligent and microsensors) used in vehicles
PEK_W02 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

**Relating to skills**

PEK_U01 Able to select and use the appropriate sensors to measure various physical quantities, investigate the fundamental characteristics of the sensors and use them to control systems and control vehicles

PEK_U02 The student is able to assess the usefulness of routine methods and tools used for solving of a simple and practical engineering task, characteristic for the studied field of study and to select and apply the appropriate method and tools

**Relating to social competences**

PEK_K01 Able to interact and work in a group (a group of laboratory), taking part in a variety of roles

PEK_K02 The student is aware of the importance and understands the non-technical aspects and results of engineering activity, including its impact on the environment, and the associated responsibility for made decisions

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Sensor systems for automotive - historical overview | 2 |
| Le_02 | Fuel supply systems - tasks, principles of operation, sensors | 2 |
| Le_03 | Ignition systems - tasks, principles of operation, sensors | 2 |
| Le_04 | Combustion control systems of air-fuel mixture | 2 |
| Le_05 | Microsystems for active and passive safety | 3 |
| Le_06 | Microsystems for navigation and driver information | 2 |
| Le_07 | Test | 2 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Lambda sensor for stoichiometric mixture | 3 |
| La_02 | Sensors: throttle position, absolute pressure (MAP), oil pressure, fuel level | 3 |
| La_03 | Sensors for the position and speed of the crankshaft | 3 |
| La_04 | Accelerometers | 3 |
| La_05 | Additional term | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Traditional lecture with the use of transparencies and slides

ND_02 Self study – preparation for laboratory class

ND_03 Report preparation

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Final test |
| P2 = F2 (lab) | PEK_U01, PEK_U02, PEK_K01 | Partial tests and quizzes, lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Herner A., Elektronika w samochodzie, WKŁ Warszawa, 2001
2. Marek J., Sensors for Automotive Technology, Wiley-VCH, Darmstadt, 2003
3. Nwagboso Ch., Automotive Sensory Systems, Chapman&Hall, London, 1993


**Secondary literature**


1. Technical catalogue, Czujniki w pojazdach samochodowych, f-ma Bosch, 2002
2. Technical catalogue, Mikroelektronika w pojazdach, f-ma Bosch, 2002
3. Technical catalogue, Układy bezpieczeństwa i komfortu jazdy, f-ma Bosch, 2002


## SUBJECT SUPERVISOR


**Janusz.Markowski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Automotive Microsystems**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K!MTR_W15 | C01, C02 | Le_01-Le_06 | ND_01 |
| PEK_W02 | InzA_W02 | C01, C02, C04 | Le_01-Le_06 | ND_01 |
| PEK_U01 (skills) | K1MTR_U15 | C01, C02 | La_01-La_05 | ND_02, ND_03 |
| PEK_U02 | InzA_U07 | C01, C02, C04 | La_01-La_05 | ND_02, ND_03 |
| PEK_K01 (competences) | K1MTR_K03 | C03 | La_01-La_05 | ND_03 |
| PEK_K02 | InzA_K01 | C03, C04 | La_01-La_05 | ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Fotonika** | |
| Name in English: | **Photonics** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036201** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 30 | | |
| Number of hours of total student workload (CNPS) | 30 | | 60 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 2 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of Physics (including geometric optics) and fundamentals of the physics of solid-state
2. Successful completion of the course: Fundamentals of electrical engineering, Electronics Elements and Devices, Applications of the optoelectronics

## SUBJECT OBJECTIVES

C01 To familiarize students with the basic optical phenomena in semiconductors, including the transmission of light in semiconductors and optical fiber, structure, parameters and conditions of optoelectronic components supply
C02 To familiarize with the semiconductor detectors and sources of light, their design and working conditions
C03 Persisting the ability to work in a group
C04 Pre-treatment of research that uses fiber optic, light emitters and detectors

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has ordered and supported in theory, knowledge of photonics, including the knowledge necessary to understand the physical basis of optical components and systems for application areas as well as student knows telecommunications optical track in particular in the automotive, energy and microsystems

PEK_W02 The student has a basic knowledge of the life cycle of the technical equipment, facilities, and systems

**Relating to skills**

PEK_U01 Student can use known methods and mathematical models as well computer simulations for the analysis and performance evaluation of optoelectronic components and simple optical fiber systems, student can correctly use the selected methods and facilities to enable the measurement of the basic parameters of elements and integrated optoelectronic. Student can develop documentation for implementation of engineering tasks and prepare a text containing an overview of the results of the implementation of this task

PEK_U02 The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions

PEK_U03 The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks

**Relating to social competences**

PEK_K01 Able to interact and work in a group of laboratory, taking in the different roles

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction. Optical phenomena in semiconductor | 1 |
| Le_02 | Color theory I | 2 |
| Le_03 | Materials for optoelectronics | 1 |
| Le_04 | Techniques for producing optoelectronic structures | 2 |
| Le_05 | Optoelectronic lighting devices | 2 |
| Le_06 | Displays | 2 |
| Le_07 | Optoelectronics in technology | 4 |
| Le_08 | Test | 1 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Introduction | 3 |
| La_02 | Color theory I | 3 |
| La_03 | Color theory II | 3 |
| La_04 | Fiber Optics | 3 |
| La_05 | Semiconductor light source characteristics | 3 |
| La_06 | Light radiation detectors | 3 |
| La_07 | Optocouplers | 3 |
| La_08 | Solar cells I | 3 |
| La_09 | Solar cells II | 3 |
| La_10 | Make-up lab meeting | 3 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED | |
|---|---|
| ND_01 | Traditional lecture with presentations and discussion |
| ND_02 | Laboratory: a short, 10-minute test at the beginning of the exercises |
| ND_03 | Self work – preparing for the lab exercises |
| ND_04 | Self work – independent studies and preparation for the test |
| ND_05 | Tutorials |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01 | Discussions and final test |
| P2 = F2 (lab) | PEK_U01-PEK_U03, PEK_K01 | Test at the beginning of the exercises, laboratory reports, evaluation class implementation exercises |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. B. Mroziewicz, M. Bugajski, Wł. Nakwaski, Lasery półprzewodnikowe, WNT, 1985
2. B. Ziętek, Optoelektronika, Wyd. UMK, 2004
3. J. E. Midwinder, Y. L. Guo, Optoelektronika i technika światłowodowa, WKŁ, 1995
4. J. I. Pankove, Zjawiska optyczne w półprzewodnikach, WNT, 1984
5. J. Piotrowski, A. Rogalski, Półprzewodnikowe detektory podczerwieni, WNT, 1985
6. Z. Bielecki, A. Rogalski, Detekcja sygnałów optycznych, WNT, 2001


**Secondary literature**


1. A. Smoliński, Optoelektronika światłowodowa, WKŁ, 1985
2. G. Einarsson, Podstawy telekomunikacji światłowodowej, WKŁ, 1983
3. J. Godlewski, Generacja i detekcja promieniowania optycznego, PWN, 1974
4. J. Hennel, Podstawy elektroniki półprzewodnikowej, WNT, 1986
5. J. Siuzdak, Wstęp do współczesnej telekomunikacji światłowodowej, WKŁ, 1997
6. K. Booth, S. Hill, Optoelektronika, WKŁ, 2001
7. M. Marciniak, Łączność światłowodowa, WKŁ, 1998
8. R. Bacewicz, Optyka ciała stałego, Oficyna Wydawnicza Politechniki Warszawskiej, 1995


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Photonics**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_MM_W02 | C01, C02, C04 | Wy_01-Wy_08 | ND_01-ND_05 |
| PEK_W02 | InzA_W01 | C01, C02, C04 | Wy_01-Wy_08 | ND_01-ND_05 |
| PEK_U01 (skills) | K1MTR_MM_U02 | C01-C04 | La_01-La_10 | ND_02, ND_03, ND_05 |
| PEK_U02 | InzA_U01 | C04 | La_01-La_10 | ND_02, ND_03, ND_05 |
| PEK_U03 | InzA_U02 | C04 | La_01-La_10 | ND_02, ND_03, ND_05 |
| PEK_K01 (competences) | K1MTR_K03 | C03, C04 | La_01-La_10 | ND_01-ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Mikro- i nanoelektronika** | |
| Name in English: | **Micro- Nano- Electronics** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD036202** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | | | |
| Number of hours of total student workload (CNPS) | 60 | | | | |
| Form of crediting | Z | | | | |
| Number of ECTS points | 2 | | | | |
| Including number of ECTS points for practical (P) classes | 0 | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge in physics
2. Basic knowledge in chemistry
3. Basic knowledge in mathematics

## SUBJECT OBJECTIVES

C01 Acquaint students with fabrication techniques modern micro- and nano-electronic circuits and elements
C02 Acquaint students with the properties of elements fabricated using micro- and nanoelectronic techniques
C03 Acquaint students with state of the art and development trends of micro- and nanoelectronic technologies
C04 Preliminary preparation to carry out the researches in fields related to mikro- and nanoelectronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has ordered and theoretically grounded knowledge concerning materials, technology, structure as well as specific electrical properties and stability of classical and modern components and passive elements of electronic circuits in mechatronic systems

PEK_W02 Student knows and understands technological processes associated with the fabrication of micro- and nano-devices used in mechatronics. Is familiar with the current state and developing trends in micro- and nano-electronic technologies

PEK_W03 The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study

PEK_W04 The student knows the typical engineering technologies in the area of studied field of study

**Relating to skills**

PEK_U01 Student is able to design a technological process for the fabrication of an basic electronic element device

PEK_U02 The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks

PEK_U03 The student is able to identify and formulate a specification of simple and practical engineering tasks, characteristic for the studied field of study

**Relating to social competences**

PEK_K01 Student understands the need and knows the possibilities of lifetime learning process (2-nd and 3-rd level studies, post- graduate studies, courses) in raising the professional, personal and social competences

PEK_K02 Student correctly recognizes and settles dilemmas associated with performing professional activities; is conscious of the social role of technical university graduates. Understands the need to formulate and share in society the information concerning technical achievements and other aspects of engineering activity; is able to share such information and opinion in a clear way, justifying various points of view

PEK_K03 The student is aware of the importance and understands the non-technical aspects and results of engineering activity, including its impact on the environment, and the associated responsibility for made decisions

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Introduction, technology roadmap of modern semiconductor technology, overview of basic processes of micro- and nanotechnology | 2 |
| Le_02 | Advanced micro- and nano-lithographic techniques (photolithography, electron-beam lithography, X-ray lithography, ion-beam lithography, nanoimprint, interference lithography, scanning probe lithography) | 2 |
| Le_03 | Doping of layers: diffusion and ion implantation, annealing (RTA) | 2 |
| Le_04 | Wafer cleaning, dry and wet etching of layers and MEMS and NEMS | 2 |
| Le_05 | Metallic contact and interconnects fabrication (silicides, AL, Cu), thin layers materials for diffusion barriers and etch stop layers | 2 |
| Le_06 | Properties of individual nanoparticles, carbon nanotubes, carbon nanotube transistor | 2 |
| Le_07 | Fundamentals of Thick and Thin Film technology | 2 |
| Le_08 | Wafer fabrication (doped silicon, strained silicon, SiGe, SOI and SON technologies) silicon epitaxy | 2 |
| Le_09 | Thermal oxidation of silicon, dielectric layers and polysilicon fabrication by LPCVD, high-k and low-k dielectric, ULK porous materials | 2 |
| Le_10 | Design rules of Thick Film elements | 2 |
| Le_11 | High temperature Thick Film - materials, processes, properties, applications | 2 |

| | | |
|---|---|---|
| Le_12 | Polymer Thick Film - materials, processes, properties, applications | 2 |
| Le_13 | LTCC (Low Temperature Cofired Ceramics) technology - materials, processes, properties | 2 |
| Le_14 | Application of LTCC in microelectronics and microsystems | 2 |
| Le_15 | Future trends of micro- nanotechnologies | 2 |
| | **TOTAL** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Lecture<br>ND_02 Multimedia presentation<br>ND_03 Consultations |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W04 | Partial test at the end of the lecture no. 8 and 15 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Dziedzic, Grubowarstwowe rezystywne mikrokompozyty polimerowo-węglowe, Oficyna Wydawnicza Politechniki Wrocławskiej, 2001
2. L. Golonka, Zastosowanie ceramiki LTCC w mikroelektronice, Oficyna Wydawnicza Politechniki Wrocławskiej, 2001
3. S. Dimitrijev, Understanding Semiconductor Devices, OUP, USA, 2000
4. T. Norio, Nanotechnology: Integrated Processing Systems for Ultra-Precision and Ultra-Fine Products, OUP, England, 2000


## SUBJECT SUPERVISOR


**Regina.Paszkiewicz@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Micro- Nano- Electronics**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_MM_W01 | C01, C02 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_W02 | K1MTR_MM_W03 | C01, C03 | Le_01-Le_15 | ND_01-ND_03 |

| | | | | |
|---|---|---|---|---|
| PEK_W03 | InzA_W02 | C01, C03, C04 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_W04 | InzA_W05 | C01, C04 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_U01 (skills) | K1MTR_U18 | C01-C03 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_U02 | InzA_U02 | C01, C04 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_U03 | InzA_U06 | C04 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_K01 (competences) | K1MTR_K01 | C01-C03 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_K02 | K1MTR_K03 | C01-C03 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_K03 | InzA_K01 | C04 | Le_01-Le_15 | ND_01-ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Praktyka zawodowa** | |
| Name in English: | **Student's practice** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD030002** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | | |
| Number of hours of total student workload (CNPS) | | | | | |
| Form of crediting | | | | | |
| Number of ECTS points | | | | | |
| Including number of ECTS points for practical (P) classes | | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

## SUBJECT OBJECTIVES

C01 Presentation of the using knowledge which was learned
C02 Presentation of working company

## SUBJECT EDUCATIONAL EFFECTS

**Relating to skills**

PEK_U01 Have got knowledge how choose materials, parts and construction of devices for technical demands and utilization conditions
PEK_U02 Have got knowledge how to use safety instructions

**Relating to social competences**

PEK_K01 Is working independent and with team.
PEK_K02 The student is able to think and act in an entrepreneurial way

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 | PEK_U1, PEK_U02, PEK_K01, PEK_K02 | Opinion of the practice administrator |

| **SUBJECT SUPERVISOR** |
|---|
| **Damian.Radziewicz@pwr.edu.pl** |

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Student's practice**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_U01 (skills) | K1MTR_U04 | C01, C02 | | |
| PEK_U02 | K1MTR_U29 | C01, C02 | | |
| PEK_K01 (competences) | K1MTR_K02 | C01, C02 | | |
| PEK_K02 | K1MTR_K03 | C01, C02 | | |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Seminarium dyplomowe** | |
| Name in English: | **Diploma Seminar** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD037001** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | | 30 |
| Number of hours of total student workload (CNPS) | | | | | 60 |
| Form of crediting | | | | | Z |
| Number of ECTS points | | | | | 2 |
| Including number of ECTS points for practical (P) classes | | | | | 2 |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | | 1.4 |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. ECTS credit no greater than it is due to the resolution of the Council of the Faculty

## SUBJECT OBJECTIVES

C01 Persisting the ability to work in a group
C02 Preparing to conduct research in the field of mechatronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 The student has an ordered and build on the theory, knowledge of required study Mechatronics

**Relating to skills**

PEK_U01 Student can present their own skills with a range of knowledge, skills and social competences typical for the direction of Mechatronics

**Relating to social competences**

PEK_K01 Student is able to think and act in a way that is creative and enterprising, he can interact and work in a group

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Se_01 | Introduction to the course | 1 |
| Se_02 | Information about diploma work and diploma exam - requirements | 1 |
| Se_03 | Overview and scope of the topics diploma works foreseen and the rules for creating the correct technical and scientific texts | 4 |
| Se_04 | Multimedia presentations, CV (expanded version), discussion | 4 |
| Se_05 | Discussion of the issues concerning diploma exam, comments | 8 |
| Se_06 | Multimedia presentations of the diploma works, discussion | 6 |
| Se_07 | Presentation and preparations for the diploma exam | 4 |
| Se_08 | Summary of coursework and grading | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Presentation of selected issues relating to the thesis and discussion
ND_02 Preparing a multimedia presentation on the task issues - self work
ND_03 Independent study and preparation for diploma thesis final exam - self work
ND_04 Tutorials

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (sem) | PEK_W01 | The nature and quality of the presentation of the given topics |
| F2 | PEK_U01, PEK_K01 | The ability to discuss the issues raised in the discussion, activity in the course classes |
| P1 (seminar) = F1 + F2 | | |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. Rules of studies at Wroclaw University of Technology
2. Publications from the scope of the thesis carried out
3. Lecture materials and other carried out courses

## SUBJECT SUPERVISOR

**Ryszard.Korbutowicz@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Diploma Seminar**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01-K1MTR_W28 K1MTR_MM_W01-K1MTR_MM_W06 | C01, C02 | Se_03-Se_07 | ND_01, ND_02, ND_04 |
| PEK_U01 (skills) | K1MTR_U01-K1MTR_U33, K1MTR_MM_U01-K1MTR_MM_U06 | C01, C02 | Se_03-Se_07 | ND_01, ND_02, ND_04 |
| PEK_K01 (competences) | K1MTR_K03 | C01 | Se_02-Se_07 | ND_01-ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Praca dyplomowa** | |
| Name in English: | **Diploma Thesis** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD037002** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | | |
| Number of hours of total student workload (CNPS) | | | | | |
| Form of crediting | | | | | |
| Number of ECTS points | | | | | |
| Including number of ECTS points for practical (P) classes | | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. ECTS deficit no greater than it is due to the resolution of the Faculty Council

## SUBJECT OBJECTIVES

C01 Conduct by the student thesis on the basis of the acquired while studying structured, underpinned by the theory of general and detailed knowledge with a range of science and technical areas relevant to the direction of Mechatronics
C02 Writing by a student
C03 Persisting the ability to work independently and in a team
C04 Preparing to conduct research in the field of mechatronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Made the thesis based on gained knowledge during his studies for the direction of Mechatronics

**Relating to skills**

PEK_U01 Student can create technical texts ("thesis") and multimedia presentations from the scope of the field of the Mechatronics

**Relating to social competences**

PEK_K01 Student can work independently and interact in a group, taking different roles

| TEACHING TOOLS USED |
|---|
| ND_01 Presentation of selected issues relating to the thesis and discussion |
| ND_02 Own work - study of literature from the scope of the topic of the thesis and research work |
| ND_03 Own work - writing technical and scientific text controlled by the promoter |
| ND_04 Consultation |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 | PEK_W01, PEK_U01, PEK_K01 | Tests, discussions |

| PRIMARY AND SECONDARY LITERATURE |
|---|
| **Primary literature** |
| 1. Different authors, literature agreed with the promoter |

| SUBJECT SUPERVISOR |
|---|
| **Ryszard.Korbutowicz@pwr.edu.pl** |

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Diploma Thesis**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01-K1MTR_W28 K1MTR_MM_W01-K1MTR_MM_W06 | C01, C04 | | ND_01, ND_02, ND_04 |
| PEK_U01 (skills) | K1MTR_U01-K1MTR_U33, K1MTR_MM_U01-K1MTR_MM_U06 | C02, C04 | | ND_01, ND_02, ND_04 |
| PEK_K01 (competences) | K1MTR_K03 | C03 | | ND_01-ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Mikro- i nanoelektronika** |
| Name in English: | **Micro- Nano- Electronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **I level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD037201** |
| Group of courses: | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | 15 | | |
| Number of hours of total student workload (CNPS) | | | 60 | | |
| Form of crediting | | | Z | | |
| Number of ECTS points | | | 2 | | |
| Including number of ECTS points for practical (P) classes | | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | 1,4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge in physics
2. Basic knowledge in chemistry
3. Basic knowledge in mathematics

## SUBJECT OBJECTIVES

C01 Acquaint students with fabrication techniques of modern micro- and nano-electronic circuits and elements
C02 Acquaint students with the properties of elements fabricated using micro- and nanoelectronic techniques
C03 Acquaint students with state of the art and development trends of micro- and nanoelectronic technologies
C04 Preliminary preparation to carry out the researches in fields related to mikro- and nanoelectronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

| | |
|---|---|
| PEK_W01 | Student knows and understands technological processes associated with the fabrication of micro- and nano- devices used in mechatronics. Is familiar with the current state and developing trends in micro- and nano electronic technologies |
| PEK_W02 | The student knows the basic methods, techniques, tools and materials used in solving simple engineering problems from the studied field of study |
| PEK_W03 | The student knows the typical engineering technologies in the area of studied field of study |

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Student is able to design a technological process for the fabrication of an electronic device, taking into account assumed application and economic criteria, with the use of proper methods, techniques, tools and materials |
| PEK_U02 | Student is able to obtain thin-films with desired electrical properties and assess the influence of technological parameters on the values of these properties |
| PEK_U03 | The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks |
| PEK_U04 | The student is able to identify and formulate a specification of simple and practical engineering tasks, characteristic for the studied field of study |

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | Student is able to co-operate and work in a team, taking up different roles |
| PEK_K02 | Student is able to define priorities in realization of a task established by self or someone else |
| PEK_K03 | The student is aware of the importance and understands the non-technical aspects and results of engineering activity, including its impact on the environment, and the associated responsibility for made decisions |

## PROGRAMME CONTENT

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Clean room - operation, construction, maintenance, basic technologies | 3 |
| La_02 | Bonding and characterisation of fabricated semiconductor device | 3 |
| La_03 | Selected thick films technologies | 3 |
| La_04 | Fabrication of multilayered LTCC systems | 3 |
| La_05 | Modern techniques of pattern fabricationcreation | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Consultation

ND_02 Laboratory experiment

ND_03 Unassisted preparation of the students to the laboratory

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (lab) | PEK_U01-PEK_U04 | Short test before the laboratory |
| F2 | PEK_U01, PEK_K01-PEK_K03 | Evaluation of the prepared report |
| P1 (laboratory) = 0,5*(F1 + F2) | | |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Dziedzic, Grubowarstwowe rezystywne mikrokompozyty polimerowo-węglowe, Oficyna Wydawnicza Politechniki Wrocławskiej, 2001
2. L. Golonka, Zastosowanie ceramiki LTCC w mikroelektronice, Oficyna Wydawnicza Politechniki Wrocławskiej, 2001
3. Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, Third Edition, Boca Raton, USA, 2011


## SUBJECT SUPERVISOR


**Regina.Paszkiewicz@pwr.wroc.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Micro- Nano- Electronic**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W42 | C01-C03 | La_01-La_05 | ND_01-ND_03 |
| PEK_W02 | InzA_W02 | C01-C04 | La_01-La_05 | ND_01-ND_03 |
| PEK_W03 | InzA_W05 | C01-C04 | La_01-La_05 | ND_01-ND_03 |
| PEK_U01 (skills) | K1MTR_U18 | C01-C03 | La_01-La_05 | ND_01-ND_03 |
| PEK_U02 | K1MTR_U18 | C01-C03 | La_01-La_05 | ND_01-ND_03 |
| PEK_U03 | InzA_U02 | C01-C04 | La_01-La_05 | ND_01-ND_03 |
| PEK_U04 | InzA_U06 | C01-C04 | La_01-La_05 | ND_01-ND_03 |
| PEK_K01 (competences) | K1MTR_K03, K1MTR_K04 | C01-C03 | La_01-La_05 | ND_01-ND_03 |
| PEK_K02 | K1MTR_K03, K1MTR_K04 | C01-C03 | La_01-La_05 | ND_01-ND_03 |
| PEK_K03 | InzA_K01 | C01-C04 | La_01-La_05 | ND_01-ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Metody numeryczne** | |
| Name in English: | **Numerical Methods** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD037202** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | 15 | |
| Number of hours of total student workload (CNPS) | | | | 60 | |
| Form of crediting | | | | Z | |
| Number of ECTS points | | | | 2 | |
| Including number of ECTS points for practical (P) classes | | | | 2 | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | 1.4 | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge on basics of mathematics and physics
2. Knowledge on basics of computer programming
3. Basic computer skills

## SUBJECT OBJECTIVES

C01 To familiarize students with the basic numerical algorithms and methods used in engineering including restrictions, disadvantages and advantages of numerical techniques. In addition, gaining skills in using the Python scripting language
C02 Consolidation ability to work independently and in collaboration with the available educational materials
C03 The course is connected with the research activities in the area of numerical prototyping
C04 Application of numerical methods for solving simple engineering problems

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has a basic, orderly and theoretically founded knowledge on the numerical methods used in engineering. The scope of knowledge includes an analysis of errors, methods, numerical differentiation and integration, solving systems of linear and nonlinear equations, interpolation and approximation methods, algorithms, single- and multicriteria optimization and design of experiments methods

PEK_W02 Knows and understands the basic numerical methods and tools for solving typical engineering problems

**Relating to skills**

PEK_U01 Is able to select and apply in a practical way right tools, programs, methods and numerical algorithms to solve typical problems in the field of numerical prototyping in engineering. Additionally, is able to interpret the results, and use the appropriate methods for validation of measurement results

PEK_U02 Student is able to plan experiments and numerical simulations including interpretation of the acquired results and draw conclusions

**Relating to social competences**

PEK_K01 Can appropriately define the priorities for implementation of specified tasks

PEK_K02 Can properly distinguished and understand technical and none technical aspects of a contemporary engineering

## PROGRAMME CONTENT

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Introduction to numerical methods and engineering computing with Python programming language | 2 |
| Pr_02 | Numerical computing errors - sources and types | 2 |
| Pr_03 | Numerical differentiation and integration | 2 |
| Pr_04 | Linear and nonliner equations and set of equations | 2 |
| Pr_05 | Interpolation, approximation and extrapolation | 2 |
| Pr_06 | Optimization and design of experiments | 2 |
| Pr_07 | Partial differential equations | 2 |
| Pr_08 | Individual project / Assessment | 1 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Laboratory: 5-minutes introduction and 5-minutes introductory tests
ND_02 Consultation
ND_03 Individual work: preparation for laboratories
ND_04 Individual work: laboratory reports

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (project) | PEK_W01, PEK_W02, PEK_U01, PEK_U02, PEK_K01, PEK_K02 | Short tests and lab reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Feynmann R.P., Feynmana wykłady z fizyki, tom I i II, PWN, 1968
2. Janowski WE., Matematyka, tom I i II, PWN,1968
3. Volk W., Statystyka stosowana dla inżynierów, WNT, 1973


**Secondary literature**


1. Kreyszig E., Advanced Engineering Mathematics, John Wiley and Sons, 2006
2. Montgomery D., Design and Analysis of Experiments, John Wiley and Sons, 2005
3. Pang T., An Introduction to Computational Physics, Cambridge University Press, 2006


## SUBJECT SUPERVISOR


**Artur.Wymyslowski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Numerical Methods**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_MM_W04 | C01, C02 | Pr_01 | ND_01, ND_02 |
| PEK_W02 | InzA_W02 | C01, C02 | Pr_01 | ND_01, ND_02 |
| PEK_U01 (skills) | K1MTR_MM_U04 | C03, C04 | Pr_02-Pr_07 | ND_03, ND_04 |
| PEK_U02 | InzA_U01 | C03, C04 | Pr_02-Pr_07 | ND_03, ND_04 |
| PEK_K01 (competences) | K1MTR_K01, K1MTR_K04 | C03, C04 | Pr_08 | ND_03, ND_04 |
| PEK_K02 | InzA_K01 | C03, C04 | Pr_08 | ND_03, ND_04 |

Załącznik nr 4 do ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Montaż zespołów elektronicznych i fotonicznych** |
| Name in English: | **Packaging of Electronic and Photonics** |
| Main field of study: | **Mechatronics** |
| Level and form of studies: | **I level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD037203** |
| Group of courses: | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 60 | | 30 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 2 | | 1 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 1 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 0.7 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The knowledge gained in this course: Electronic Components

## SUBJECT OBJECTIVES

C01 Mastery of theoretical knowledge specified in Wy_01-Wy_09
C02 Gaining practical skills through laboratory tasks L_01-L_06
C03 Able to work in a group of laboratory, taking in the different roles

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Structured and theoretical knowledge in the field of electronic packaging allows independent design of electronic systems based on the available electronic components and packaging techniques
PEK_W02 The knowledge of electronic packaging allows independent performance electronic systems

**Relating to skills**

PEK_U01 Ability for proper selection and applying the techniques of electronic packaging according to the design requirements and reliability made devices

**Relating to social competences**

PEK_K01 Ability for setting priorities in the use of adequate techniques for of electronic packaging

PEK_K02 Ability for cooperation and work in a group of laboratory, taking in the different roles

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | The scope of the lecture; packaging levels | 1 |
| Le_02 | Elements and architecture of connections | 2 |
| Le_03 | Substrates. Printed circuit boards | 2 |
| Le_04 | Wire bonding | 1 |
| Le_05 | Flip chip bonding | 2 |
| Le_06 | Soldering technology | 2 |
| Le_07 | Adhesives for packaging; materials and technology | 2 |
| Le_08 | Connections and connectors | 1 |
| Le_09 | Environmental exposure, heat dissipation problems | 1 |
| Le_10 | Completion of the course | 1 |
| | **SUM** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Introduction to laboratory classes, health and safety regulations | 2 |
| La_02 | Surface mount technology | 3 |
| La_03 | The use of electrically conductive adhesives for electronic packaging | 3 |
| La_04 | The study of mechanical strength of solder and adhesive joints | 3 |
| La_05 | The study of ionic contamination introduced in the packaging processes | 3 |
| La_06 | Completion of the course | 1 |
| | **SUM** | 15 |

## TEACHING TOOLS USED

ND_01 Lecture with multimedia presentations and discussion

ND_02 Laboratory: a brief 10-minute introduction to the course and knowledge test

ND_03 Consultation

ND_04 Self-study and preparation for test

ND_05 Self-study and preparation for laboratory classes

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture | PEK_W01 | Final test |
| P2 = F 2 (lab) | PEK_W02, PEK_U01, PEK_K01, PEK_K02 | Summary results of the work carried out within the framework of the laboratory |

## PRIMARY AND SECONDARY LITERATURE

**PRIMARY LITERATURE**

1. J. Felba, Montaż w elektronice, Oficyna Wydawnicza Politechniki Wrocławskiej, 2010

**SECONDARY LITERATURE**

1. K. Bukat, H. Hackiewicz, Lutowanie bezołowiowe, Wydawnictwo BTC, Warszawa, 2007
2. R. Kisiel, Podstawy technologii dla elektroników, Wydawnictwo BTC Korporacja, 2012

## SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Packaging of Electronic and Photonics Systems**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W18 | C01 | Le_01-Le_09 | ND_01, ND_03, ND_04 |
| PEK_W02 | K1MTR_W18 | C02 | La_01-La_05 | ND_02, ND_03, ND_05 |
| PEK_U01 (skills) | K1MTR_U18 | C01, C02 | Le_01-Le_09, La_01-La_05 | ND_01-ND_05 |
| PEK_K01 (competences) | K1MTR_K04 | C01, C02 | Le_01-Le_09, La_01-La_05 | ND_01-ND_05 |
| PEK_K02 | K1MTR_K03 | C03 | La_01-La_05 | ND_02, ND_03, ND_05 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Urządzenia peryferyjne systemów komputerowych** | |
| Name in English: | **Peripheral Devices in Computer Systems** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Optional** | **/ Faculty** |
| Subject code: | **MCD037204** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | | 15 | |
| Number of hours of total student workload (CNPS) | 60 | | | 30 | |
| Form of crediting | Z | | | Z | |
| Number of ECTS points | 2 | | | 1 | |
| Including number of ECTS points for practical (P) classes | 0 | | | 1 | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | | 0.7 | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic PC computer skills
2. Basic knowledge in the field of information technology and information transmission

## SUBJECT OBJECTIVES

C01 Mastering the intermediate level of knowledge of the principles of operation and maintenance of peripheral devices used in computer systems

C02 Knowledge and skill in standard modes of communication with PC peripherals, principles of data transmission, processing and collection

C03 Preparing students to carry out research in the field of digital electronics, mechatronics, electronic and optoelectronic sensors

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Theoretical and practical knowledge of a wide range of peripheral devices used in computer systems

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Ability to use and practical application of peripherals, including advanced acquisition and data systems |
| PEK_U02 | The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the acquired results and draw conclusions |
| PEK_U03 | The student is able to use the analytical, simulation and experimental methods for formulating and solving engineering tasks |

**Relating to social competences**

| | |
|---|---|
| PEK_K01 | The student is able to interact and work in a project group, assuming different roles in the project |

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Classification of peripheral computer systems, integration of peripheral devices in computer systems - interfaces and control protocols | 3 |
| Le_02 | Monitors and graphics adapters | 3 |
| Le_03 | Data storage. Physical rules for recording information on a different medium | 3 |
| Le_04 | Graphics devices. Ways to create characters and graphics | 3 |
| Le_05 | Sound cards - digital recording and sound synthesis | 3 |
| Le_06 | Keyboard and pointing devices | 3 |
| Le_07 | Wired communication interfaces | 3 |
| Le_08 | Wireless communication interfaces | 3 |
| Le_09 | The measuring equipment running on ISA, PCI, PCI Express busses. | 3 |
| Le_10 | Test | 3 |
| | **TOTAL** | 30 |

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | The development of theoretical assumptions of the proposed device | 4 |
| Pr_02 | Carrying out computer simulation of the designed device | 4 |
| Pr_03 | The preparation of documentation of designed device | 7 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

| | |
|---|---|
| ND_01 | Traditional lecture supported by presentations and interactive elements of the knowledge evaluation |
| ND_02 | Proof test in the mid of the course |
| ND_03 | Laboratory: short, 10-minute tests on the beginning of the exercises |
| ND_04 | Own work - preparation for laboratory exercises |
| ND_05 | Self-study and preparation for test |
| ND_06 | Consultations |
| ND_07 | Final test |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01 | Final written test |

| | | |
|---|---|---|
| P2 = F2 (project) | PEK_U01-PEK_U03, PEK_K01 | Assessment of the performed exercises, evaluating the effectiveness of the implementation of exercises |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Halsall F., Data Communications, Computer Networks and Open Systems, Addison-Wesley, 1992
2. Kolan Z., Urządzenia techniki komputerowej, SCREEN, Wrocław, 1994
3. Kolan Z., Urządzenia peryferyjne mikrokomputerów, CWK, Wrocław, 1992
4. Rembold U., Armbruster K., Ulzmann W., Interface technology for computer controlled manufacturing processes,, Marcel Dekker Inc., New York, 1983
5. Smith N., Drukarki laserowe HP Laser Jet, MIKOM, 1995
6. Wojtuszkiewicz K., Urządzenia techniki komputerowej, Cz.2 Urządzenia peryferyjne i interfejsy, MIKOM, 2007


**Secondary literature**


1. Gniadek K., Optyczne przetwarzanie informacji, PWN, Warszawa, 1992
2. Kopacz T., Karty graficzne VGA i SVGA, MIKOM, 1995
3. Prendergast R., Brekke D., Modemy, krótki kurs, ZNI MIKOM, 1996


## SUBJECT SUPERVISOR


**Mateusz.Wosko@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Peripheral Devices in Computer Systems**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_MM_W02 | C01-C03 | Le_01-Le_10 | ND_01, ND_02, ND_05, ND_06 |
| PEK_U01 (skills) | K1MTR_MM_U02 | C03 | Pr_01-Pr_03 | ND_03, ND_04, ND_06 |
| PEK_U02 | InzA_U01 | C03 | Pr_01-Pr_03 | ND_03, ND_04, ND_06 |
| PEK_U03 | InzA_U02 | C01-C03, C06 | Pr_01-Pr_03 | ND_03, ND_04, ND_06 |
| PEK_K01 (competences) | K1MTR_K03 | C04, C05 | Pr_01-Pr_03 | ND_03, ND_04, ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Fizyka 1.2** | |
| Name in English: | **Physics 1.2** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **FZP001058** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | 30 | | | |
| Number of hours of total student workload (CNPS) | 120 | 60 | | | |
| Form of crediting | E | Z | | | |
| Number of ECTS points | 4 | 2 | | | |
| Including number of ECTS points for practical (P) classes | 0 | 2 | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 2.4 | 1.4 | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Competence in mathematics and physics at the level of secondary school

## SUBJECT OBJECTIVES

C01 Acquisition of basic knowledge, taking into account aspects of applications, from the following sections of classical physics: classical mechanics, oscillatory and wave motion, thermodynamics

C02 Acquiring the ability of qualitative understanding, interpretation and quantitative analysis - based on the laws of physics - selected physical phenomena and processes in the field: classical mechanics, oscillatory and wave motion, thermodynamics

C03 Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

| | |
|---|---|
| PEK_W01 | Has a basic knowledge of classical mechanics, wave motion and thermodynamics, knows the importance of discoveries and achievements in physics for technical sciences and the progress of civilization |
| PEK_W02 | Knows the basics and principles of dimensional analysis to estimate the values of physical quantities |
| PEK_W03 | Knows the basics of vector calculus in a rectangular coordinate system |
| PEK_W04 | Has knowledge of kinematics description rectilinear and curvilinear motion (projections: vertical, horizontal, diagonal, circular motion, the angular size of the kinematic relationships with linear kinematic quantities) |
| PEK_W05 | Has knowledge of the fundamentals and applications of dynamics; has detailed knowledge of: a) the reference systems (inertial and non-inertial), b) understanding the importance of the dynamics of physical mass and strength, c) the types of interactions the primary and types of forces observed in nature (conservative, non-conservative, central, friction, inertia) d) the principles of Newton and scope of their application, e) the correct formulation of the equations of motion, f) knowledge and understanding of the physical meaning of the transformation of Galileo g) the dynamics of particles / body in curvilinear motion in the inertial reference system, h) the dynamics of particles / bodies in non-inertial systems reference i) the physical sense of inertia, together with an indication of their manifestations and consequences |
| PEK_W06 | Has knowledge of the conservative and non-conservative forces observed in nature and everyday life; known concepts: a) conservative forces, b) a force field at the field strength conservative c) of the work and power mechanical force, d) the kinetic and potential energy; knows the theorem of work and kinetic energy; has the knowledge to explain the relationship conservative forces of potential energy; knows, with mathematical justification, the principle of conservation of mechanical energy particles / body in the field of conservative forces |
| PEK_W07 | Knows and understands the terms: a) drive strength b) particles and the momentum of the mechanical system of material points; knows the formulation of the second law of dynamics using the concept of momentum; has knowledge concerning: a) the principles of conservation of momentum particles and the material system and the conditions of its applicability, b) elastic collision and inelastic; knows and understands the concept of a system of points and its center of gravity; has knowledge about the dynamics of the center of mass of the material points |
| PEK_W08 | Is familiar with the term: a) with respect to torque / rotation axis, b) the angular momentum of a particle, system of particles and rigid bodies with respect to / axis of rotation, c) moment of inertia: a particle system of particles and rigid bodies with respect to the axis of rotation; he knows the second law of dynamics for rotational motion of a rigid body about a fixed axis of rotation; knowledgeable about. kinetic energy of the rotation, work and power in rotation; knows the correct qualitative and quantitative description of the phenomenon of precession and reciprocating rigid body; has knowledge concerning: a) the principle of conservation of angular momentum of a particle, the system of particles and rigid bodies with respect to a fixed axis of rotation, b) the conditions of applicability of the principle of conservation of angular momentum |
| PEK_W09 | Knows the vector character of the law of universal gravitation; knows the concept: a) current and potential gravitational field, b) the gravitational potential energy of the body and the body; has knowledge concerning: a) the principle of conservation of mechanical energy of the body / the bodies in a gravitational field, b) of the potential of the intensity of the field and the gravitational force of gravitational energy potential, b) Kepler's laws and their justification on the basis of the law of universal gravitation and the law of conservation the angular momentum of the planet; familiar with the concept of I, II and III space velocity |
| PEK_W10 | Knows the basics of statics of solids and elastic properties of liquids and solids |
| PEK_W11 | Know the basics of hydrostatics and hydrodynamics of fluids; has detailed knowledge of: hydrostatic pressure, Pascal's and Archimedes' rights, surface tension and the effects it caused, types of ideal fluid flows and non-ideal, continuity and Bernoulli's equation, viscosity and the effects it caused, the dynamics of motion of bodies in a viscous medium, law Stokes |
| PEK_W12 | Has knowledge on the basics of kinematics and dynamics and oscillating motion applications; has detailed knowledge of: a) simple harmonic motion oscillating pendulum: mathematical, physical, torsion and the particles subjected to the force potential, and performing small oscillations about the point where the potential energy assumes a minimum value, b) the vibratory motion suppressed, c) forced vibration outer sinusoidal force; He has knowledge of the physics of the phenomenon of mechanical resonance |

| | |
|---|---|
| PEK_W13 | Has knowledge on the basics of wave motion and its applications; has detailed knowledge of: a) generating and basic properties of mechanical waves, b) the kinds of waves, c) the wave equation flat monochrome d) the basic physical quantities wave motion (length and frequency of the wave, the wave vector, the frequency circular) and their units of measurement, e) the speed associated with the operation waveform (phase, particles resort, group), f) depending on velocity of longitudinal and transverse of the elastic properties of the medium (units: Young's modulus, shear and elastic volume), g) the transport of mechanical energy by the waves (energy and power average, the intensity, the average energy density wave in the resort) h) depending on the intensity of the wave on the distance from the source |
| PEK_W14 | Has detailed knowledge concerning: a) generating, types and characteristics of acoustic waves (speed of sound in air, the volume / intensity of the wave energy transfer), b) the law of refraction and reflection, c) the pressure and force exerted by the wave incident on the surface d) Doppler e) uses ultrasound, f) the wave interference (superposition), g), standing waves and sound sources, h) beats, s) selected applications of sound and ultrasound |
| PEK_W15 | Has knowledge of the zero and the first law of thermodynamics; knows the basic concepts (macroscopic system, equilibrium thermodynamic parameters, functions of state, thermodynamic processes, gas ideal gas equation of state of ideal and actual); has detailed knowledge of: a) the temperature thermodynamic temperature scale and measurement units in various applicable scales, b) definition of the unit of measure Kelvin, c) the concept of internal energy of the system, d) the value of the elementary work done on the gas the ideal e) the work done over / by and with the environment of said heat in thermodynamic processes ideal gas |
| PEK_W16 | Has a basic knowledge of the second and third law of thermodynamics; has detailed knowledge of: a) reversible and irreversible processes, b) the entropy of a macroscopic system, content II principles and the elementary values of entropy change of the system, c) methods for the quantitative determination of entropy change ideal gas, d) thermodynamic machine / thermal engines and their performance in cycles simple and inverse e) the third law of thermodynamics |
| PEK_W17 | Has knowledge on the basics of statistical thermodynamics; has detailed knowledge of: a) objectives and mathematical formalism (probability and mathematical statistics) statistical thermodynamics, b) macroscopic thermodynamic parameter as a random variable; c) microstate, macrostate and weight statistics, d) statistical interpretation of the Boltzmann-Planck entropy, e) the function of the Boltzmann distribution (barometric formula), f) the distribution function Maxwell velocity of the gas molecules ideal g) the speed of the most probable and the average speed of the square of the gas molecules of ideal , h) of the average particle energy of degrees of freedom, i) microscopic interpretation of temperature and pressure ideal gas, j) rules equipartition heat |

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Is able to correctly and efficiently apply the learned principles and laws of physics to qualitative and quantitative analysis of selected physical problems of engineering. Is able to: a) identify and justify discoveries and achievements in physics, which contributed to the progress of civilization, b) explain the basics of physical activity everyday consumer devices |
| PEK_U02 | Is able to: a) apply the basic principles of dimensional analysis and qualitative analysis; b) The estimated value of the physical quantities of simple and complex |
| PEK_U03 | Is able to: a) to distinguish between scalar of vector b) provide size vector in the Cartesian coordinate system, c) use have met the elements of vector calculus, in particular knows how to set: the vectors, angles between vectors, intersections: scalar, vector, mixed and triple |
| PEK_U04 | Is able to set - using the transformation of Galileo - the size of the kinematic moving relative to each other inertial reference systems |
| PEK_U05 | Is able to identify and determine the kinematic quantities (vectors: position, velocity, acceleration total, tangential acceleration, acceleration of normal) in progressive movements and rotational and quantitative relationships between linear and angular kinematic quantities |
| PEK_U06 | Is able to correctly identify the forces acting on a given particle / body system and identify the resultant force in an inertial and non-inertial set |
| PEK_U07 | Is able to apply principles of dynamics to describe the motion of the body in the inertial frame of reference, in particular, can: a) correctly formulate the equations of motion vector character and his scalar character in the selected coordinate system, b) solve the formulated scalar equations of motion with regard to the initial conditions |
| PEK_U08 | Is able to apply principles of dynamics to describe the motion of the body in non-inertial frame of reference, in particular knows how: a) indicate the forces acting on a given particle / body and properly formulate the equation of motion in a non-inertial set b) explain the observed effects associated with the Earth's rotation |

| | |
|---|---|
| PEK_U09 | Is able to properly use the concept of work and energy to the description of physical phenomena, in particular to apply the principle of conservation of energy to solve problems related to kinematics and dynamics of motion of the particles / bodies concerned / a; knows how to determine the value of: a) the mechanical work and the power of fixed and variable force, kinetic and potential energy, b) changes in the kinetic energy of the particle / body with the use of claims about work and kinetic energy, c) the conservative forces on the basis of a particular analytical form of potential energy |
| PEK_U10 | Is able to apply principles of dynamics to describe a system of points, in particular set of values: drive force acting on the body, momentum particles / material system and the position of the center of mass of a system of points and quantitatively analyze the movement of the center of mass of the material points under the influence of the resultant of external forces |
| PEK_U11 | Is able to properly apply the principle of conservation of momentum for quantitative and qualitative analysis of the dynamic properties of the material points, in particular for the quantitative analysis of elastic collision and inelastic |
| PEK_U12 | Is able to apply the concept of torque and momentum to analyze simple problems related to kinematics and dynamics of rotation of rigid body around a fixed axis, in particular knows how to determine the value of: a) the moment of the force about point / axis of rotation, b) the angular momentum of a particle system of particles and rigid bodies with respect to / axis of rotation, c) formulate and solve the equation of motion of a rigid body rotating around a fixed axis of rotation, d) qualitatively describe the phenomenon of precession e) to formulate and solve the equation reciprocating, rotary rigid body |
| PEK_U13 | Is able to apply the principle of conservation of angular momentum to solve selected problems of physical and technical |
| PEK_U14 | Is able to apply the concept of work and kinetic energy of a rigid body to solve the problems associated with rotary motion of the rigid body, in particular, can determine the value of a) the kinetic energy of rotational motion, work and power in rotational motion, b) changes in the kinetic energy of rotation of the particles / body the use of statements about work and kinetic energy to rotational motion |
| PEK_U15 | Is able to a) justify the conservative nature of the gravitational field, b) explain the physical meaning of Kepler's laws, c) properly apply the principle of conservation of mechanical energy of the body / the bodies in a gravitational field, knows how to determine the value of: a) current and potential gravitational field, b) gravity the potential energy of the body and the body, c) I, II and III space velocity |
| PEK_U16 | Is able to analyze and solve simple tasks on hydrostatic and hydrodynamics of fluids, in particular, can calculate the surface tension, the speed and efficiency of fluid flow; able to solve simple tasks related to the dynamics of bodies in fluids, taking into account the forces of resistance |
| PEK_U17 | Is able to properly describe the properties of a periodic movement, and in particular to formulate and solve the differential equations of oscillatory motion for simple cases (pendulum: mathematical, physical, torsion and particles performing small oscillations around the position of stable equilibrium); can analyze kinematic and dynamic properties of harmonic motion in the case of braking forces, and periodic exciting force; can calculate periods of vibration and qualitatively and quantitatively characterize the mechanical resonance phenomenon |
| PEK_U18 | Is able to: a) clarify the relationship of the wave motion of the elastic properties of the medium b) quantitatively characterize the mechanical energy transport by the waves running c) correctly describe quantitatively diffraction, interference, polarization and the pressure exerted by the wave incident on the surface |
| PEK_U19 | Is able to explain, based on knowledge of standing waves, the physical principles generating acoustic waves by the sound source; can explain and determine: a) the frequency of the received wave depending on the traffic source and the receiver (the Doppler effect), b) the frequency beats |
| PEK_U20 | Is able to apply the first law of thermodynamics to the quantitative and qualitative description of the ideal gas transformation and set values: heat mentioned with the environment, the work done on the gas and the ideal gas, internal energy changes in these changes; knows how to graphically represent the ideal gas conversion, can justify / deduce the formula Mayer and put the adiabatic equation |
| PEK_U21 | Is able to calculate, using the first and second law of thermodynamics, the value of: a) changes in the entropy of a thermodynamic system, in particular ideal gas has undergone a certain transformation thermodynamic b) the efficiency of machines / heat engines working in a series of straight or reverse c) describe quantitatively the thermal transfer |
| PEK_U22 | Is able to: a) calculate the dependence of pressure from the height using the function of the Boltzmann distribution, b) provide statistical interpretation of entropy, c) derived using the distribution function Maxwell, depending on the speed of the most probable and the average speed |

of a square particle ideal gas of temperature, d) use equipartition principle of thermal energy, e) determine the microscopic interpretation of temperature and pressure ideal gas

**Relating to social competences**

Acquisition and consolidation of competences in the field of:

PEK_K01 search for information and its critical analysis,
PEK_K02 team cooperation on improving the methods for the selection of a strategy to optimally solving problems assigned to the group,
PEK_K03 understanding of the need for self-education, including improving the skills of attention and focus on important things, and develop the ability to independently apply their knowledge and skills,
PEK_K04 capacity building self-esteem and self-control and responsibility for the results of actions taken,
PEK_K05 compliance with the customs and rules in academia,
PEK_K06 independent and creative thinking,
PEK_K07 the impact of discoveries and achievements in physics from technical progress, society and the environment through openness and curiosity for knowledge relating to scientific achievements and advanced technologies,
PEK_K08 objectively examine the arguments of rational explanations and justifications own point of view, using the knowledge of physics.

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Organizational matters. The methodology of physics | 2 |
| Le_02 | Organizational matters. The methodology of physics | 2 |
| Le_03 | Kinematics. Newton 's laws | 2 |
| Le_04 | Kinematics. Newton 's laws | 2 |
| Le_05 | Work and mechanical energy. The principle of conservation of mechanical energy | 2 |
| Le_06 | Work and mechanical energy. The principle of conservation of mechanical energy | 2 |
| Le_07 | The dynamics of system of particles and rigid bodies. The principles of conservation of momentum and angular momentum | 2 |
| Le_08 | The dynamics of system of particles and rigid bodies. The principles of conservation of momentum and angular momentum | 2 |
| Le_09 | Gravitation | 2 |
| Le_10 | Oscillatory motion and mechanical waves | 2 |
| Le_11 | Oscillatory motion and mechanical waves | 2 |
| Le_12 | Oscillatory motion and mechanical waves | 2 |
| Le_13 | Phenomenological thermodynamics with elements of classical statistical physics | 2 |
| Le_14 | Phenomenological thermodynamics with elements of classical statistical physics | 2 |
| Le_15 | Phenomenological thermodynamics with elements of classical statistical physics | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Classes** | | Quantity |
|---|---|---|
| Cl_01 | Organizational matters. A solution for: dimensional analysis; estimating the value of physical quantities; vector calculus and differential-integral | 2 |
| Cl_02 | Application of the principles of Newton to solve the equations of motion; Depending on the time setting values of basic kinematic and dynamic still and moving relative to each other inertial and non-inertial reference systems | 2 |
| Cl_03 | Application of the principles of Newton to solve the equations of motion; Depending on the time setting values of basic kinematic and dynamic still and moving relative to each other inertial and non-inertial reference systems | 2 |

| | | |
|---|---|---|
| Cl_04 | Solving selected issues of movement dynamics using concepts of mechanical work, kinetic and potential energy, theorem of work and energy and the principle of conservation of mechanical energy | 2 |
| Cl_05 | Solving selected issues of movement dynamics using concepts of mechanical work, kinetic and potential energy, theorem of work and energy and the principle of conservation of mechanical energy | 2 |
| Cl_06 | Quantitative and qualitative analysis tasks using the concept of center of mass, the law of conservation of momentum applied to the material points, the elastic collision and inelastic | 2 |
| Cl_07 | A solution for kinematics and dynamics of rigid body rotational motion around a fixed axis and the principle of conservation of angular momentum | 2 |
| Cl_08 | A solution for kinematics and dynamics of rigid body rotational motion around a fixed axis and the principle of conservation of angular momentum | 2 |
| Cl_09 | Quantitative and qualitative analysis of selected issues concerning the physics of gravitational field: a) determining the value of the gravitational force, intensity, potential, potential energy; b) motion of bodies in a gravitational field using the principles of behavior (energy orbital angular momentum) and Kepler's laws | 2 |
| Cl_10 | Analysis and problem solving dynamic range of oscillating motion: simple harmonic (various pendulums, particles executing small oscillations around a stable equilibrium position), damped, forced and mechanical resonance | 2 |
| Cl_11 | Solving physics mechanical and acoustic waves. Calculating the values of basic wave motion, energy transport by waves and wave interference | 2 |
| Cl_12 | Solving the physics of acoustic waves and relating to: the speed of sound in solids and fluids, pressure and force exerted by the acoustic wave, standing waves, Doppler, beat and sources of acoustic waves | 2 |
| Cl_13 | Solving problems using the principles of thermodynamics concerning: a) determining values: heat mentioned with the environment, the work done on the gas and the gas, subject to change internal energy in the transformation of ideal gas, b) a graphical representation of the transformations ideal gas, c) the efficiency of thermal machines, d ) determining the entropy change of the ideal gas in the thermodynamic conversion, e) thermal conductivity | 2 |
| Cl_14 | Solving problems using the principles of thermodynamics concerning: a) determining values: heat mentioned with the environment, the work done on the gas and the gas, subject to change internal energy in the transformation of ideal gas, b) a graphical representation of the transformations ideal gas, c) the efficiency of thermal machines, d ) determining the entropy change of the ideal gas in the thermodynamic conversion, e) thermal conductivity | 2 |
| Cl_15 | Solving problems using the principles of thermodynamics concerning: a) determining values: heat mentioned with the environment, the work done on the gas and the gas, subject to change internal energy in the transformation of ideal gas, b) a graphical representation of the transformations ideal gas, c) the efficiency of thermal machines, d ) determining the entropy change of the ideal gas in the thermodynamic conversion, e) thermal conductivity | 2 |
| | **Total** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Traditional lecture using transparency and slides |
| ND_02 Tutorials - discussion of solutions jobs |
| ND_03 Tutorials - short 10 min. written tests |
| ND_04 Teaching materials available on the website |
| ND_05 Consultations |
| ND_06 Self - preparation for exercise |
| ND_07 Self - self-study and exam preparation |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W17 | Exam |
| P2 = F2 (classes) | PEK_U01-PEK_U22, PEK_K03-PEK_K07 | Oral answers, discussions, written tests |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. D. Halliday, R. Resnick, J. Walker, Podstawy fizyki, tom 1. i 2., Wydawnictwo Naukowe PWN, Warszawa 2003
2. J. Walker, Podstawy fizyki. Zbiór zadań, PWN, Warszawa 2005
3. I.W. Sawieliew, Wykłady z fizyki, tom 1 i 2, Wydawnictwa Naukowe PWN, Warszawa, 2003
4. K. Jezierski, B. Kołodka, K. Sierański, Zadania z rozwiązaniami, cz. 1., i 2., Oficyna Wydawnicza SCRIPTA, Wrocław 1999-2003
5. W. Salejda, Fizyka a postęp cywilizacyjny, opracowanie dostępne w pliku do pobrania pod adresem http://www.if.pwr.wroc.pl/dokumenty/jkf/fizyka_a_postep_cywilizacyjny.pdf
6. W. Salejda, Metodologia fizyki, opracowanie dostępne w pliku do pobrania pod adresem http://www.if.pwr.wroc.pl/dokumenty/jkf/metodologia_fizyki.pdf


**Secondary literature**


1. J. Massalski, M. Massalska, Fizyka dla inżynierów, cz. 1., WNT, Warszawa 2008
2. J. Orear, Fizyka, tom 1., WNT, Warszawa 2008
3. Z. Kleszczewski, Fizyka klasyczna, Wyd. Politechniki Śląskiej, Gliwice 2001
4. L. Jacak, Krótki wykład z fizyki ogólnej, Oficyna Wydawnicza PWr, Wrocław 2001; podręcznik dostępny na stronie Dolnośląskiej Biblioteki Cyfrowej
5. K. Sierański, K. Jezierski, B. Kołodka, Wzory i prawa z objaśnieniami, cz. 1. i 2., Oficyna Wydawnicza SCRIPTA, Wrocław 2005;
6. K. Sierański, J. Szatkowski, Wzory i prawa z objaśnieniami, cz. 3., Oficyna Wydawnicza SCRIPTA, Wrocław 2008
7. W. Salejda, M.H. Tyc, Zbiór zadań z fizyki, Wrocław 2001, podręcznik internetowy dostępny pod adresem http://www.if.pwr.wroc.pl/dokumenty/jkf/listamechanika.pdf
8. W. Salejda, R. Poprawski, J. Misiewicz, L. Jacak, Fizyka dla wyższych szkół technicznych, Wrocław 2001; dostępny jest obecnie rozdział Termodynamika pod adresem: http://www.if.pwr.wroc.pl/dokumenty/podreczniki_elektroniczne/termodynamika.pdf
9. Witryna dydaktyczna Instytutu Fizyki PWr; http://www.if.pwr.wroc.pl/index.php?menu=studia zawiera duży zbiór materiałów dydaktycznych
10. H.D. Young, R. A. Freedman, SEAR'S AND ZEMANSKY'S UNIVERSITY PHYSICS WITH MODERN PHYSICS, Addison-Wesley Publishing Company, wyd. 10, 2000; wyd. 12. z roku 2007; podgląd do wydania 12. z roku 2008
11. D. C. Giancoli, Physics Principles with Applications, 6th Ed., Addison-Wesley, 2005; Physics: Principles with Applications with MasteringPhysics, 6th Ed., Addison-Wesley 2009.
12. R R. A. Serway, Physics for Scientists and Engineers, 8th Ed., Brooks/Cole, Belmont 2009; Physics for Scientists and Engineers with Modern Physics, 8th Ed., Brooks/Cole, Belmont 2009
13. Paul A. Tipler, Gene Mosca, Physics for Scientists and Engineers, Extended Version, W. H. Freeman 2007


## SUBJECT SUPERVISOR


**Jan.Masajada@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Physics 1.2**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01-PEK_W03 (knowledge) | K1MTR_W01 | C01 | Le_01, Le_02 | ND_01, ND_05, ND_07 |
| PEK_W04-PEK_W14 | K1MTR_W02 | C01 | Le_03-Le_12 | ND_01, ND_05, ND_07 |
| PEK_W15-PEK_W17 | K1MTR_W02, K1MTR_W12 | C01 | Le_13-Le_15 | ND_01, ND_05, ND_07 |
| PEK_U01-PEK_U19 (skills) | K1MTR_U01, K1MTR_U02, K1MTR_U24 | C02 | Cl_01-Cl_12 | ND_02-ND_07 |
| PEK_U20-PEK_U22 | K1MTR_U12, K1MTR_U24 | C02 | Cl_13-Cl_15 | ND_02-ND_07 |
| PEK_K01-PEK_K08 (competences) | K1MTR_K01, K1MTR_K02, K1MTR_K07, K1MTR_K12 | C03 | Le_01-Le_15 Cl_01-Cl_15 | ND_01, ND_07 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Fizyka 2.8** | |
| Name in English: | **Physics 2.8** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **FZP003002** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | | 15 | | |
| Number of hours of total student workload (CNPS) | 60 | | 60 | | |
| Form of crediting | E | | Z | | |
| Number of ECTS points | 2 | | 2 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 2 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | 1.4 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Competence in the field of mathematical analysis, algebra and physics in terms of the course Physics 1

## SUBJECT OBJECTIVES

C01 The acquisition of basic knowledge, taking into account aspects of applications, from the following sections classical electrodynamics: electrostatics, electric current, magnetostatics, electromagnetic induction

C02 The acquisition of basic knowledge, taking into account aspects of applications, from the following sections of modern physics: special relativity, quantum physics, physics of the atomic nucleus

C03 Learning basic techniques and methods of measurement of selected physical quantities

C04 Acquiring skills: planning and execution experience in the Laboratory of Physics (LPF) consisting of the experimental verification of selected laws / rules of physics and measurement of physical quantities, the development of measurement results, estimation of measurement uncertainty, develop a written report from the measurements using utility software

C05 Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students with a view to effective problem solving, responsibility, honesty and fairness in the proceedings; observance force in academia and society

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

| | |
|---|---|
| PEK_W01 | Has a basic knowledge of classical electrodynamics (electrostatics, electricity, magnetostatics, electromagnetic induction, electromagnetic waves, optics), selected elements of modern physics (special theory of relativity, quantum physics, physics: atom, atomic nucleus, elementary particles) and astrophysics. He knows and understands the importance of discoveries and achievements of classical electrodynamics and modern physics for technical sciences and the progress of civilization |
| PEK_W02 | Knows the methods of analysis of vector fields |
| PEK_W03 | Has knowledge of electrostatics and its applications; knows and understands: Basic physical size of the vector and scalar associated with static electricity (current and potential field, the principle of superposition, the quantization of charge, charge conservation electric) charge point, discrete system of charges) Gauss' law; has detailed knowledge of: a) flow field intensity vector and the conservative nature of the field, b) electrostatic potential energy of cargo and the cargo c) field dipole electric potential energy of the dipole and torque acting on the dipole placed in an external field, d) conductor located in the field (field shielding effect), e) the dielectric polarization, f) capacitance and capacitor applications |
| PEK_W04 | Has knowledge of physics DC and its uses, in particular knows and understands a) the concept of voltage and current density vector electrical resistance / electrical conductivity / competent, SEM, work, power, electrical current and heat Joule, b) physical electrical conduction mechanisms, c) Ohm's law (in the form of differential and integral) and Kirchhoff's law, d) the principles of quantitative analysis of simple electric circuits |
| PEK_W05 | Has knowledge of magnetostatics and its uses, knows and understands: a) the term of the magnetic field vector magnetic induction and field intensity, b) the concept of the Lorentz force and its impact on the movement of electric charges in a magnetic field, c) the law of Gauss for the magnetic field d) the physical principles of operation: a cyclotron particle speed selector, mass spectrometer, e) the magnetic field guide and frame with the flow |
| PEK_W06 | Has knowledge about. Electromagnetic induction and its applications; know and understand: a) the concept of magnetic flux, b) Faraday's law and Lenz's law, c) inductance self-inductance |
| PEK_W07 | Knows and understands the concept of displacement current and the physical meaning of Maxwell's equations (in the form of integral and differential) |
| PEK_W08 | Has a basic knowledge of electromagnetic waves and their applications |
| PEK_W09 | Has a basic knowledge of the special theory of relativity and its applications |
| PEK_W10 | Has the knowledge of the foundations of quantum physics and its selected applications; has detailed knowledge of: a) the rights of blackbody radiation, thermal radiation of bodies and its applications, b) the Bohr model of the atom of hydrogen (quantization of energy and angular momentum of an electron), and the quantum energy levels of electrons in atoms c) of the photoelectric and Compton, d ) corpuscular-wave duality of light and elementary particles (hypothesis de Broglie waves of matter), e) Heisenberg's uncertainty principle, f) of the Schrödinger equation (temporal and timeless), g) a prohibition Pauli h) spatial quantization of the orbital angular momentum and magnetic moment of electrons in an atom |
| PEK_W11 | Has knowledge of the basic physics of the atomic nucleus and its applications, in particular know the quantities characterizing the nucleus, its isotopes and nuclear forces, have knowledge of: a) the binding energy of nucleons and its importance for nuclear power (fusion of heavy nuclei / isotopes), fusion of light nuclei, stability of heavy nuclei, b) the radioactivity of natural / artificial c) the types of radioactive decay, d) the law of radioactive decay e) radioisotope dating methods, f) nuclear reactions, g) nuclear h) the biological effects of radiation |
| PEK_W12 | Knows the safety rules in force in the Laboratory of Physics |
| PEK_W13 | Knows the methods to perform simple and complex measurements of physical quantities |
| PEK_W14 | Knows the methods of processing the results of measurements and uncertainty estimation of simple and complex measurements |

**Relating to skills**

| | |
|---|---|
| PEK_U01 | Is able to: a) independently written or oral expression correctly and succinctly present the issues discussed in the lectures that are the content of these learning outcomes in the field of knowledge (PEK_W01-PEK_W14), b) use the transferred and described above knowledge to the analysis of selected aspects of engineering and experiment planning, measurement of physical quantities, the |

| | |
|---|---|
| | development of the results of measurements in the form of a report or presentation and the estimation of measurement uncertainty with the use of computer tools (word processing, office software, computing environments). Is able to: a) identify and justify discoveries and achievements of classical electrodynamics and modern physics, which contributed to the progress of civilization |
| PEK_U02 | Is able to apply knowledge of electrostatics to) the qualitative and quantitative characteristics of the electrostatic field, the source of which there are loads and loads of point systems, in particular, has the skills to determining, based on Gauss' law, electrostatic field strengths of selected distributions of cargo; ) Measurements in the Laboratory of Physics (LPF) and the development of measurement results in the form of a written report |
| PEK_U03 | Is able to apply knowledge of physics DC to: a) quantitative characteristics of the current (amperage electric current density vector) in a simple electrical circuits, b) the designation of work, power, electrical current and heat Joule c) determining the resistance of the battery resistors, d) measurement in the LPF and the development of measurement results in a written report. Can explain the physical mechanisms of electrical conductivity and justify the utility nature of electric current, which is to transport electricity |
| PEK_U04 | Is able to identify the source of the magnetic field and apply knowledge of magnetostatics to: a) the qualitative and quantitative characteristics of the magnetic field (determination of vectors of magnetic induction and intensity) originating from different sources (straight and circular guide with the current, coil toroid), b) motion electric charges in the magnetic field and the determination of the force acting on the conductor in a magnetic field |
| PEK_U05 | Has skills to apply the knowledge in the field of electromagnetic induction to: a) the qualitative and quantitative performance characteristics of generators AC and DC, including the determination of the value generated SEM, b) explain the phenomenon of self-induction |
| PEK_U06 | Is able to correctly explain the physical meaning of Maxwell's equations (in the integral form). Moreover unable to correctly define the equations used in physical size and to determine their unit of measure |
| PEK_U07 | Is able to apply knowledge of the foundations of quantum physics to the quantitative interpretation of selected phenomena and physical effects of the microworld, phenomena and effects that occur over distances of the order of nanometers and smaller; in particular, can: a) show, using the appropriate accounts, quantization of energy in the Bohr model of the atom of hydrogen, b) justified, based on experimental facts, corpuscular nature of light, c) to justify the inadequacy of the use of classical physics to describe the phenomena of the microworld and explain the probabilistic nature quantum phenomena d) apply knowledge of basic physics of quantum measurements performed in the LPF selected physical quantities and to develop measurement results in the form of a written statement / report |
| PEK_U08 | Is able to: a) explain, based on the concept of binding energy of nucleons, the physical principles of energy production in nuclear reactors and tokamaks - devices to carry out controlled thermonuclear fusion b) identify and characterize the positive and negative aspects of nuclear power, c) characterize the types of decays of radioactive d) describe the use of radioactivity, biological effects of radiation, e) describe light nuclei fusion reactions occurring inside the Sun |
| PEK_U09 | Is able to use simple measuring instruments for the measurement of physical quantities |
| PEK_U10 | Is able to perform simple and complex measurements of physical quantities using manual measuring station |
| PEK_U11 | Is able to carry out the measurements, analyze uncertainties and edit report / report of measurements on the LPF using computer tools (word processing, office software, computing environments) |

**Relating to social competences**

Acquisition and consolidation of competences in the field of:

| | |
|---|---|
| PEK_K01 | search for information and its critical analysis, |
| PEK_K02 | team cooperation on improving the methods for the selection of a strategy to optimally solving problems assigned to the group, |
| PEK_K03 | understanding of the need for self-education, including improving the skills of attention and focus on important things, and develop the ability to independently apply their knowledge and skills, |
| PEK_K04 | capacity building self-esteem and self-control and responsibility for the results of actions taken, |
| PEK_K05 | compliance with the customs and rules in academia, |
| PEK_K06 | independent and creative thinking, |
| PEK_K07 | the impact of discoveries and achievements in physics from technical progress, society and the environment through openness and curiosity for knowledge relating to scientific achievements and |

| | |
|---|---|
| PEK_K08 | advanced technologies,<br>objectively examine the arguments of rational explanations and justifications own point of view, using the knowledge of physics. |

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Organizational matters. Mathematical analysis of vector fields, electrostatics | 3 |
| Le_02 | The electric current and magnetic field | 3 |
| Le_03 | Electrostatic induction. Maxwell's equations | 2 |
| Le_04 | Elements of special theory of relativity | 2 |
| Le_05 | Quantum physics | 3 |
| Le_06 | Elements of nuclear physics | 2 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Lab Introduction to LPF: issues of organization and conduct of classes, to familiarize students with: a) the safety rules for measurements (short health and safety training), b) how to prepare writing reports, c) the basics of the measurement uncertainty analysis. Carrying out simple measurements | 2 |
| La_02 | Making measurements using analog and digital gauges. Statistical processing of simple and complex results of measurements , estimation of measurement uncertainty, graphical presentation of the results of measurements and measurement uncertainty, the development of the report | 2 |
| La_03 | Making measurements of selected physical quantities, developing reports | 2 |
| La_04 | Making measurements of selected physical quantities, developing reports | 2 |
| La_05 | Making measurements of selected physical quantities, developing reports | 2 |
| La_06 | Making measurements of selected physical quantities, developing reports | 2 |
| La_07 | Making measurements of selected physical quantities, developing reports | 2 |
| La_08 | Supplementary classes, crediting, repetitory | 1 |
| | **Total** | 15 |

| TEACHING TOOLS USED | |
|---|---|
| ND_01 | Using traditional lecture, slides, demonstrations and presentations rights / phenomena |
| ND_01 | Self - preparation for laboratory exercises |
| ND_02 | Laboratory - discussion of ways to do measurements, analysis of results and the estimation of measurement uncertainty, evaluation reports / reports |
| ND_03 | Laboratory - a few minutes prior written tests measurements |
| ND_04 | Self - independent measurements |
| ND_05 | Self - self-study and exam preparation |
| ND_06 | Consultations |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W14 | Oral and written exam |
| P2 = F2 (classes) | PEK_U01-PEK_U11, PEK_K01-PEK_K08 | Oral response, discussions, quizzes and reports for each class |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. D. Halliday, R. Resnick, J. Walker, Podstawy fizyki, tomy 1-5, Wydawnictwo Naukowe PWN, Warszawa 2003
2. J. Walker, Podstawy fizyki. Zbiór zadań, PWN, Warszawa 2005
3. I.W. Sawieliew, Wykłady z fizyki, tom 1 i 2, Wydawnictwa Naukowe PWN, Warszawa, 2003
4. R. Poprawski, W. Salejda, Ćwiczenia laboratoryjne z fizyki, Cz. I-IV, Oficyna Wydawnicza PWr; wersja elektroniczna 5. wydania cz. 1. dostępna po kliknięciu nazwy Zasady opracowania wyników pomiarów z witryny Dolnośląskiej Biblioteki Cyfrowej; wersje elektroniczne pozostałych części podręcznika dostępne na stronie internetowej LPF pod adresem http://www.if.pwr.wroc.pl/LPF , gdzie znajdują się: regulamin LPF i regulamin BHP, spis ćwiczeń, opisy ćwiczeń, instrukcje robocze, przykładowe sprawozdania i pomoce dydaktycznych
5. W. Salejda, Fizyka a postęp cywilizacyjny, opracowanie dostępne w pliku do pobrania pod adresem http://www.if.pwr.wroc.pl/dokumenty/jkf/fizyka_a_postep_cywilizacyjny.pdf


**Secondary literature**


1. J. Massalski, M. Massalska, Fizyka dla inżynierów, cz. 1., WNT, Warszawa 2008
2. J. Orear, Fizyka, tom 1., WNT, Warszawa 2008
3. Z. Kleszczewski, Fizyka klasyczna, Wyd. Politechniki Śląskiej, Gliwice 2001
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6. K. Sierański, J. Szatkowski, Wzory i prawa z objaśnieniami, cz. 3., Oficyna Wydawnicza SCRIPTA, Wrocław 2008
7. Witryna dydaktyczna Instytutu Fizyki PWr; http://www.if.pwr.wroc.pl/index.php?menu=studia zawiera duży zbiór materiałów dydaktycznych
8. H.D. Young, R. A. Freedman, SEAR'S AND ZEMANSKY'S UNIVERSITY PHYSICS WITH MODERN PHYSICS, Addison-Wesley Publishing Company, wyd. 10, 2000; wyd. 12. z roku 2007; podgląd do wydania 12. z roku 2008
9. D. C. Giancoli, Physics Principles with Applications, 6th Ed., Addison-Wesley, 2005; Physics: Principles with Applications with MasteringPhysics, 6th Ed., Addison-Wesley 2009.
10. R R. A. Serway, Physics for Scientists and Engineers, 8th Ed., Brooks/Cole, Belmont 2009; Physics for Scientists and Engineers with Modern Physics, 8th Ed., Brooks/Cole, Belmont 2009
11. Paul A. Tipler, Gene Mosca, Physics for Scientists and Engineers, Extended Version, W. H. Freeman 2007


## SUBJECT SUPERVISOR


**Jan.Masajada@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Physics 2.8**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01-PEK_W08 (knowledge) | K1MTR_W01, K1MTR_W02, K1MTR_W13, K1MTR_W25 | C01 | Le_01-Le_03 | ND_01, ND_06, ND_07 |
| PEK_W09-PEK_W14 | K1MTR_W02, K1MTR_W07, K1MTR_W14, K1MTR_W25 | C02 | Le_04-Le_05 | ND_01, ND_06, ND_07 |
| PEK_U01-PEK_U11 (skills) | K1MTR_U01, K1MTR_U024, K1MTR_U25 | C03-C05 | La_01-La_08 | ND_01-ND_07 |
| PEK_K01-PEK_K08 (competences) | K1MTR_K02, K1MTR_K11 | C05 | La_01-La_08 | ND_01-ND_07 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Algebra z geometrią analityczną** | |
| Name in English: | **Algebra and Analytic Geometry** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MAT001402** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | 15 | | | |
| Number of hours of total student workload (CNPS) | 60 | 60 | | | |
| Form of crediting | E | Z | | | |
| Number of ECTS points | 2 | 2 | | | |
| Including number of ECTS points for practical (P) classes | 0 | 2 | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | 1.4 | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It is recommended to know the basic algebraic operations on rational and real numbers, and knowledge of basic geometric figures and shapes

## SUBJECT OBJECTIVES

C01 Understanding the basic properties of complex numbers
C02 Learning basic algebraic properties of polynomials
C03 Mastering the concept of a vector, a vector space and the base of a linear space
C04 Learning how to calculate the distance between the points in the space Rn, how to determine the equations of lines and planes and understanding the concept of conic sections
C05 Mastering the concepts of matrices, matrix operations, and learn the methods of solving systems of linear equations

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows basic properties of complex numbers
PEK_W02 Knows basic algebraic properties of polynomials
PEK_W03 Knows basic concepts of theory of linear spaces and methods of description of lines, planes and conic sections
PEK_W04 Knows basic methods of solving systems of linear equations

**Relating to skills**

PEK_U01 Can carry out calculations with complex numbers
PEK_U02 Can add, multiply and divide polynomials
PEK_U03 Can find the equations of planes and lines in three dimensional space
PEK_U04 Can add and multiply matrices and calculate determinants
PEK_U05 Can solve systems of linear equations

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Natural, rational and real numbers. Mathematical induction. Newton's binomial formula | 2 |
| Le_02 | Complex numbers. Basic operations, modulus, complex conjugate | 2 |
| Le_03 | Polar form of complex number. Multiplication, division and exponentiation in polar form. Roots of complex numbers. The notion of algebraic field | 2 |
| Le_04 | Polynomials. Addition and multiplication of polynomials. Roots of polynomial. Polynomial remainder theorem. Fundamental theorem of algebra | 2 |
| Le_05 | The decomposition of a polynomial with real coefficients into product of linear and quadratic factors. Rational functions. Real simple rational factors. Decomposition of the functions into rational simple factors | 2 |
| Le_06 | Vectors in the space Rn. Addition and multiplication by scalars. Distance between points. Scalar product. Length of vector. Cauchy–Schwarz inequality. The angle between vectors | 2 |
| Le_07 | Analytic geometry of the plane. Straight line formulas (normal parametric and directional form). Distance of a point from a line. The angle between lines | 2 |
| Le_08 | Analytic geometry of the space R3. Equations for lines and planes. Distance between point and a plane. Intersection of planes | 2 |
| Le_09 | Linear combinations of vectors. Linearly independent vectors. The base of a space. Linear mappings. Matrix representation of linear mappings | 2 |
| Le_10 | Addition and multiplication of matrices and its correlation with operations on linear mappings. Example of matrices | 2 |
| Le_11 | Permutations and its sign. Definition of determinant and methods of calculation of determinant Algebraic complement of an element of a matrix. Laplace' formula for determinant. Determinant and volume | 2 |
| Le_12 | Inverse matrix. Systems od linear equations. Cramer's formulas. Examples. Homogeneous and non-homogeneous systems | 2 |
| Le_13 | Properties of linear mappings (kernel, image, rank). Rouché –Capelli theorem. Gaussian elimination | 2 |
| Le_14 | Eigenvalues and eigenvectors | 2 |
| Le_15 | Conic sections | 2 |
| | **TOTAL** | 30 |

| Form of classes - Classes | | Quantity |
|---|---|---|
| Cl_01 | Real and complex numbers | 2 |
| Cl_02 | Polynomials | 2 |
| Cl_03 | Geometry of the plane | 2 |
| Cl_04 | Geometry of the space R3 | 2 |
| Cl_05 | Basis and linear mappings | 2 |
| Cl_06 | Matrices and determinants | 2 |
| Cl_07 | Systems of linear equations | 2 |
| Cl_08 | Test | 1 |
| | **Total** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Lecture - traditional method<br>ND_02 Classes - traditional method<br>ND_03 Student's self-work with the assistance of mathematical packages |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W04 | Exam or e-exam |
| P2 = F2 (classes) | PEK_U01-PEK_U05 | Oral answers, quizzes, written tests and/or e-tests |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Białynicki-Birula, Algebra Liniowa z Geometrią, PWN 1976
2. F. Leja, Geometria analityczna, PWN, Warszawa 1972
3. A. Mostowski, M. Stark, Elementy algebry wyższej, PWN, Warszawa 1963
4. G. Banaszak, W. Gajda, Elementy algebry liniowej, część I, WNT, Warszawa 2000


**Secondary literature**


1. G. Farin, D. Hansford, Practical Linear Algebra: A Geometry Toolbox 2004, AK Peters, 2005
2. T. Jurlewicz, Z. Skoczylas, Algebra i geometria analityczna. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2011
3. T. Jurlewicz, Z. Skoczylas, Algebra liniowa. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2005
4. T. Jurlewicz, Z. Skoczylas, Algebra i geometria analityczna.. Definicje, twierdzenia i wzory. Oficyna Wydawnicza GiS, Wrocław 2011
5. T. Jurlewicz, Z. Skoczylas, Algebra liniowa. Definicje, twierdzenia i wzory. Oficyna Wydawnicza GiS, Wrocław 2005
6. E. Kącki, D. Sadowska, L. Siewierski, Geometria analityczna w zadaniach, PWN, Warszawa 1993
7. W. Stankiewicz, Zadania z matematyki dla wyższych uczelni technicznych, Cz. A, PWN, Warszawa 2003


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Algebra and Analytic Geometry**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01 | C01 | Le_01-Le_03, Le_014 | ND_01, ND_03 |
| PEK_W02 | K1MTR_W01 | C02 | Le_04, Le_05 | ND_01, ND_03 |
| PEK_W03 | K1MTR_W01 | C03, C04 | Le_06-Le_09, Le_015 | ND_01, ND_03 |
| PEK_W04 | K1MTR_W01 | C05 | Le_010-Le_013 | ND_01, ND_03 |
| PEK_U01 (skills) | K1MTR_U01 | C01 | Cl_01, Cl_06, Cl_07 | ND_01-ND_03 |
| PEK_U02 | K1MTR_U01 | C02 | Cl_02 | ND_01-ND_03 |
| PEK_U03 | K1MTR_U01 | C03, C04 | Cl_03- Cl_05 | ND_01-ND_03 |
| PEK_U04 | K1MTR_U01 | C05 | Cl_06, Cl_07 | ND_01-ND_03 |
| PEK_U05 | K1MTR_U01 | C05 | Cl_06, Cl_07 | ND_01-ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Analiza Matematyczna 1.1 A** | |
| Name in English: | **Mathematical Analysis 1.1 A** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MAT001412** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | 30 | | | |
| Number of hours of total student workload (CNPS) | 150 | 90 | | | |
| Form of crediting | E | Z | | | |
| Number of ECTS points | 5 | 3 | | | |
| Including number of ECTS points for practical (P) classes | 0 | 3 | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 3.0 | 2.1 | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It is recommended that the knowledge of mathematics is equivalent to secondary school certificate at the advanced level

## SUBJECT OBJECTIVES

C01 Understanding the basic methods of analysis of the graph of functions of one variable
C02 Understanding the concept of definite integral and its basic properties and methods of determination
C03 Understanding the practical applications of mathematical methods for the analysis of functions of one variable

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the basic definitions and theorem from Mathematical Analysis of functions of one variable
PEK_W02 Knows the notion of definite integral and its basic applications

**Relating to skills**

PEK_U01 Can examine graphs of simple functions
PEK_U02 Can calculate integrals of simple functions

**Relating to social competences**

PEK_K01 Understand how calculus affects the development of technical civilization

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - Lecture** | | Quantity |
| Le_01 | Mathematical notations (logical connectives, quantifiers), elements of set theory, real numbers, subsets of real numbers (intervals, half-lines). Linear and quadratic functions | 2 |
| Le_02 | Basic properties of functions (injective and monotonic functions). Composition of functions. The inverse function. Power and exponential functions, and opposite to them. Properties of logarithms | 2 |
| Le_03 | Trigonometric functions and their inverses. Graphs of trigonometric and of its inverses | 2 |
| Le_04 | Sequences and limits. Basic formulas and theorems. Number e. Improper limits | 2 |
| Le_05 | The limit of a function in a point. Directional limits of function. Asymptotics of function | 2 |
| Le_06 | Continuity of a function in a point and on the interval. Basic properties of continuous functions. Approximate solutions of equations. Points of discontinuity | 2 |
| Le_07 | The definition of derivative. Basic formulas and theorems. Geometric and physics interpretations. Mean value theorem. De L'Hospital rule | 2 |
| Le_08 | Extreme values, monotonicity. Higher order derivatives. Convexity of function | 2 |
| Le_09 | Examination of the graph of a function. | 2 |
| Le_10 | Taylor formula. Approximation of function. Applications | 2 |
| Le_11 | Definite integral. Simple examples. Connection between integral and derivative (Fundamental Theorem of Calculus). Simple examples | 2 |
| Le_12 | Indefinite integral: basic formulas. Areas of simple figures | 2 |
| Le_13 | The basic methods of calculus of integrals: integration by parts and by substitution | 2 |
| Le_14 | The basic methods of calculus of integrals: simple rational functions. Area and perimeter of a circle. The volume of rotary figures | 2 |
| Le_15 | Application of methods of mathematical analysis of one variable functions | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Classes** | | Quantity |
|---|---|---|
| Cl_01 | Tautologies, de Morgan laws, union, intersection and complement of set | 2 |
| Cl_02 | Natural numbers, integers, rational and real numbers. Logarithm | 2 |
| Cl_03 | Graphs of simple functions. Inverse function. Composition of functions | 2 |
| Cl_04 | Trigonometric functions and trigonometric identities | 2 |
| Cl_05 | Limit of sequences | 2 |
| Cl_06 | The limit of a function in point | 2 |
| Cl_07 | Continuous functions | 2 |
| Cl_08 | Points of discontinuity. Solutions of equations | 2 |
| Cl_09 | Derivatives. Tangent line to a graph of a function | 2 |

| | | |
|---|---|---|
| Cl_10 | Examination of graphs of functions - I | 2 |
| Cl_11 | Examination of graphs of functions - II | 2 |
| Cl_12 | Taylor formula. De L'Hospital rule | 2 |
| Cl_13 | Integration - I | 2 |
| Cl_14 | Integration - II | 2 |
| Cl_15 | Integration - applications | 2 |
| | **Total** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Lecture - traditional method<br>ND_02 Classes - traditional method<br>ND_03 Student's self-work with the assistance of mathematical packages |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01, PEK_W02 | Exam or e-exam |
| P2 = F2 (classes) | PEK_U01, PEK_U02, PEK_K01 | Oral answers, quizzes, written tests and/or e-tests |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. F. Leja, Rachunek Różniczkowy i Całkowy, Wydawnictwo Naukowe PWN, 2012
2. W. Krysicki, L. Włodarski, Analiza Matematyczna w Zadaniach, Cz. I, PWN, Warszawa 2006


**Secondary literature**


1. K. Kuratowski, Rachunek Różniczkowy i Całkowy. Funkcje Jednej Zmiennej, Wydawnictwo Naukowe PWN, 2012
2. G. M. Fichtenholz, Rachunek Różniczkowy i Całkowy, T. I-II, PWN, Warszawa 2007
3. M. Gewert, Z. Skoczylas, Analiza Matematyczna 1. Przykłady i Zadania, Oficyna Wydawnicza GiS, Wrocław 2011


## SUBJECT SUPERVISOR


**Jacek.Cichon@pwr.edu.pl, Agnieszka.Wylomanska@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Mathematical Analysis 1.1 A**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01 | C01 | Le_01-Le_15, Cl_01-Cl_15 | ND_01-ND_03 |
| PEK_W02 | K1MTR_W01 | C02, C03 | Le_11-Le_15, Cl_13-Cl_15 | ND_01-ND_03 |
| PEK_U01 (skills) | K1MTR_U01 | C01 | Le_01-Le_15, Cl_01-Cl_15 | ND_01-ND_03 |
| PEK_U02 | K1MTR_U01 | C01-C03 | Le_01-Le_10, Le_15, Cl_01-Cl_10, Cl_15 | ND_01-ND_03 |
| PEK_K01 (competences) | K1MTR_K01 | C01, C02 | Cl_06, Cl_07 | ND_01-ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Analiza Matematyczna 2.1 A** | |
| Name in English: | **Mathematical Analysis 2.1 A** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MAT001422** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | 30 | | | |
| Number of hours of total student workload (CNPS) | 120 | 90 | | | |
| Form of crediting | E | Z | | | |
| Number of ECTS points | 4 | 3 | | | |
| Including number of ECTS points for practical (P) classes | 0 | 3 | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 2.4 | 2.1 | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Can explore convergence of sequences and calculate the limits of functions of one variable
2. Knows the calculus of functions of one variable and its applications
3. Knows and can use the indefinite integral functions of one variable
4. Knows the basic concepts of linear algebra

## SUBJECT OBJECTIVES

C01 Knowing the structure and properties of the definite integral. Acquiring skills in the use of the definite integral (including inappropriate) for engineering calculations
C02 Understanding the basic concepts of differential and integral calculus of several variables
C03 Mastery of basic knowledge about numerical series and power series
C04 Application of acquired knowledge to develop and analyze mathematical models to solve theoretical and practical issues in various fields of science and technology

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the structure of the definite integral and its properties, knows the concept of the integral wrong

PEK_W02 Knows the basics of differential and integral calculus of several variables

PEK_W03 Has a basic knowledge of the theory of series and power series, knows the convergence criteria

**Relating to skills**

PEK_U01 He can calculate and interpret the definite integral, is able to solve engineering problems using integrals

PEK_U02 He can calculate partial derivatives, directional and gradient function of several variables and interpret the values, is able to solve tasks of optimization for the function of many variables

PEK_U03 He can calculate and interpret the multiple integral, is able to solve engineering problems using double and triple integrals

PEK_U04 He can develop functions in power series, knows how to use received results for estimated calculations

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Mathematical notations (logical connectives, quantifiers), elements of set theory, real numbers, subsets of real numbers (intervals, half-lines). Linear and quadratic functions | 2 |
| Le_02 | Basic properties of functions (injective and monotonic functions). Composition of functions. The inverse function. Power and exponential functions, and opposite to them. Properties of logarithms | 3 |
| Le_03 | Trigonometric functions and their inverses. Graphs of trigonometric and of its inverses | 2 |
| Le_04 | Sequences and limits. Basic formulas and theorems. Number e. Improper limits | 2 |
| Le_05 | The limit of a function in a point. Directional limits of function. Asymptotics of function | 2 |
| Le_06 | Continuity of a function in a point and on the interval. Basic properties of continuous functions. Approximate solutions of equations. Points of discontinuity | 2 |
| Le_07 | The definition of derivative. Basic formulas and theorems. Geometric and physics interpretations. Mean value theorem. De L'Hospital rule | 3 |
| Le_08 | Extreme values, monotonicity. Higher order derivatives. Convexity of function | 2 |
| Le_09 | Examination of the graph of a function. | 2 |
| Le_10 | Taylor formula. Approximation of function. Applications | 2 |
| Le_11 | Definite integral. Simple examples. Connection between integral and derivative (Fundamental Theorem of Calculus). Simple examples | 2 |
| Le_12 | Indefinite integral: basic formulas. Areas of simple figures | 4 |
| Le_13 | The basic methods of calculus of integrals: integration by parts and by substitution | 2 |
| | **TOTAL** | 30 |

| Form of classes - Classes | | Quantity |
|---|---|---|
| Cl_01 | Tautologies, de Morgan laws, union, intersection and complement of set | 5 |
| Cl_02 | Natural numbers, integers, rational and real numbers. Logarithm | 4 |
| Cl_03 | Graphs of simple functions. Inverse function. Composition of functions | 3 |
| Cl_04 | Trigonometric functions and trigonometric identities | 4 |
| Cl_05 | Limit of sequences | 8 |

| | | |
|---|---|---|
| Cl_06 | The limit of a function in point | 4 |
| Cl_07 | Continuous functions | 2 |
| | **Total** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Lecture - traditional method<br>ND_02 Classes - traditional method<br>ND_03 Consultations<br>ND_04 Student's self-work – preparation to classes |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W03 | Exam or e-exam |
| P2 = F2 (classes) | PEK_U01-PEK_U04 | Oral answers, quizzes, written tests and/or e-tests |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. W. Żakowski, W. Kołodziej, Matematyka, Cz. II, WNT, Warszawa 2003
2. W. Żakowski, W. Leksiński, Matematyka, Cz. IV, WNT, Warszawa 2002
3. M. Gewert, Z. Skoczylas, Analiza matematyczna 2. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2012
4. M. Gewert, Z. Skoczylas, Równania różniczkowe zwyczajne. Teoria, przykłady, zadania, Oficyna Wydawnicza GiS, Wrocław 2011
5. W. Krysicki, L. Włodarski, Analiza matematyczna w zadaniach, Cz. I-II, PWN, Warszawa 2006


**Secondary literature**


1. G. M. Fichtenholz, Rachunek różniczkowy i całkowy, T. I-II, PWN, Warszawa 2007
2. M. Gewert, Z. Skoczylas, Analiza matematyczna 2, Definicje, twierdzenia, wzory. Oficyna Wydawnicza GiS, Wrocław 2012
3. F. Leja, Rachunek różniczkowy i całkowy ze wstępem do równań różniczkowych, PWN, Warszawa 2008
4. R. Leitner, Zarys matematyki wyższej dla studiów technicznych, Cz. 1-2, WNT, Warszawa 2006
5. H. i J. Musielakowie, Analiza matematyczna, T. I, Cz. 1-2 oraz T. II, Cz. 1, Wydawnictwo Naukowe UAM, Poznań 1993 oraz 2000
6. J. Pietraszko, Matematyka. Teoria, przykłady, zadania, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000
7. W. Stankiewicz, Zadania z matematyki dla wyższych uczelni technicznych, Cz. B, PWN, Warszawa 2003


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Mathematical Analysis 2.1 A**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01 | C01, C04 | Le_01-Le_03 | ND_01, ND_03, ND_04 |
| PEK_W02 | K1MTR_W01 | C02, C04 | Le_04-Le_11 | ND_01, ND_03, ND_04 |
| PEK_W03 | K1MTR_W01 | C03, C04 | Le_12, Le_13 | ND_01, ND_03, ND_04 |
| PEK_U01 (skills) | K1MTR_U01 | C01, C04 | Cl_01 | ND_02-ND_04 |
| PEK_U02 | K1MTR_U01 | C02, C04 | Cl_02-Cl_04 | ND_02-ND_04 |
| PEK_U03 | K1MTR_U01 | C02, C04 | Cl_05 | ND_02-ND_04 |
| PEK_U04 | K1MTR_U01 | C03, C04 | Cl_07 | ND_02-ND_04 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **Równania różniczkowe zwyczajne** | |
| Name in English: | **Ordinary Differential Equations** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **I level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MAT001452** | |
| Group of courses: | **NO** | |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 15 | 15 | | | |
| Number of hours of total student workload (CNPS) | 60 | 60 | | | |
| Form of crediting | Z | Z | | | |
| Number of ECTS points | 2 | 2 | | | |
| Including number of ECTS points for practical (P) classes | 0 | 2 | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | 1.4 | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows the calculus of functions of one and several variables
2. Knows and knows how to use indefinite and definite integrals of functions of one variable
3. Understands basic concepts of numerical series and a power and knows how to explore the convergence of series
4. Can use in the calculation of complex numbers
5. Knows the basic concepts of linear algebra

## SUBJECT OBJECTIVES

C01 Understanding the basic types of ordinary differential equations and methods of solving them
C02 Acquisition of stacking skills of differential equations to describe simple models in physics and engineering
C03 Mastering the Laplace operators methods for solving equations and systems of differential equations
C04 Knowledge of basic methods for testing the stability of systems of differential equations

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the most important types of differential equations and methods of solving
PEK_W02 Knows the method for solving systems of linear equations with constant coefficients
PEK_W03 Knows the Laplace operator method of solving differential equations

**Relating to skills**

PEK_U01 Can arrange and solve a differential equation describing simple physical models
PEK_U02 Can solve basic types of differential equations
PEK_U03 Can solve differential equations with constant coefficients

**Relating to social competences**

PEK_K01 Is able to search for and use of literature recommended for the course and independently acquire knowledge

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Ordinary differential equations of the first order. Problems leading to differential equations. Differential equations with separated variables. Linear ordinary differential equations of the first order | 2 |
| Le_02 | Examples of issues that lead to differential equations of the second order. Preliminary notions for linear ordinary differential equations of the second order | 1 |
| Le_03 | Linear ordinary differential equations second order homogeneous. Lowering the order linear differential equation of second order | 2 |
| Le_04 | Linear ordinary differential equations second order inhomogeneous. Method of variation of parameters | 2 |
| Le_05 | Linear ordinary differential equations of the second order with constant coefficients. Method of undetermined coefficients | 2 |
| Le_06 | Preliminary notions for systems of ordinary differential equations. Homogeneous systems of linear ordinary differential equations | 2 |
| Le_07 | Systems of linear ordinary differential equations with constant coefficients (simple eigenvalues) | 2 |
| Le_08 | Applications of Laplace transform to solve initial value problems for linear ordinary differential equations with constant coefficients | 2 |
| | **TOTAL** | 15 |

| Form of classes - Classes | | Quantity |
|---|---|---|
| Cl_01 | Construction of differential equations describing the simple physical issues. Solving differential equations with separated variables. Finding solutions to problems early | 1 |
| Cl_02 | Construction and solving differential equations of the first order | 2 |
| Cl_03 | Construction and solving differential equations of the second order, and initial value problems for such equations | 2 |
| Cl_04 | Solving linear ordinary differential equations of the second order non-homogeneous method of variation of parameters | 2 |
| Cl_05 | Solving linear ordinary differential equations of the second order with constant coefficients method of undetermined coefficients. | 2 |
| Cl_06 | Solving homogeneous systems of linear ordinary differential equations | 2 |
| Cl_07 | Solving linear systems of ordinary differential equations with constant coefficients of individual eigenvalues | 2 |
| Cl_08 | Solve initial value problems for linear ordinary differential equations with constant coefficients by Laplace Transformation | 2 |
| | **Total** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Lecture - traditional method<br>ND_02 Classes - traditional method<br>ND_03 Consultations<br>ND_04 Student's self-work – preparation to classes |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 = F1 (lecture) | PEK_W01-PEK_W03 | Exam or lecture assessment |
| P2 = F2 (classes) | PEK_U01-PEK_U03, PEK_K01 | Classes assessment |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. M. Gewert, Z. Skoczylas, Równania różniczkowe zwyczajne. Teoria, przykłady, zadania, Oficyna Wydawnicza GiS, Wrocław 2007

**Secondary literature**

1. J. Muszyński, A. D. Myszkis, Równania różniczkowe zwyczajne, PWN, Warszawa 1984
2. M. M. Matwiejew, Zadania z równań różniczkowych zwyczajnych, PWN, Warszawa 1976

## SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Ordinary Differential Equations**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**Mechatronics**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W01 (knowledge) | K1MTR_W01 | C01, C02 | Le_01-Le_09 | ND_01-ND_04 |
| PEK_W02 | K1MTR_W01 | C03 | Le_10-Le_13 | ND_01-ND_04 |
| PEK_W03 | K1MTR_W01 | C04 | Le_14, Le_15 | ND_01-ND_04 |
| PEK_U01 (skills) | K1MTR_U01 | C01, C02 | Cl_01-Cl_08 | ND_01-ND_04 |

| | | | | |
|---|---|---|---|---|
| PEK_U02 | K1MTR_U01 | C03 | Cl_01-Cl_08 | ND_01-ND_04 |
| PEK_U03 | K1MTR_U01 | C04 | Cl_01-Cl_08 | ND_01-ND_04 |
| PEK_K01 (competences) | K1MTR_K01 | C01-C04 | Cl_01-Cl_08 | ND_01-ND_04 |