# PROGRAMME OF EDUCATION

**FACULTY**: ***Microsystem Electronics and Photonics***

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

**in area of technical science**

**EDUCATION LEVEL:** ***2-nd level master study***

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

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

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

Content:



Microsystem Electronics and Photonics Faculty Council resolution no. ***124/11/2016-2020 of 17.05.2017***

In effect since ***01.10.2017***

# Field of study educational effects
# for *Mechatronics*
# second level studies – general academic

**Faculty: Microsystem Electronics and Photonics**
**Field of study: Electronics and Telecommunication**
**Level of studies: second level, full time study**

Location of the field of study in the area of education

Area of education: technical studies
Branch of science: technical studies
Discipline: electronics (main discipline), automatic control and robotics, information science

The field of study *Mechatronics* belongs to the area of education in technical sciences and is connected with such Fields of study as *Electronics, Informatics, Mechanics, Mechanical Engineering and Automatics and Robotics*. The graduates in the field of *Mechatronics* have interdisciplinary knowledge and skills that allow to solve specific interdisciplinary issues, i.e. electronic, programming and mechanical problems on the level of components, systems and instrumentation.

The concept of studies and their connection with the first level studies

A person applying for the second level study in the field of study *Mechatronics* should posses the first level qualifications and competences necessary for continuing education at the second level study in this field of study. The candidate should have the competences which encompass the following:

1. knowledge and skills in the field of mathematics, physics, metrology, production management and engineering and data recording in technique,
2. knowledge and skills in the field of material engineering, mechanics, construction design, driving systems, manufacturing technologies, thermodynamics,
3. knowledge and skills in the field of electrical engineering, electronics and optoelectronics, sensors and actuators, microprocessors and microcontrollers, control automatics, robotics and technologies in electronics,
4. knowledge and skills in the field of programming, programming languages, communication networks and interfaces, signal and imaging processing and computer aided engineering design,

5. knowledge about review and applications of mechatronics and basic skills connected with designing mechatronic systems, especially aspects connected with programming and electronics,
6. skills connected with interpretation, presentation and documentation of experimental results and presentation and documentation of a project-like task,
7. the skill of using English-language documents and literature.

Legend:

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

**P7U_W, P7U_U, P7U_K** – Universal characteristics of levels in Polish Qualification Framework
**P7S_WG, P7S_WK, P7S_UW, P7S_UK, P7S_UO, P7S_UU, P7S_KK, P7S_KO, P7S_KR** – Second stage characteristics of Polish Qualification Framework
For the precise definition of the reference to the definitions of the characteristics of the second stage of the Polish Qualification Framework, the following extensions were added and numbered:
**P7S_WG_NT, P7S_WK_NT, P7S_UW_NT** – Scope of teaching in the field of technical sciences
**P7S_WG_INŻ, P7S_WK_INŻ, P7S_UW_INŻ -** Qualifications covering engineering competencies

| **Field of study educational effects for the 2nd level studies in *Mechatronics*** | **DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS**<br><br>**Upon completion of the second level study in the field of *Mechatronics* the graduate:** | **Correlation of educational effects with universal characteristics of PQF, with second stage characteristics of PQF for qualifications on the 7th level, with second stage characteristics of PQF for engineering competences on the 7th level** |
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| **KNOWLEDGE** | | |
| K2MTR_W01 | knows the principle of operation of popular digital telecommunication interfaces used in mechatronics | P7U_W |
| K2MTR_W02 | knows the methodology of design and programming of electronic embedded systems for applications used in mechatronics | P7U_W |
| K2MTR_W03 | has actual knowledge about principles of operation and design methods of battery-less and wireless systems | P7U_W<br>P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W04 | has theoretically grounded general knowledge concerning designing and construction of electronic apparatus | P7U_W |
| K2MTR_W05 | has precise knowledge concerning construction, principles of operation and application area of microprocessors integrated circuits | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W06 | has theoretically grounded knowledge concerning material's diagnostic methods applied in electronics | P7S_WG |

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| K2MTR_W07 | has general knowledge from the completed main courses during the studies, detailed knowledge on specific topics and knows development trends in mechatronics and other disciplines connected with mechatronics | P7S_W<br>P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W08 | has completed the diploma thesis, basing on the acquired during the studies knowledge, specific for studied field of study in *Mechatronics* | P7U_W<br>P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W09 | has knowledge concerning manufacturing processes and application of novel optoelectronic elements and devices in microsystems | P7S_WG |
| K2MTR_W10 | knows the application principles of micromechanisms and microdrives in the technology and daily life | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W11 | knows the construction, technology and application possibilities of micro-opto-electro mechanical systems (MOEMS) in modern technique | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W12 | has theoretically grounded knowledge concerning optical fibre technique, including knowledge necessary to understand physical principles of operation of optical fibres and optical telecommunication systems | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W13 | has theoretically grounded and practical knowledge concerning numerical methods and tools for electronic micro- and nanosystems modelling and designing | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W14 | has knowledge concerning reliability theory in mechatronics including: methods of mechatronic systems testing and diagnostics, reliability characteristics and distributions, estimation of reliability parameters, failure models | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W15 | has ordered, theoretically grounded knowledge concerning construction, principle of operation, properties and applications of chemical and optical fibre sensors used in electronics and knows development trends of advanced sensing systems | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W16 | has ordered and extended knowledge concerning construction and principle of operation of analogue and digital electronic circuits and signal processing methods, i.e. from sensing system | P7U_W<br>P7S_WG |

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| K2MTR_W17 | has ordered and theoretically grounded knowledge concerning advanced microelectronic technologies, manufacturing processes of thin and thick film electronic elements and integrated circuits and biochemical sensors, knows the actual state of the art and development trends in advanced microelectronic technologies | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W18 | knows and understands the area of application and characteristics of optoelectronic systems and basic concepts concerning construction of electronic elements, especially the optoelectronic elements | P7S_WG |
| K2MTR_W19 | has extended knowledge concerning metrology and application of devices for control and measurements; knows and understands methods of physical quantities measurements, characteristics of measured objects and remote control by virtual apparatus | P7U_W<br>P7S_WG |
| K2MTR_W20 | has knowledge concerning applications of laser technology for manufacturing i.e. cutting, welding, hardfacing and laser micromachining; understands the principle of laser's operation, optical energy transfer and its interaction with matter | P7U_W<br>P7S_WG |
| K2MTR_W21 | has knowledge concerning enterprise management, in particular projects and management of interdisciplinary teams, that implements mechatronic projects | P7S_WK<br>P7S_WK_NT<br>P7S_WK_INŻ |
| K2MTR_W22 | has knowledge concerning the basic concepts of the theory and techniques of systems and operational processes management; also has the knowledge of innovative problem solving, conceptual design and rules of solution selection | P7U_W<br>P7S_WG |
| K2MTR_W23 | has knowledge concerning the construction and operation of the typical mechatronic systems in working machines and a variety of vehicles (hoists, storage devices, construction, mining, agriculture machines, etc.) | P7S_WG<br>P7S_WG_NT<br>P7S_WG_INŻ |
| K2MTR_W24 | has knowledge of the dynamics modelling of mechatronic systems, taking into account the definition of the finite element of mechanical, electrical, electrohydraulic objects, etc. | P7S_WG |
| K2MTR_W25 | has knowledge concerning probability theory, mathematical statistics and probability distributions, particularly related to mechatronics | P7U_W |
| **SKILLS** | | |
| K2MTR_U01 | is able to choose and configure digital communication interface, according to mechatronic project requirements | P7S_UW<br>P7S_UW2_NT<br>P7S_UW4_NT<br>P7S_UW2_INŻ<br>P7S_UW4_INŻ |

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| K2MTR_U02 | is able to design, program and construct an embedded system, which is an integral part of a mechatronic system | P7S_UW<br>P7S_UW2_NT<br>P7S_UW4_NT<br>P7S_UW2_INŻ<br>P7S_UW4_INŻ |
| K2MTR_U03 | is able to design and program a wireless and battery-less electronic system | P7S_UW<br>P7S_UW2_NT<br>P7S_UW4_NT<br>P7S_UW2_INŻ<br>P7S_UW4_INŻ |
| K2MTR_U04 | is able to assess and choose adequate diagnostic methods for materials and technologies applied in electronics | P7U_U<br>P7S_UW1_NT<br>P7S_UW2_NT<br>P7S_UW3_NT<br>P7S_UW1_INŻ<br>P7S_UW2_INŻ<br>P7S_UW3_INŻ |
| K2MTR_U05 | is able to choose and program a microprocessor or microcontroller for application in a specialised mechatronic project | P7S_UO<br>P7S_UW4_NT<br>P7S_UW4_INŻ |
| K2MTR_U06 | is able to present own research results, acquire and analyse information from the literature, databases and other correctly chosen sources; present own qualifications concerning knowledge, skills and social competences relevant to the field of study in *Mechatronics* | P7S_UW<br>P7S_UK<br>P7S_UU |
| K2MTR_U07 | is able to create technical texts (“Diploma Thesis”) and multimedia presentations, presenting own research results, acquire and analyse data concerning problems connected with field of study in *Mechatronics*; critically analyse and assess current technical solutions and is able to propose new ones | P7S_UW<br>P7S_UU<br>P7S_UW3_NT<br>P7S_UW3_INŻ |
| K2MTR_U08 | is able to design and use a microsystem with optoelectronic elements and assess its functional capabilities and also can propose possible upgrades | P7S_UW3_NT<br>P7S_UW3_INŻ |
| K2MTR_U09 | is able to correctly choose micomachines and microdrives in practical applications | P7S_UW<br>P7S_UW2_NT<br>P7S_UW2_INŻ |

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| K2MTR_U10 | is able to design a measurement experiment, can use correctly chosen measuring units and systems, calculate measurement uncertainty and compile the measurements results | P7S_UW1_NT<br>P7S_UW1_INŻ |
| K2MTR_U11 | is able to correctly choose MOEMS for practical application | P7S_UW<br>P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U12 | is able to design, start-up and test electronic analogue circuits, is able to make a cost estimation model, knows the health and safety rules | P7S_UW<br>P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U13 | knows and uses the workplace health and safety rules in work with lasers and optical fibres; is able to use basic measurement devices and build a measuring system for application in optical fibre technique | P7S_UW1_NT<br>P7S_UW1_INŻ |
| K2MTR_U14 | is able to use appropriate numerical methods and devices for computer aided design for electronic micro- and nanosystems design (i.e. Ansys, FlexPDE, Material Studio, etc.) | P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U15 | is able to solve problems concerning reliability theory of mechatronic systems, including: calculation of reliability characteristics and parameters on the basis of measured data, planning methods of diagnostics and tests | P7S_UW1_NT<br>P7S_UW1_INŻ |
| K2MTR_U16 | is able to design specific chemical and optical fibre sensor and prepare concepts of its construction and parameters; is able to use appropriate constructions in designed sensing systems | P7S_UW<br>P7S_UW1_NT<br>P7S_UW1_INŻ |
| K2MTR_U17 | is able to assess and compare analogue and digital circuit on the basis of its parameters and is able to analyse its operation in different applications; is able to assess the usefulness and application possibilities of novel solutions concerning signal processing systems and methods | P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U18 | is able to design a technological manufacturing process of a specific semiconductor or optoelectronic devices and systems or elements manufactured in thick-film technology, is able to specify further self-study area | P7S_UU<br>P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U19 | is able to choose technique and required data needed for completion of a designed project and is able to design basic optoelectronic systems projects by self | P7S_UW<br>P7S_UW3_NT<br>P7S_UW3_INŻ |
| K2MTR_U20 | is able to use virtual control and measuring apparatus and is able to build and configure appropriate control and measuring systems applied in engineering practice | P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U21 | is able to use, parameterise and investigate the operation results of a mechatronic devices in different manufacturing technologies | P7S_UW1_NT<br>P7S_UW1_INŻ |
| K2MTR_U22 | is able to choose laser beam parameters for specific process, is able to use specialised equipment used in laser micromachining processes | P7S_UW1_NT<br>P7S_UW1_INŻ |

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| K2MTR_U23 | is able to analyse the construction and operation principle of various mechatronic systems applied in the working machines and vehicles, is able to design and carry out a research experiment | P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U24 | is able to perform computer simulation of hydraulic system's operation, analyse dynamic processes; is able to analyse and construct a hydrotronic system | P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U25 | is able to model mechatronic system in professional virtual design programs (CAS, MBS, MES), perform static and dynamic calculations in linear and non-linear range | P7S_UW2_NT<br>P7S_UW2_INŻ |
| K2MTR_U26 | knows foreign language at the upper-intermediate level (B2+) used in the studied field of specialisation; is able to communicate in work (oral communication and writing), knows more than one foreign language | P7S_UK |
| K2MTR_U27 | understands and is able to use the basic concepts of probability theory and mathematical statistics in mechatronic practice | P7U_U<br>P7S_UW2_NT<br>P7S_UW2_INŻ |
| **SOCIAL COMPETENCES** | | |
| K2MTR_K01 | is able to think and act in creative and entrepreneurial way, work in a group, understands the importance and knows possibilities of constant self-study, analyses taken decision and its influence on the environment and dilemmas related with it | P7U_K<br>P7S_KO<br>P7S_KR |
| K2MTR_K02 | is able to work by self and in a group, undertaking different roles in the group | P7U_K |
| K2MTR_K03 | is able to co-work and work in a group, undertaking different roles in the group | P7U_K |
| K2MTR_K04 | plans his or her actions in a creative way, is able to specify priorities and the order of tasks | P7S_KK |
| K2MTR_K05 | understands the need to learn and use new techniques and technologies and is able to define goals and predicts the effects of the undertaken experimental work and works independently and in a team | P7S_KK |
| K2MTR_K06 | takes into account the necessity for application of numerical methods in electronic system design | P7S_KK |
| K2MTR_K07 | is able to see the aspects connected with the reliability of mechatronic systems and statistical presentation of the measurement data in various fields of engineering practice | P7U_K |
| K2MTR_K08 | understands the necessity for constant learning and understands the operation principle of the sensor systems and the necessity for their application in diagnostic and control systems | P7S_KK |
| K2MTR_K09 | while working in a group, properly identifies, solves and implements knowledge concerning the design and application of electronic circuits | P7U_K<br>P7S_KR |
| K2MTR_K10 | understands the influence of applied technologies on the environment and is conscious of limits that are connected with it | P7S_KO<br>P7S_KR |
| K2MTR_K11 | development of skills connected with working in group and taking responsibility for results of own work | P7U_K |
| K2MTR_K12 | is able to see positive aspects of virtual control and measuring apparatus application in engineering practice | P7S_KK |

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| K2MTR_K13 | is conscious of importance and understands the non-technical aspects and results of mechatronic engineer work, its influence on the environment and responsibility for own decisions | P7S_KR |
| K2MTR_K14 | is able to specify the priorities concerning the completion of a task specified by himself or others | P7S_KK<br>P7S_KO |
| K2MTR_K15 | is able to search and use the literature, acquire knowledge by himself, works systematically and develops skills; is able to work in a group | P7U_K |

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

# PROGRAMME OF STUDIES

## 1. Description

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| *Number of semesters:*<br>***3*** | *Number of ECTS points necessary to obtain qualifications:*<br>***90*** |
| *Prerequisites:*<br>*1. The order of admission is determined by the value of the recruitment factor $W_{II}$.*<br>*2. On the studies are admitted graduates of the first degree studies in Mechatronics or related field of study with professional degree of engineer or M.Sc. engineer (in any field of studies from the list of related fields): automatics and robotics, electronics and telecommunications, electronics, telecommunications, electrical engineering, power engineering, physics, technical physics, informatics, biomedical engineering, material engineering, mathematics, mechatronics, mechanical engineering, teleinformatics*<br><br>***Recruitment factor $W_{II}$ = D x 10 + RK + OD***<br>***D – grade in diploma***<br>***RK – interview***<br>*The faculty reserves the right to interview the candidates if the number of candidates exceeds the accepted limits of places.*<br>*If the interview is not carried out than the RK value is zero.*<br>***OD – achievement rating***<br>*Achievement rating will not be carried out – OD = 0* | *Upon completion of studies graduate obtains*<br>*professional degree of: **M. Sc. engineer***<br>*2-nd level qualifications* |

| *Possibility of continuing of the studies:* | *Graduate profile, employability:* |
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| ***Graduate is prepared for the 3-rd level study*** | ***The graduate of the second level studies in field of Mechatronics has education, achieved during the first level studies, including in principle knowledge and skills in electronics, optoelectronics, informatics, mechanics and mechanical engineering. Is prepared to work in an interdisciplinary project teams, conduct research and continue education on the third level studies. The graduate of the second level studies in Mechatronics:***<br>***• has knowledge and skills to use modern, innovative electronic, optoelectronic and microsystems devices,***<br>***• has knowledge in the field of control and measurements devices application in the control and automatic regulation systems,***<br>***• fluently uses modern informatics tools (inter-system communication, embedded systems, modelling, programming of manufacturing processes and microcontrollers),***<br>***• is able to design, participate and supervise the manufacturing processes and use the automated measurement and control equipment in the field of mechatronics,***<br>***• knows foreign language at intermediate level in field of mechatronics' specialization.***<br>***The graduate can work in small/medium companies and industrial enterprises with wide production profile (electronics, mechatronics, mechanics, electrics and similar), scientific and technical institutions and the development teams. Moreover, he can work in service points and institutions that exploit and service the mechatronic machines and equipment.*** |

*Indication of the connection with University's mission and its development strategy:*

*Wrocław University of Science and Technology is a pubic academy, an autonomous public university operating since 1945, with a status of technical university, acting on the basis of the act of July 27, 2005 "Law on Higher Education" and University Statute. The future of Wrocław University of Science and Technology, and therefore also the Faculty of Microsystem Electronics and Photonics, will be decided by, whether and to what extent, will be taken challenges concerning the evolution of education and research area. The mission of Wrocław University of Science and Technology is to develop creative, critical and tolerant personalities of students and PhD students and setting directions for the development of science and technology. The university, in the service of society carries out its mission by: creativity and innovation, the highest standards of research, knowledge transfer, quality of education and freedom of criticism with respect for the truth. Wrocław University of Science and Technology, as the academic community is open to all, cherishes the values and traditions of the university, cooperation with other universities and strives for a prominent place among the universities of Europe and the world. The mission of the university in Wrocław University of Science and Technology Development Plan specifies that the key issues within the area of the university activities are: organization of infrastructure, research activity and teaching. In the field of education, set of key issues of the Plan of Wrocław University of Science and Technology, includes:*

- elite system of education,
- quality of education,
- education in foreign languages,
- mobility of students and PhD students,
- distance education.

*Mission and the Development Plan of Wrocław University of Science and Technology are also the STRATEGY of the university, matching the developed strategic objectives defined for Strategy of Lower Silesia. One of them is the goal of No. 8 Strategy of Lower Silesia - Raising the level of education, life-long learning. In the field of education Wrocław University of Science and Technology strategic objectives are as follows:*

- *Correlation of university's activity with market needs,*
- *Improvement of the quality of education through interdisciplinary teaching,*
- Internationalization of study,
- *Improvement of the quality of study by stimulating entrepreneurship among students and PhD students and increase their involvement in research,*
- *Increasing the attractiveness of the education by the expansion and modernization of educational and research infrastructure, taking into the account the disabled persons,*
- *Expanding the range of postgraduate studies and specialist courses, that respond to the needs of the region.*

*Taking into account the mission and strategic objectives outlined in the Development Plan of Wrocław University of Science and Technology, the Development Plan of the Faculty of Microsystem Electronics and Photonics of Wrocław University of Science and Technology, on the one hand outlines the desired target model of the Faculty, on the other hand shows the specific, undertaken and carried out projects, that make this state closer.*

*The Faculty of Microsystem Electronics and Photonics, created in 2001 and has been operating since 01-01-2002 year, is one of the basic units of Wrocław University of Science and Technology, essential in the implementation and combination of high theoretical, research and expert competences of the University with the teaching and educational competences. The Faculty is the leading center for research and teaching in Poland in the field of electronics and related disciplines (telecommunications, mechatronics, materials engineering, biomedical engineering, nanotechnology), also known outside the Poland. At the Faculty the technological and design research related to* ***micro-*** *and* ***nanoelectronics****,* ***micro-*** *and* ***nanosystems*** *or* ***micro-*** *and* ***nanophotonics*** *and* ***mechatronics*** *are dominating. The research interests are reflected in the carried out education profile, especially in the second and third degree. The profile of education is complemented by the humanities and social sciences courses that perfect civilization education of engineers, that are available for the whole student community of Wrocław University of Science and Technology.*

*The Faculty currently has the following fields of study:* ***Electronics and telecommunications - I degree*** *(specialization* ***Electronic and photonic engineering*** *and* ***Digital electronics****),* ***Electronics and telecommunications - II degree*** *(specialization* ***Optoelectronics and fiber optics****,* ***Microsystems*** *and* ***Electronics, Photonics, Microsystems*** *in English language) - the studies in this field of study was assessed with outstanding mark by Polish Accreditation Commission (November 2009) and called the best field of study (title given by the Minister of Science and Higher Education (July 2012),* ***Mechatronics – I degree*** *(interdepartmental I degree studies - cooperation with the* ***Faculty of Mechanical Engineering*** *and the* ***Faculty of Electrical Engineering****).*

*In 2020 the Faculty is planning to carry out by itself or in cooperation with other base units of Wrocław University of Science and Technology in the following fields of study:* ***Electronics - first and second degree*** *(second degree focused on* ***micro- and nanoengineering****),* ***Optoelectronics*** *(possibly* ***Photonics****) - I and II degree*, ***Mechatronics - I and II degree***, ***Engineering Materials - I degree*** *and in scope of its competence postgraduate teaching and studies for elderly people.*

*The Faculty carries out an active and systematic campaign to persuade talented high school graduates for college education. The Faculty is cooperating with high schools and other schools from the south-west region of Poland and other regions of Poland (competition ELEKTRON). The Faculty presents itself during education fairs, advertises in print and online information brochure for high school graduates, actively participates in festivals of science, has eye-catching website, runs open laboratory classes for high school students. The Faculty does not neglect the contacts between its employees with their high schools.*

*The Faculty strives to recruit candidates for II and III degree studies from outside its region. The Faculty has been cooperating with other universities (e.g. vocational state university) that educate engineers in the field of I degree education.*

*The Faculty focuses on the interactive, discursive and experimental development of skills of its students. The Faculty educates professionals and innovators, taking into account the individual capabilities of students. Provides the skills that increase the competitiveness on the market and teaches cooperation. It provides an intellectually stimulating study*

*conditions, including international contacts. Follows the evolution of thematically similar faculties in the world, adapting successful solutions to its specific situation. This pillar concerning development of teaching competence additionally is complemented by: research potential, the business efficiency and regional roots. These are the essential pillars of the faculty's development, essential for faculty's general importance to its surrounding. The programmes of studies at the Faculty harmonize the directly useful professional knowledge, the knowledge needed for later adaptations and knowledge needed for forming a rational view of the world. Achieving practical skills and social competences is possible thanks to a very well organized and equipped student laboratories, as well as research laboratories, to which students have access (many new educational infrastructure is located in the teaching facilities at Długa Street 61/65 - M-4, M-6bis and M-11 buildings). At the same the Faculty pays attention to the use of the potentials of the information technology (including e-learning and new methods and technologies for learning). Students can also benefit from the teaching laboratories outside course hours (already such opportunities are created in the Faculty's Open Laboratory (**M-6 bis** building), which is the most recognizable laboratory of the Faculty). Science clubs offer students the opportunity to pursue their ambitious ideas and to test their abilities in the creative solving of practical problems (clubs or individual students are invited to participate in creative research projects).*
*Students of the Faculty, as all students of the University, have provided good linguistic preparation, referring also to the studied field of study, according to the rule: a foreign language and English language (treated as a second language, not a foreign language). As part of the University System of Education Quality Assessment, the Faculty's Committee of Education Quality Assessment and Assurance is assessing the quality of education. In addition, due to the very positive ratios when it comes to the number of students per academic teacher, to a greater extent than in the bigger faculties (field of studies), the interpersonal relationships with students master-student relationship are used to evaluate the quality of teaching.*
*The Faculty creates decent operation conditions for activities of the Student Council, provides its infrastructure and subsidizes (for specific tasks) some initiative and student events. Special attention is paid to the student tourism (including teaching activities combined with trips).*

## 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***

## 3. Concise analysis of consistency between assumed educational effects and labor market needs

*The resources of knowledge, skills and social competences of the students/graduates of the Faculty in the field "Electronics and Telecommunication" result from assigning the educational effects at a particular field of study to the provided courses. The educational effects associated with specialization, related to the educational effects in the area of technical sciences, should provide the students/graduates (at the particular educational level) with elemental knowledge (1-st level) and theoretically grounded detailed knowledge (2-nd level) in the range of engineering areas connected with the Electronics and Telecommunication field of study or other disciplines. The applied solutions concerning "enhanced" competences upon achieving a higher qualification level and, at the same time, securing "accessibility" of the 1-st and 2-nd level studies, make possible to acquire at the higher level, more advanced knowledge and skills (at specified social competences) but in a narrower subject range. The potential prospective employers should be aware of the students/graduates of the 1-st and 2-nd level studies level of knowledge, skills and social competences.*
*The basic and detailed knowledge, acquired by a student/graduate in a particular area should be wide enough to enable him/her self-study within the lifetime learning process to adapt his/her competences to the changing conditions and challenges which may emerge during a long-lasting professional career. Such expectations have the employers who implement modern work organization and innovative technologies in their enterprises. The assigned to courses effects, achieved during the educational process, enable, according to the expectations of prospective employers, acquiring by the graduate the knowledge about trends in development and novel, currently implemented achievements not only in the field of electronics and telecommunications, optoelectronics, photonics and informatics but also in medicine or environment protection.*

*The assumed effect concerning knowledge in the educational process is acquiring by the graduate the basic knowledge about technology transfer as well as the knowledge associated with management (including quality management) and running business. As educational effect should also be concerned the general knowledge used in engineering practice, necessary to understand, social, economic, legal and other beyond technical aspects of engineering activities. The effects are attained by realization of university-wide courses, Such knowledge will enable the graduates to understand the realities concerning organization of production processes and conditions in which they are conducted. It would enable them to take into account these conditions in individual and team job, which they would be able to take up as a result of achieving these goals. Such resources of knowledge are expected to be acquired by an university graduate in the contemporary labour market. The educational effects, included in the subject cards of the courses realized in the field of study, assure additionally achieving by the graduate the ability to integrate the knowledge from various areas and disciplines with the application of system approach in formulating and solving engineering tasks. The labor market expects that the effects achieved by the graduates as a result of the educational process, will prepare them to the work in an industrial environment, with the knowledge of industrial safety rules connected with the work, especially with the work at a particular stand/apparatus. In this respect, the effects achieved during realization of laboratory courses and the courses such as Students' practice, are especially important. Student/graduate should perceive the need of improvement and modification of production process or the solutions existing on the working place. Upon achieving the assumed educational effects, they should be able, taking into account beyond technical aspects, according to the given specification, to design and complete (using suitable methods, techniques and tools) a complex device, system or process.*

*Having in mind that the objective of the assumed and achieved educational effects in the specialization field of study is to fulfill, at possibly high level, the expectations of entrepreneurs who employ our graduates, an important aspect of evaluation of educational process are hospitations conducted during each semester and faculty polls addressed to graduates. Verification of conformity of the assumed educational effects and the market expectations and needs takes place during numerous meetings of our graduates with the Faculty staff.*

*Taking into the account the above mentioned comments, the Faculty helps in organizing special courses conducted by experts and practitioners from outside the University and provides a contact with such people as part of the regular courses. The Faculty creates possibilities for selection of master's theses topics that are related to the needs of companies in the field of electronics (especially microelectronics, microsystems and optoelectronics, telecommunications and mechatronics). On the basis of bilateral agreements concluded with entrepreneurs, students have the opportunity to realize their theses under the supervision of the supervisor from the Wrocław University of Science and Technology and the company supervisor. In the learning process, the interpersonal skills are developed, which are necessary to work in a group and the skills needed to manage human resources and project management. In the final phase of the studies, the Faculty promotes and creates possibilities for simultaneous learning and professional work.*

## 4. List of education modules

### 4.1. List of obligatory modules

#### 4.1.1. List of general education modules

##### 4.1.1.1. *Humanities* 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. | FLH121521W | Philosophy of science and technology | 1 | | | | | | 15 | 30 | 1 | 0.6 | T | Z | O | | KO | Ob. |
| | | Total | 1 | 0 | 0 | 0 | 0 | | 15 | 30 | 1 | 0.6 | | | | | | |

**Altogether for general 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 | | | | |
| 1 | 0 | 0 | 0 | 0 | 15 | 30 | 1 | 0.6 |

### 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. | MAT001454W | Statistics and probability | 1 | | | | | K2MTR_W25 K2MTR_K15 | 15 | 30 | 1 | 0.6 | T | Z | O | | PD | Ob |
| 2. | MAT001454L | Statistics and probability | | | 1 | | | K2MTR_U27 K2MTR_K15 | 15 | 60 | 2 | 1.4 | T | Z | O | P | PD | Ob |
| | | Total | 1 | 0 | 1 | 0 | 0 | | 30 | 90 | 3 | 2 | | | | | | |

**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 | | | | |
| 1 | 0 | 1 | 0 | 1 | 30 | 90 | 3 | 2 |

### 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. | MCD021001W | Micromachines and Microactuators | 2 | | | | | K2MTR_W10 | 30 | 30 | 1 | 0.6 | | E | | | K | Ob |
| 2. | MCD021001L | Micromachines and Microactuators | | | 1 | | | K2MTR_W10 K2MTR_U09 K2MTR_U10 K2MTR_K03 | 15 | 60 | 2 | 1.4 | | Z | | P | K | Ob |
| 3. | MCD021002W | Advanced microelectronic technologies | 2 | | | | | K2MTR_W17 K2MTR_K10 | 30 | 30 | 1 | 0.6 | | Z | | | K | Ob |
| 4. | MCD021002L | Advanced microelectronic technologies | | | 1 | | | K2MTR_U18 K2MTR_K10 | 15 | 60 | 2 | 1.4 | | Z | | P | K | Ob |
| 5. | MCD021003W | Applied optoelectronics | 1 | | | | | K2MTR_W09 | 15 | 30 | 1 | 0.6 | | E | | | K | Ob |
| 6. | MCD041003L | Applied optoelectronics | | | 1 | | | K2MTR_U08 K2MTR_K05 | 15 | 30 | 1 | 0.7 | | Z | | P | K | Ob |
| 7. | MCD021004W | Design and Construction of Optoelectronic Circuits | 1 | | | | | K2MTR_W18 | 15 | 30 | 1 | 0.6 | | Z | | | K | Ob |
| 8. | MCD021004P | Design and Construction of Optoelectronic Circuits | | | | 1 | | K2MTR_U19 K2MTR_K11 | 15 | 60 | 2 | 1.4 | | Z | | P | K | Ob |
| 9. | MCD021005W | Foundations of electronic apparatus construction | 1 | | | | | K2MTR_W04 K2MTR_K10 K2MTR_K14 | 15 | 30 | 1 | 0.6 | | Z | | | K | Ob |
| 10. | MCM021006W | Modelling and computer simulation of mechatronic assemblies | 1 | | | | | K2MTR_W24 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 11. | MCM021006L | Modelling and computer simulation of mechatronic assemblies | | | 1 | | | K2MTR_U23 K2MTR_U24 K2MTR_U25 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| 12. | MCD022001W | Fiber Optics Technology | 1 | | | | | K2MTR_W12 | 15 | 30 | 1 | 0.6 | T | E | | | K | Ob |
| 13. | MCD022001L | Fiber Optics Technology | | | 1 | | | K2MTR_U13 K2MTR_K03 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| 14. | MCD022002W | Chemical and optoelectronic sensors | 1 | | | | | K2MTR_W15 K2MTR_K08 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 15. | MCD022002L | Chemical and optoelectronic sensors | | | 2 | | | K2MTR_U16 K2MTR_K08 | 30 | 90 | 3 | 2.1 | T | Z | | P | K | Ob |
| 16. | MCD022013W | MOEMS | 1 | | | | | K2MTR_W11 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob |
| 17. | MCD022013L | MOEMS | | | 2 | | | K2MTR_U10 K2MTR_U11 K2MTR_K03 | 30 | 90 | 3 | 2.1 | T | Z | | P | K | Ob |
| 18. | MCD022004W | Novel diagnostic methods | 2 | | | | | K2MTR_W06 | 30 | 60 | 2 | 1.4 | T | E | | | K | Ob |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19. | MCD022004L | Novel diagnostic methods | | | 3 | | | K2MTR_U04<br>K2MTR_K03 | 45 | 120 | 4 | 2.8 | T | Z | | P | K | Ob |
| 20. | MCD023008W | Reliability in mechatronics | 1 | | | | | K2MTR_W14<br>K2MTR_K07 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 21. | MCD023008L | Reliability in mechatronics | | | 1 | | | K2MTR_U15<br>K2MTR_K07 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| 22. | MCM021203W | Laser Technology | 1 | | | | | K2MTR_W20 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 23. | MCM021203L | Laser Technology | | | 1 | | | K2MTR_U21<br>K2MTR_U22<br>K2MTR_K13 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| | | Total | 15 | 0 | 14 | 1 | 0 | | 450 | 1080 | 36 | 24.0 | | | | | | |

## 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 | | | | |
| 15 | 0 | 14 | 1 | 0 | 450 | 1080 | 36 | 24.0 |

## 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] |
| | **MCM023001BK** | **Management and Logistics** | **2** | | | | | | **30** | **90** | **3** | **1.8** | | | | | | |
| 1. | MCM023002W | Small Enterprise Management | 2 | | | | | K2MTR_W21 K2MTR_W22 | 30 | 90 | 3 | 1.8 | T | Z | | | KO | W |
| 2. | MCM023002W | Enterprise Management | 2 | | | | | K2MTR_W21 K2MTR_W22 | 30 | 90 | 3 | 1.8 | T | Z | | | KO | W |
| | | Total | 2 | 0 | 0 | 0 | 0 | | 30 | 90 | 3 | 1.8 | | | | | | |

#### 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. | JZL100709BK | Foreign language B2+ | | 1 | | | | | 15 | 30 | 1 | 0.7 | T | Z | O | P | KO | W |
| 2. | JZL100710BK | Foreign language A1/A2 | | 3 | | | | | 45 | 60 | 2 | 1.4 | T | Z | O | P | KO | W |
| | | Total | 0 | 4 | 0 | 0 | 0 | | 60 | 90 | 3 | 2.1 | | | | | | |

**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 | 4 | 0 | 0 | 0 | 105 | 210 | 6 | 3.9 |

### 4.2.2. List of basic sciences modules

### 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] |
| | **MCD021001BK** | **Open laboratory** | | | | | | | | | | | | | | | | |
| 1. | MCD021006L | Open laboratory | | | 2 | | | K2MTR_U12 K2MTR_K03 K2MTR_K04 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD021002BK** | **Battery-less and wireless systems** | | | | | | | | | | | | | | | | |
| 2. | MCD021007W | Wireless battery-less networks | 2 | | | | | K2MTR_W03 K2MTR_K01 | 30 | 60 | 2 | 1.2 | | Z | | | K | W |
| 3. | MCD021007L | Wireless battery-less networks | | | 2 | | | K2MTR_U03 K2MTR_K01 K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| 4. | MCD021008W | Designing of battery-less electronic circuits | 2 | | | | | K2MTR_W03 K2MTR_K01 | 30 | 60 | 2 | 1.2 | | Z | | | K | W |
| 5. | MCD021008P | Designing of battery-less electronic circuits | | | | 2 | | K2MTR_U03 K2MTR_U06 K2MTR_K01 K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD021003BK** | **Digital communication interfaces** | | | | | | | | | | | | | | | | |
| 6. | MCD021009W | Digital interfaces in electronics | 1 | | | | | K2MTR_W01 K2MTR_K01 | 15 | 30 | 1 | 0.6 | | E | | | K | W |
| 7. | MCD021009L | Digital interfaces in electronics | | | 2 | | | K2MTR_U01 K2MTR_U06 K2MTR_K01 K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| 8. | MCD021010W | Digital data exchange in electronics | 1 | | | | | K2MTR_W01 K2MTR_K01 | 15 | 30 | 1 | 0.6 | | E | | | K | W |
| 9. | MCD021010P | Digital data exchange in electronics | | | | 2 | | K2MTR_U01 K2MTR_U06 K2MTR_K01 K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD021004BK** | **Electronic signals and circuits** | | | | | | | | | | | | | | | | |
| 10. | MCD021011W | Signal processing systems | 1 | | | | | K2MTR_W16 | 15 | 30 | 1 | 0.6 | | Z | | | K | W |
| 11. | MCD021011L | Signal processing systems | | | 2 | | | K2MTR_U17 K2MTR_K03 K2MTR_K09 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12. | MCD021012W | Design of signal processing systems | 1 | | | | | K2MTR_W16 | 15 | 30 | 1 | 0.6 | | Z | | | K | W |
| 13. | MCD021012P | Design of signal processing systems | | | | 2 | | K2MTR_U17<br>K2MTR_K03<br>K2MTR_K09 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD022001BK** | **Virtual control instruments** | | | | | | | | | | | | | | | | |
| 14. | MCD022005W | Virtual instruments | 1 | | | | | K2MTR_W19 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 15. | MCD022005L | Virtual instruments | | | 2 | | | K2MTR_U20<br>K2MTR_K03<br>K2MTR_K12 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 16. | MCD022006W | Virtual instruments programming | 1 | | | | | K2MTR_W19 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 17. | MCD022006P | Virtual instruments programming | | | | 2 | | K2MTR_U20<br>K2MTR_K03<br>K2MTR_K12 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| | **MCD022002BK** | **Microprocessors and microcontrollers** | | | | | | | | | | | | | | | | |
| 18. | MCD022007W | Communication in microcontrollers | 1 | | | | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 19. | MCD022007L | Communication in microcontrollers | | | 1 | | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 20. | MCD022008W | Microprocessor control | 1 | | | | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 21. | MCD022008P | Microprocessor control | | | | 1 | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| | **MCD022004BK** | **Embedded systems in electronics** | | | | | | | | | | | | | | | | |
| 22. | MCD022011W | Applications of embedded systems in electronics | 2 | | | | | K2MTR_W02<br>K2MTR_K01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 23. | MCD022011L | Applications of embedded systems in electronics | | | 2 | | | K2MTR_U02<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 24. | MCD022012W | Designing of embedded systems in electronics | 2 | | | | | K2MTR_W02<br>K2MTR_K01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 25. | MCD022012P | Designing of embedded systems in electronics | | | | 2 | | K2MTR_U02<br>K2MTR_U06<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| | **MCD023002BK** | **Numerical modeling methods** | | | | | | | | | | | | | | | | |
| 26. | MCD023007W | Modelling of microsystems | 1 | | | | | K2MTR_W13<br>K2MTR_K06<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 27. | MCD023007L | Modelling of microsystems | | | 2 | | | K2MTR_U14<br>K2MTR_K06<br>K2MTR_K14 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 28. | MCD023009W | Modelling of nanosystems | 1 | | | | | K2MTR_W13<br>K2MTR_K06<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29. | MCD023009L | Modelling of nanosystems | | | 2 | | | K2MTR_U14<br>K2MTR_K06<br>K2MTR_K14 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| | | Total | 9 | 0 | 15 | 11 | 0 | | 360 | 690 | 23 | 15.2 | | | | | | |

**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 | | | | |
| 9 | 0 | 15 | 11 | 0 | 360 | 690 | 23 | 15.2 |

### 4.2.3.2. *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] |
| 1. | MCD023002S | Diploma seminar | | | | | 2 | K2MTR_W07<br>K2MTR_U06<br>K2MTR_K01 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| 2. | MCD023006D | Diploma thesis | | | | | | K2MTR_W08<br>K2MTR_U07<br>K2MTR_K02 | 150 | 540 | 18 | 12.6 | T | Z | | P | K | W |
| | | Total | 0 | 0 | 0 | 0 | 2 | | 210 | 660 | 20 | 14 | | | | | | |

**Altogether for diploma dissertation:**

| 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 | | | | |
| 0 | 0 | 0 | 0 | 2 | 180 | 600 | 20 | 14 |

## 4.3. Training module (Faculty Council resolution on principles of crediting training – attachment no. …)

| **Name of training** | | **Training** | |
|---|---|---|---|
| **Number of ECTS points** | **Number of ECTS points for BK classes1** | **Training crediting mode** | **Code** |
| | | | |
| **Training duration** | | **Training objective** | |
| | | | |

### 4.4. Diploma dissertation module

| Type of diploma dissertation | engineering | |
|---|---|---|
| **Number of semesters of diploma dissertation** | **Number of ECTS points** | **Code** |
| **1** | **20** | **MCD043003D** |
| **Character of diploma dissertation** | | |
| The Faculty students may, in the collection of topics of diploma dissertations, choose a diploma dissertation of different characters:<br>- analytical, (analysis, e.g. numerical, properties)<br>- technological (Technology of epitaxial growth)<br>- project (Project of a sensor)<br>- design ( Laboratory stand for annealing by RTS method)<br>- application (Assessment of applicability)<br>- usage (Application of a heterostructure in construction)<br>- research (Testing, characterization)<br>- survey (Current state of knowledge concerning the growth mechanisms) | | |
| **Number of BK ECTS points** | **14** | |

## 5. Ways of verifying assumed educational effects

| Type of classes | Ways of verifying assumed educational effects |
|---|---|
| lecture | examination, progress/final test |
| class | oral answer progress/final test |
| laboratory | oral answer, pre-test, realization of laboratory exercise, report from laboratory |
| project | partial assessment, project defense |
| seminar | participation in discussion, multimedia topic presentation |
| diploma dissertation | prepared diploma dissertation, review, defense of 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 BK)

   60.1 ECTS

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

| | |
|---|---|
| Number of ECTS points for obligatory subjects | 3 |
| Number of ECTS points for optional subjects | 0 |
| Total number of ECTS points | 3 |

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 | 26 |
| Number of ECTS points for optional subjects | 36 |
| Total number of ECTS points | 62 |

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)

   8 ECTS

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

48 ECTS

**11. Range of diploma examination**

1. Technology and applications of LIGA micromachnies
2. Zero-energy micromachines
3. Thick-film pressure sensors
4. Bonding methods of LTCC ceramics with other materials
5. Applications of DLC and ND films in electronic elements
6. Types and applications of novel semiconductor substrates
7. Characterize the lithographic techniques applied for manufacturing of electrical elements
8. Classification and applications of specialised light sources
9. Classification and applications of specialised photodetectors
10. Novel optoelectronic pointers – constructions and applications
11. Methods and systems for display of alphanumeric and graphic information (including large format displays)
12. Methods and systems for power supplying and control of semiconductor lasers and light emitting diodes
13. List and briefly characterize computer software for design and analysis of electronic and optoelectronic systems
14. List and briefly characterize the stages of the of optoelectronic elements design
15. How the control of solar panels' position is realised?
16. How it is possible to carry out remote temperature measurements in mine, hazardous environment or with high level of industrial interferences?
17. What is the essence of environmentally conscious design (eco-design) of electronic equipment?
18. What is meant by the term "electromagnetic compatibility of electronic devices"; what types of electromagnetic interference should be taken into consideration?
19. What is a modular construction system for electronic equipment?
20. Characterize the energy sources used in battery-less, wireless electronic systems
21. Characterize the very low power microcontrollers for their applications in battery-less systems
22. Compare two selected wireless communication standards used in low-power battery-less systems
23. List and characterize digital interfaces commonly used in electronics
24. List the protocol stacks associated with the use of advanced communication interfaces and discuss in detail one of them
25. Compare the physical layer and data link interfaces in Ethernet and CAN
26. List and briefly describe the method of data acquisition systems in signal processing
27. List and briefly describe the method of signal processing and analysis
28. List and briefly describe the method of signals synthesis

29. Mechatronic systems used in machines and agricultural vehicles
30. Automation of storage and handling processes The
31. Classification of optical fibres and their parameters. Discuss the basic optical fibres used in fibre optics communication
32. Discuss methods of optical fibres manufacturing
33. Discuss methods of planar optical fibres manufacturing
34. Provide criteria and classify the fibre optic sensors
35. Give examples and compare the performance of fibre optic sensors for measurements of linear displacement (eg. sensors with modulation of amplitude, phase and wavelength)
36. Types and characteristics of any kind of chemical gas sensors
37. Give the definition of electronic noses and discuss their operation principle
38. Optical atomic microclock with CPT effect
39. Technology of microoptics components
40. Classification of diagnostic methods used in micro- and nanoelectronics
41. Structural and optical diagnostics of semiconductors
42. Methods of optical and electrical characterization of materials for transparent electronics
43. Investigation methods of the electrical properties of dielectric materials
44. Micro and nano-structures investigation by the scanning probe microscopy methods
45. Discuss the use of impedance spectroscopy for the analysis of conductivity and polarization phenomena in materials
46. Discuss the use of X-ray and computer tomography for analysis of the defects in electronic elements assembly
47. What is a virtual gauge? How are they configured, programmed and what are their advantages and disadvantages?
48. List and discuss the interfaces used in modern measurement instrumentation
49. Discuss the main objectives of the IEEE 488 and SCPI
50. Microcontroller programming languages: Assembler, C - a comparison
51. Power saving mode of the microcontroller
52. Compare 2 communication buses in microcontrollers
53. Define the term "embedded system in electronics" and give examples of such systems
54. Characterize Android system in terms of its use as embedded system
55. Discuss the important features of real-time systems, and give examples of their applications as embedded systems
56. Finite elements, the division. The choice of the finite element model and type
57. Methodology to build models for FEM numerical simulation
58. The classification of defects in mechatronic systems
59. List and discuss the basic indicators describing the reliability
60. Characterize the types of laser generators used for material processing
61. Discuss the types of laser cutting

62. Describe the welding methods that use a laser beam
63. Describe in your own words and give a definition of electronic systems
64. List and describe the typical numerical methods used to model electronic systems
65. List and describe the typical computer programs used to model electronic systems

## 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

**FACULTY**: ***Microsystem Electronics and Photonics***

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

**EDUCATION LEVEL:** ***2nd level master studies***

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

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

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

Microsystem Electronics and Photonics Faculty Council resolution no. ***124/11/2016-2020 of May 17, 2017***

In effect since ***01.10.2017***

Faculty: **Microsystem Electronics and Photonics** Faculty Council resolution from: **17.05.2017**
Field of study: **Mechatronics** In effect from: **01.10.2017**
Specialization: **-**
Studies: **2nd level, full-time**

# POINT AND HOUR LAYOUT OF THE PLAN OF STUDIES

| | **28h** | **I** | **30** | **27h** | **II** | **30** | **10h** | **III** | **30** |
|---|---|---|---|---|---|---|---|---|---|
| 28 | MCM021006 **1W + 1L** 10100<br>Modelling and computer simulation of mechatronic assemblies | | | | | | | | |
| 26 | | | | FLH12152 Philosophy of science and tech. **2W** 10000 | | | | | |
| 25 | MCD021004BK **1W +2L** 10200 | | | | | | | | |
| 24 | Electronic signals and circuits | | | MCD022004BK **2W + 2L**/P 20200 / 20020 | | | | | |
| 23 | MCD021003BK **1W + 2L/P** 10200/10020**E** | | | Embedded systems in electronics | | | | | |
| 22 | Digital communication interfaces | | | | | | | | |
| 21 | | | | MCD022002BK **1W +1L** 10100 | | | | | |
| 20 | | | | Microprocessors and microcontrollers | | | | | |
| 19 | MCD021002BK **2W + 2L**/P 20200/20020 | | | | | | | | |
| 18 | Battery-less and wireless systems | | | MCD022001BK **1W + 2L/P** 10200/10020 | | | | | |
| 17 | | | | Virtual control instruments | | | | | |
| 16 | MCD021006 **2L** 00200 | | | | | | | | |
| 15 | Open laboratory | | | MCD022004 **2W + 4L** 20300**E** | | | | | |
| 14 | MCD021005 **1W** 10000<br>Foundations of electronic apparatus construction | | | Novel diagnostic methods | | | | | |
| 13 | MCD021004 **1W + 2L** 10100 | | | | | | MCD023006 **18 p** | | |
| 12 | Design and Construction of Optoelectronic Circuits | | | | | | Diploma thesis | | |
| 11 | MCD021003 **1W + 1L** 10100**E** | | | | | | | | |
| 10 | Applied optoelectronics | | | MCD022013 **2W + 3L** 10200 | | | MCD023002 **2S** 00002 | | |
| 9 | | | | MOEMS | | | Diploma seminar | | |
| 8 | MCD021002 **1W + 2L** 20100 | | | | | | MCM021203 **1W + 1L** 10100 | | |
| 7 | Advanced microelectronic technologies | | | MCD022002 **1W + 3L** 10200 | | | Laser Technology | | |
| 6 | | | | Chemical and optoelectronic sensors | | | MCD023008 **1W + 2L** 10100 | | |
| 5 | MCD021001 **1W + 2L** 20100**E** | | | MCD022001 **1W + 1L** 10100**E** | | | Reliability in mechatronics | | |
| 4 | Micromachines and Microactuators | | | Fiber Optics Technology | | | MCD023002BK **1W + 1L** 10200 | | |
| 3 | MAT001454 **1W + 2P** 10010 | | | Foreign Language A1/A2 03000 | | | Numerical modeling methods | | |
| 2 | Statistics and probability | | | **2C** | | | MCM023001BK **3W** 20000 | | |
| 1 | Foreign Language B2+ **1C** 01000 | | | | | | Management and Logistics | | |
| | **$d_I$=12** | | | **$d_{II}$=6** | | | **$d_{III}$=0** | | |

## Legend

| | |
|---|---|
| Basic science courses | |
| University-wide courses | |
| Main field of study 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. | MAT001454W | Statistics and probability | 1 | | | | | K2MTR_W25 K2MTR_K15 | 15 | 30 | 1 | 0.6 | T | Z | O | | PD | Ob |
| 2. | MAT001454L | Statistics and probability | | | 1 | | | K2MTR_U27 K2MTR_K15 | 15 | 60 | 2 | 1.4 | T | Z | O | P | PD | Ob |
| 3. | MCD021001W | Micromachines and Microactuators | 2 | | | | | K2MTR_W10 | 30 | 30 | 1 | 0.6 | T | E | | | K | Ob |
| 4. | MCD021001L | Micromachines and Microactuators | | | 1 | | | K2MTR_W10 K2MTR_U09 K2MTR_U10 K2MTR_K03 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| 5. | MCD021002W | Advanced microelectronic technologies | 2 | | | | | K2MTR_W17 K2MTR_K10 | 30 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 6. | MCD021002L | Advanced microelectronic technologies | | | 1 | | | K2MTR_U18 K2MTR_K10 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| 7. | MCD021003W | Applied optoelectronics | 1 | | | | | K2MTR_W09 | 15 | 30 | 1 | 0.6 | T | E | | | K | Ob |
| 8. | MCD041003L | Applied optoelectronics | | | 1 | | | K2MTR_U08 K2MTR_K05 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| 9. | MCD021004W | Design and Construction of Optoelectronic Circuits | 1 | | | | | K2MTR_W18 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 10. | MCD021004P | Design and Construction of Optoelectronic Circuits | | | | 1 | | K2MTR_U19 K2MTR_K11 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| 11. | MCD021005W | Foundations of electronic apparatus construction | 1 | | | | | K2MTR_W04 K2MTR_K10 K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 12. | MCM021006W | Modelling and computer simulation of mechatronic assemblies | 1 | | | | | K2MTR_W24 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 13. | MCM021006L | Modelling and computer simulation of mechatronic assemblies | | | 1 | | | K2MTR_U23 K2MTR_U24 K2MTR_U25 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| | | Total | 9 | 0 | 5 | 1 | 0 | | 225 | 510 | 17 | 11.2 | | | | | | |

## 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. | JZL100709BK | Foreign Language B2+ | | 1 | | | | | 15 | 30 | 1 | 0.7 | T | Z | O | P | KO | W |
| | **MCD021001BK** | **Open Laboratory** | | | | | | | | | | | | | | | | |
| 2. | MCD021006L | Open laboratory | | | 2 | | | K2MTR_U12<br>K2MTR_K03<br>K2MTR_K04 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD021002BK** | **Battery-less and wireless systems** | | | | | | | | | | | | | | | | |
| 3. | MCD021007W | Wireless battery-less networks | 2 | | | | | K2MTR_W03<br>K2MTR_K01 | 30 | 60 | 2 | 1.2 | | Z | | | K | W |
| 4. | MCD021007L | Wireless battery-less networks | | | 2 | | | K2MTR_U03<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| 5. | MCD021008W | Designing of battery-less electronic circuits | 2 | | | | | K2MTR_W03<br>K2MTR_K01 | 30 | 60 | 2 | 1.2 | | Z | | | K | W |
| 6. | MCD021008P | Designing of battery-less electronic circuits | | | | 2 | | K2MTR_U03<br>K2MTR_U06<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD021003BK** | **Digital communication interfaces** | | | | | | | | | | | | | | | | |
| 7. | MCD021009W | Digital interfaces in electronics | 1 | | | | | K2MTR_W01<br>K2MTR_K01 | 15 | 30 | 1 | 0.6 | | E | | | K | W |
| 8. | MCD021009L | Digital interfaces in electronics | | | 2 | | | K2MTR_U01<br>K2MTR_U06<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| 9. | MCD021010W | Digital data exchange in electronics | 1 | | | | | K2MTR_W01<br>K2MTR_K01 | 15 | 30 | 1 | 0.6 | | E | | | K | W |
| 10. | MCD021010P | Digital data exchange in electronics | | | | 2 | | K2MTR_U01<br>K2MTR_U06<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | **MCD021004BK** | **Electronic signals and circuits** | | | | | | | | | | | | | | | | |
| 11. | MCD021011W | Signal processing systems | 1 | | | | | K2MTR_W16 | 15 | 30 | 1 | 0.6 | | Z | | | K | W |
| 12. | MCD021011L | Signal processing systems | | | 2 | | | K2MTR_U17<br>K2MTR_K03<br>K2MTR_K09 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| 13. | MCD021012W | Design of signal processing systems | 1 | | | | | K2MTR_W16 | 15 | 30 | 1 | 0.6 | | Z | | | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14. | MCD021012P | Design of signal processing systems | | | | 2 | | K2MTR_U17<br>K2MTR_K03<br>K2MTR_K09 | 30 | 60 | 2 | 1.4 | | Z | | P | K | W |
| | | Total | 4 | 1 | 8 | 6 | 0 | | 195 | 390 | 13 | 8,7 | | | | | | |

## 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 | | | | |
| 13 | 1 | 13 | 7 | 0 | 420 | 900 | 30 | 19.7 |

# 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. | FLH121521W | Philosophy of science and technology | 1 | | | | | | 15 | 60 | 2 | 1.2 | T | | | | | |
| 2. | MCD022001W | Fiber Optics Technology | 1 | | | | | K2MTR_W12 | 15 | 30 | 1 | 0.6 | T | E | | | K | Ob |
| 3. | MCD022001L | Fiber Optics Technology | | | 1 | | | K2MTR_U13 K2MTR_K03 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| 4. | MCD022002W | Chemical and optoelectronic sensors | 1 | | | | | K2MTR_W15 K2MTR_K08 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 5. | MCD022002L | Chemical and optoelectronic sensors | | | 2 | | | K2MTR_U16 K2MTR_K08 | 30 | 90 | 3 | 2.1 | T | Z | | P | K | Ob |
| 6. | MCD022013W | MOEMS | 1 | | | | | K2MTR_W11 | 15 | 60 | 2 | 1.2 | T | Z | | | K | Ob |
| 7. | MCD022013L | MOEMS | | | 2 | | | K2MTR_U10 K2MTR_U11 K2MTR_K03 | 30 | 90 | 3 | 2.1 | T | Z | | P | K | Ob |
| 8. | MCD022004W | Novel diagnostic methods | 2 | | | | | K2MTR_W06 | 30 | 60 | 2 | 1.4 | T | E | | | K | Ob |
| 9. | MCD022004L | Novel diagnostic methods | | | 3 | | | K2MTR_U04 K2MTR_K03 | 45 | 120 | 4 | 2.8 | T | Z | | P | K | Ob |
| | | Total | 6 | 0 | 8 | 0 | 0 | | 210 | 570 | 19 | 12.7 | | | | | | |

## 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. | JZL100710BK | Foreign Language A1/A2 | | 3 | | | | | 45 | 60 | 2 | 1.4 | T | Z | O | P | KO | W |
| | **MCD022001BK** | **Virtual control instruments** | | | | | | | | | | | | | | | | |
| 2. | MCD022005W | Virtual instruments | 1 | | | | | K2MTR_W19 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 3. | MCD022005L | Virtual instruments | | | 2 | | | K2MTR_U20 K2MTR_K03 K2MTR_K12 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 4. | MCD022006W | Virtual instruments programming | 1 | | | | | K2MTR_W19 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. | MCD022006P | Virtual instruments programming | | | | 2 | | K2MTR_U20<br>K2MTR_K03<br>K2MTR_K12 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| | **MCD022002BK** | **Microprocessors and microcontrollers** | | | | | | | | | | | | | | | | |
| 6. | MCD022007W | Communication in microcontrollers | 1 | | | | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 7. | MCD022007L | Communication in microcontrollers | | | 1 | | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 8. | MCD022008W | Microprocessor control | 1 | | | | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 9. | MCD022008P | Microprocessor control | | | | 1 | | K2MTR_W05<br>K2MTR_U05<br>K2MTR_K14 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| | **MCD022004BK** | **Embedded systems in electronics** | | | | | | | | | | | | | | | | |
| 10. | MCD022011W | Applications of embedded systems in electronics | 2 | | | | | K2MTR_W02<br>K2MTR_K01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 11. | MCD022011L | Applications of embedded systems in electronics | | | 2 | | | K2MTR_U02<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| 12. | MCD022012W | Designing of embedded systems in electronics | 2 | | | | | K2MTR_W02<br>K2MTR_K01 | 30 | 60 | 2 | 1.2 | T | Z | | | K | W |
| 13. | MCD022012P | Designing of embedded systems in electronics | | | | 2 | | K2MTR_U02<br>K2MTR_U06<br>K2MTR_K01<br>K2MTR_K03 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | W |
| | | Total | 4 | 3 | 5 | 5 | 0 | | 180 | 330 | 11 | 7.3 | | | | | | |

## 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 | | | | |
| 10 | 3 | 13 | 5 | 0 | 390 | 900 | 30 | 20.0 |

# 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. | MCD023008W | Reliability in mechatronics | 1 | | | | | K2MTR_W14 K2MTR_K07 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 2. | MCD023008L | Reliability in mechatronics | | | 1 | | | K2MTR_U15 K2MTR_K07 | 15 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| 3. | MCM021203W | Laser Technology | 1 | | | | | K2MTR_W20 | 15 | 30 | 1 | 0.6 | T | Z | | | K | Ob |
| 4. | MCM021203L | Laser Technology | | | 1 | | | K2MTR_U21 K2MTR_U22 K2MTR_K13 | 15 | 30 | 1 | 0.7 | T | Z | | P | K | Ob |
| 5. | MCD023002S | Diploma seminar | | | | | 2 | K2MTR_W07 K2MTR_U06 K2MTR_K01 | 30 | 60 | 2 | 1.4 | T | Z | | P | K | Ob |
| | | Total | 2 | 0 | 2 | 0 | 2 | | 90 | 210 | 7 | 4.7 | | | | | | |

## 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. | MCD023006D | Diploma thesis | | | | | | K2MTR_W08 K2MTR_U07 K2MTR_K02 | 150 | 540 | 18 | 12.6 | T | Z | | P | K | W |
| | **MCM023001BK** | **Management and Logistics** | | | | | | | | | | | | | | | | |
| 2. | MCM023002W | Small Enterprise Management | 2 | | | | | K2MTR_W21 K2MTR_W22 | 30 | 90 | 3 | 1.8 | T | Z | | | KO | W |
| 3. | MCM023002W | Enterprise Management | 2 | | | | | K2MTR_W21 K2MTR_W22 | 30 | 90 | 3 | 1.8 | T | Z | | | KO | W |
| | **MCD023002BK** | **Numerical modeling methods** | | | | | | | | | | | | | | | | |
| 4. | MCD023007W | Modelling of microsystems | 1 | | | | | K2MTR_W13 K2MTR_K06 K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. | MCD023007L | Modelling of microsystems | | | 2 | | | K2MTR_U14<br>K2MTR_K06<br>K2MTR_K14 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| 6. | MCD023009W | Modelling of nanosystems | 1 | | | | | K2MTR_W13<br>K2MTR_K06<br>K2MTR_K14 | 15 | 30 | 1 | 0.6 | T | Z | | | K | W |
| 7. | MCD023009L | Modelling of nanosystems | | | 2 | | | K2MTR_U14<br>K2MTR_K06<br>K2MTR_K14 | 30 | 30 | 1 | 0.7 | T | Z | | P | K | W |
| | | Total | 3 | 0 | 2 | 0 | 0 | | 225 | 690 | 23 | 15.7 | | | | | | |

**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 | | | | |
| 5 | 0 | 4 | 0 | 2 | 315 | 900 | 30 | 20.4 |

## 2. Set of exams in semestral arrangement

| Course code | Name of course credited by examination | Semester |
|---|---|---|
| MCD021003W<br>MCD021001W<br>MCD021003BK | Applied optoelectronics<br>Micromachines and Microactuators<br>Digital communication interfaces | 1 |
| MCD022004W<br>MCD022001W | Novel diagnostic methods<br>Fiber Optics Technology | 2 |

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

| Semester | Allowable deficit of ECTS points after semester |
|---|---|
| 1 | 12 |
| 2 | 6 |

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:** | **17.05.2017** |
| **Field of study:** | **Mechatronics** | **In effect from:** | **01.10.2017** |
| **Studies:** | **2nd level, full-time** | | |

# COURSE CATALOG

**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).**

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Statystyka i rachunek prawdopodobieństwa** |
| Name in English: | **Statistics and probability** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MAT001454** |
| 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. Knows the differential and integral calculus for functions of one variable
2. Has the basic knowledge from the theory of number series and power series
3. Can calculate double integrals

## SUBJECT OBJECTIVES

C01 Study of the basic concepts and methods of probability theory and mathematical statistics

C02 Study of classic probability distributions, their properties and applications in science, technology and different practical problems

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the basic concepts and methods of probability theory and mathematical statistics
PEK_W02 Knows classic probability distributions and their properties

**Relating to skills**

PEK_U01 Understands the basic concepts of probability theory and mathematical statistics
PEK_U02 Can apply the basic methods of mathematical statistics in different theoretical and practical problems

**Relating to social competences**

PEK_K01 Can, without assistance, search for necessary information in the literature
PEK_K02 Understands the need for systematic and independent work on mastery of course material
PEK_K03 Can cooperate in the student group

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Basic concepts of probability. Random variables and their characteristics. | 4 |
| Le_02 | Introduction on the basic methods of descriptive presentation for experimental data: frequency distribution, histogram and cumulative distribution, empirical quantile of the sample, descriptive statistics. | 3 |
| Le_03 | Methods of estimators construction - the method of moments, method of maximum likelihood. Desirable properties of estimators. Simple linear regression. The construction of the regression line. Interval estimation. | 4 |
| Le_04 | Testing of statistical hypothesis. The errors of the first and the second kind in the statistical hypothesis testing. Tests of significance for the mean and variance. The test of comparison of the means of the normal distribution. The general theory of statistical tests: the level of significance and the power of test. | 3 |
| Le_05 | Test for evaluation. | 1 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Solving practical tasks connected with the theory presented in the lecture, | 15 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Lecture – traditional method
ND_02 Laboratory
ND_03 Consultations
ND_04 Student's self work – preparation for the classes

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F1 (labs) | PEK_U01, PEK_U02 PEK_K01-PEK_K03 | Computer projects, solving problems by using statistical packages |
| P = F2 (lecture) | PEK_W01, PEK_W02, PEK_U01, PEK_U02, PEK_K01, PEK_K02 | Test for evaluation |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. A. Pacut, Prawdopodobieństwo. Teoria. Modelowanie probabilistyczne w technice, WNT, Warszawa 1985
2. D. Bobrowski, Probabilistyka w zastosowaniach technicznych, Warszawa 1980
3. W. Krysicki i inni, Rachunek prawdopodobieństwa i statystyka matematyczna w zadaniach, PWN, Warszawa 1995
4. W. Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna. Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław 2003


**Secondary literature**


1. H. Jasiulewicz, W. Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2003
2. W. Feller, Wstęp do rachunku prawdopodobieństwa, PWN, Warszawa 1980
3. Y. Viniotis, Probability and Random Processes for Electrical Engineers, McGraw-Hill, Boston 1998


## SUBJECT SUPERVISOR


**Agnieszka.Wylomanska@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Statistics and probability**

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) | K2MTR_W25 | C01, C02 | Le_01-Le_05 | ND_01, ND_03 |
| PEK_W02 | K2MTR_W25 | C02 | Le_01-Le_05 | ND_01, ND_03 |
| PEK_U01 (skills) | K2MTR_U27 | C01, C02 | La_01 | ND_02-ND_04 |
| PEK_U02 | K2MTR_U27 | C01, C02 | La_01 | ND_02-ND_04 |

| | | | | |
|---|---|---|---|---|
| PEK_K01 (competences) | K2MTR_K15 | C01, C02 | Le_01-Le_05<br>La_01 | ND_02-ND_04 |
| PEK_K02 | K2MTR_K15 | C01, C02 | Le_01-Le_05<br>La_01 | ND_01-ND_04 |
| PEK_K03 | K2MTR_K15 | C01, C02 | La_01 | ND_01-ND_04 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Mikromechanizmy i Mikronapędy** |
| Name in English: | **Microcmachines and Microactuators** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021001** |
| 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) | 30 | | 60 | | |
| Form of crediting | E | | 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 courses on microsystem technique preferred but not obligatory if intensive self-education accepted

## SUBJECT OBJECTIVES

C01 Main goal is accommodation of the knowledge concerning newly developed group of microsystems able to generate move/force and actuation to understand their material/construction and work principles as well as technical applications of different kinds of micromechanisms and microdrives

C02 Additionally, student will be able to choose and use microamachines and microactutors practically

C03 Participation in conducted research on micromachines and microactuators

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student knows the rules of applications of micromachines and microactuators

**Relating to skills**

PEK_U01 Student is able to properly select micromachines and microactuators for specific application. She/he can plan experimental works, use properly selected measurement systems and devices and interpret results of measurements

**Relating to social competences**

PEK_K01 Student is able to cooperate in the group

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Foundaments of micro-engineering, main micromachines and microdrives | 2 |
| Le_02 | Generation and use of move in the microscaled devices | 2 |
| Le_03 | Static and dynamic bulk micromachines: sensors and actuators | 2 |
| Le_04 | Surface micromachines; sensors, actuators, micro drives | 2 |
| Le_05 | LIGA micromachines; microengines, microdrives, tools | 2 |
| Le_06 | Energy harvesters, zero-energetic microsystems | 2 |
| Le_07 | Fluidic flow maintains in micro and nano scale; introduction to lab-chips technique, fluidic micromachines | 2 |
| Le_08 | Micro-automobiles and micro flying objects, another moving micromachines | 2 |
| Le_09 | RF MEMS | 2 |
| Le_10 | Microoptics: parts and systems | 2 |
| Le_11 | Micromachined sensors for vehicles | 2 |
| Le_12 | Micromachines for bio-medicine | 2 |
| Le_13 | Space MEMS and micromachines | 2 |
| Le_14 | 2020 horizon forecast; autonomous micromachine systems | 2 |
| Le_15 | Nanomachines; state-of-art and future development | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Microengines and microgears | 3 |
| La_02 | RF-MEMS; filters and switchers | 3 |
| La_03 | Avionic multiparameters platform | 3 |
| La_04 | Micropumps, microvalves; maintance of microfluidic flow | 3 |
| La_05 | Vibrating systems; sensors of chosen mechanical values | 3 |
| | **TOTAL** | 15 |

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

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 | PEK_W01 | Final colloquium |
| P1 | PEK_U01 | Notes form each laboratory exercise. |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Jan A Dziuban; Bonding in microsystem technology, Springer 2007
2. Nadim Maluf, Kirt Wiliams, An introduction to Microelectromechanical Systems Engineering, Artech House, 2004


**Secondary literature**


1. Wolfgang Menz and others, Microsystem Technology, Wiley-VCH 2001


## SUBJECT SUPERVISOR


**Jan.Dziuban@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Micromachnies and Microactuators**

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) | K2MTR_W10 | C01-C03 | Le_01-Le_15<br>La_01-La_05 | ND_01<br>ND_02 |
| PEK_U01 (skills) | K2MTR_U09, K2MTR_U10 | C01-C03 | La_01-La05 | ND_02 |
| PEK_K01 (competences) | K2MTR_K03 | C01-C03 | La_01-La05 | ND_02 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Zaawansowane technologie mikroelektroniczne** |
| Name in English: | **Advanced microelectronic technologies** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021002** |
| 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) | 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
2. Basic knowledge of mathematics
3. Basic knowledge of chemistry

## SUBJECT OBJECTIVES

C01 Knowledge in the field of advanced fabrication technologies of microelectronic components

C02 Knowledge in the field of modern thin- and thick technologies

C03 To familiarize students with the current state and development trends of advanced micro-and nano-electronics technologies

C04 Participation in research carried out in the laboratories of faculty

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 The student has structured and theoretically founded knowledge in the field of advanced microelectronic technologies, processes of thin-and thick-film electronic components and systems, and transducers of bio-chemical sensors, versed in the current state and development trends of advanced microelectronic technology

**Relating to skills**

PEK_U01 The student is able to design a manufacturing process of selected elements and system fabricated in semiconductors and thick- film technology, is able to determine the direction of further self-learning and achieve learning process

**Relating to social competences**

PEK_K01 The student has an understanding of the influence of technology on the environment, and is aware of the associated limitations

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Modern semiconductor laboratories, „clean room", purity of air, water, reagents and technological gases, safety issues | 2 |
| Le_02 | Types of modern semiconductor substrates, application, fabrication technologies | 2 |
| Le_03 | Fabrication technologies of semiconductor device heterostructures | 2 |
| Le_04 | Technology and application of functionally graded materials | 2 |
| Le_05 | Technology and application of diamond layers, DLC, ND, graphene | 2 |
| Le_06 | Advanced lithographic technologies: immersion lithography, DUV, EUV, EBL, nano-imprint | 2 |
| Le_07 | Fabrication technologies of compound semiconductors electronic devices: HEMT and MOSFET transistors, gas- and bio-sensor transducers | 2 |
| Le_08 | Thin and thick film circuits - basic information | 2 |
| Le_09 | Manufacturing steps of thick film technology | 2 |
| Le_10 | LTCC technology (*Low Temperature Cofired Ceramics*) | 2 |
| Le_11 | Manufacturing of LTCC devices; advanced ceramic package | 2 |
| Le_12 | Design and manufacturing of thick film and LTCC sensors | 2 |
| Le_13 | LTCC microreactors and microsystems | 2 |
| Le_14 | Development trends LTCC technology | 2 |
| Le_15 | Test | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Fabrication of semiconductor device heterostructures | 3 |
| La_02 | Pattern fabrication by EBL | 3 |
| La_03 | Thick film components on alumina substrate | 3 |
| La_04 | Thick film sensors | 3 |
| La_05 | LTCC multilayer devices | 3 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Problem lecture<br>ND_02 Multimedia presentation<br>ND_03 Consultation<br>ND_04 Laboratory experiment<br>ND_05 Own work - preparation for laboratory |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 | PEK_W01, PEK_U01, PEK_K01 | Test |
| F2 | PEK_W01, PEK_U01, PEK_K01 | Report on laboratory exercises |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. R.R. Tummala, Introduction to System-on-Package (SOP), McGraw-Hill, New York, 2008
2. M.Prudenziati and J.Hormadaly, Printed Films", Woodhead Publ., Cambridge, 2012
3. L.Golonka, Zastosowanie ceramiki LTCC w mikroelektronice, Oficyna Wydawnicza PWr, 2001
4. A.Dziedzic, Grubowarstwowe rezystywne mikrokompozyty polimerowo-węglowe, Oficyna Wydawnicza PWr, 2001.
5. Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, Third Edition, Boca Raton, USA, 2011
6. S. Franssila, Introduction to Microfabrication, John Wiley&Sons Ltd, England, 2004
7. Kazuaki Suzuki, Microlithography: Science and Technology, Second Edition, CRC Press, Boca Raton, USA, 2007
8. G. Cao, Y. Wang, Nanostructures and Nanomaterials*:* Synthesis, Properties, and Applications, Second Edition, World Scientific Publishing Co., Pte. Ltd., Singapore, China, 2011


**Secondary literature**


1. Journals: Sensors and Actuators, Microelectronic Reliability. Conference Proceedings (COE, CICMT, ELTE, IMAPS Poland Chapter)
2. Journals: Compound Semiconductors, Semiconductor Engineering


## SUBJECT SUPERVISOR


**Regina.Paszkiewicz@pwr.edu.pl, Leszek.Golonka@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Advanced microelectronic technologies**

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) | K2MTR_W17 | C01-C04 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U18 | C01-C04 | La_01-La_05 | ND_03-ND_05 |
| PEK_K01 (competences) | K2MTR_K10 | C01-C04 | Le_01-Le_15, La_01-La_05 | ND_01-ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Optoelektronika stosowana** |
| Name in English: | **Applied optoelectronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021003** |
| 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 | E | | 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. Knowledge of basic physics
2. Complete course Basic of Photonics
3. Complete course Micro and nanoelectronics

## SUBJECT OBJECTIVES

C01 Presentation of physics of working, construction and technology of applied optoelectronic devices for microsystem units

C02 Acquiring of the sill in measuring and characterisation of optoelectronic systems and devices used in Microsystems

C03 Practice of the team work skills

C04 Participation in research in optoelectronics (e.g., sensors and detectors, miniature photovoltaics, optical converters)

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has got knowledge about technology and applications of modern optoelectronic devices and systems in microsystems

**Relating to skills**

PEK_U01 Has got knowledge how design microsystems with optoelectronic devices and evaluate its functional possibilities

**Relating to social competences**

PEK_K01 Understands the needed of using new technics and technologies and is able to define destinations and forecast results in experimental works also works alone and in team

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Applied optoelectronic – introduction | 1 |
| Le_02 | Specialized light sources in spectra characterisation devices | 3 |
| Le_03 | Photodetectors with high sensitivity and low level of noise | 3 |
| Le_04 | Modern photovoltaic devices for applying in micro power devices | 2 |
| Le_05 | Signal converters in devices optical signal – electric signal | 2 |
| Le_06 | Optoelectronic indicators – optoelectronic linear indicators | 2 |
| Le_07 | Colloquium | 2 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Introduction – basic optoelectronic measurements | 3 |
| La_02 | Measurements of physical quantity with optoelectronic detectors | 3 |
| La_03 | Specialized power sources – spectral characterization | 3 |
| La_04 | Measurements of micro power sources – micro photovoltaics | 3 |
| La_05 | Signal indicators: optical signal – electric signal | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Lecture with presentation and discussion
ND_02 Laboratory: preparing reports
ND_03 Own work – preparing tasks to the lecture
ND_04 Own work – study and preparing to the laboratory
ND_05 Own work – study and preparing to the colloquium

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F1 | PEK_U01, PEK_K01 | Marks average from tasks |
| P = F2 | PEK_W01 | Colloquium |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Printed materials
2. B. Mroziewicz, M. Bugajski, Wł. Nakwaski, Lasery półprzewodnikowe, WNT 1985
3. P. Bhattacharya, Semiconductor Optoelectronic Devices, Second Edition, Prentice Hall New Jersey 1997
4. B. Ziętek, Optoelektronika, Wydawnictwo Uniwersytetu Mikołaja Kopernika, Toruń 2004


**Secondary literature**


1. M. Tłaczała, Epitaksja MOVPE w technologii heterostruktur związków AIIIBV, Oficyna Wydawnicza PWr., 2002


## SUBJECT SUPERVISOR


**Damian.Radziewicz@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Applied 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) | K2MTR_W09 | C01, C04 | Le_01 – Le_07 | ND_01, ND_03, ND_04, ND_06 |
| PEK_U01 (skills) | K2MTR_U08 | C02-C04 | La_01 – La_05 | ND_02, ND_03, ND_05 |
| PEK_K01 (competences) | K2MTR_K05 | C02-C04 | La_01 – La_05 | ND_02, ND_03, ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Projektowanie urządzeń optoelektronicznych** |
| Name in English: | **Design and Construction of Optoelectronic Circuits** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021004** |
| 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. Basic skills and knowledge in electronics

## SUBJECT OBJECTIVES

C01 Learn the basics of design of electronic systems with particular emphasis on optoelectronic components

C02 Learn how to perform basic projects optoelectronic circuits, interaction skills and teamwork

C03 The acquisition of skills in software used to design and analysis of electronic circuits

C04 Improving skills in catalogs and electronic databases

C05 Participation in conducted research in field of optoelectronics, with special attention paid to laser-based system for deflection measurement of the beams applied in near-filed microscopy

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knowledge and understanding of the areas of application and characteristics of optoelectronic circuits and the basic concepts of design of electronic systems with particular emphasis on optoelectronic components

**Relating to skills**

PEK_U01 The ability to select technology and data needed to complete project tasks and projects. Individual performing of basic optoelectronic circuits projects

**Relating to social competences**

PEK_K01 The development of social skills, while also taking responsibility for the results of their actions

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Some organizational lecture: to determine the scope of the course and the requirements for inclusion, discussion of the lecture material, provide a list of literature. Lecture: Principles for determining the technical assumptions and design. | 2 |
| Le_02 | Optoelectronics in electronic circuits. LED types, parameters, and control. Open discussion on the topic. | 2 |
| Le_03 | Semiconductor lasers, types, parameters, and control. Light Detectors - Types, basic configurations preamplifiers. Open discussion on the topic. | 2 |
| Le_04 | Photoelectric Sensors-types, structures, parameters, control. Open discussion on the topic. | 2 |
| Le_05 | Alphanumeric Displays and Imaging. Types, structures, parameters, control, applications. Optocouplers - types, characteristics and applications. Open discussion on the topic. | 2 |
| Le_06 | Light sources and detectors, fiber-optic telecommunications. Light sources and detectors to work with plastic optical fibers. Open discussion on the topic. | 2 |
| Le_07 | Overview of electronic systems of optoelectronic components. Open discussion on the topic. | 2 |
| Le_08 | Summary of the lecture. Prospects for the development of optoelectronic circuit design techniques. Knowledge test. | 1 |
| | **TOTAL** | 15 |

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Determination of the basic assumptions of technical and design for individual student projects. Discuss the practical aspects. | 2 |
| Pr_02 | Analysis of the functions of the designed optoelectronic system. Discuss the practical aspects. | 2 |
| Pr_03 | Analysis of the data directory and the intelligence to adapt to the needs of the project. Discuss the practical aspects. | 2 |
| Pr_04 | Design of optoelectronic circuits meeting technical design assumptions based on existing knowledge and skills. Discuss the practical aspects. | 2 |
| Pr_05 | Design the wiring diagram for the forthcoming project. Simulation of components. Discuss the practical aspects. | 2 |

| | | |
|---|---|---|
| Pr_06 | PCB design for the forthcoming project. To visualize the PCBs. Parts distribution inside device housing. The project of the faceplate. Parameters evaluation. Discussion of results. | 2 |
| Pr_07 | Presentation and defense of the projects. Open discussion about them. | 2 |
| Pr_08 | Presentation and defense of the projects. Open discussion about them. | 1 |
| | **TOTAL** | 15 |

| **TEACHING TOOLS USED** | |
|---|---|
| ND_01 | Traditional lecture with multimedia presentations |
| ND_02 | Presentation of software for the design and analysis of electronic circuits |
| ND_03 | Sample analysis of optoelectronic circuits datasheets |
| ND_04 | Materials for the lecture and project on-line |
| ND_05 | Individual project tasks to execute by each student |
| ND_06 | Common open discussion in the classroom at different stages of learning |
| ND_07 | Consultations and e-mail contact |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (project) | PEK_U01, PEK_K01 | Rating substantive participation in open discussions in class |
| F2 (project) | PEK_U01, PEK_K01 | Rating of the project task design and its presentation |
| F3 (lecture) | PEK_W01 | Knowledge test |
| P1 (lecture) = F3 | | Positive evaluation of the test |
| P2 (project) = 0,3*F1 + 0,7*F2 | | Average rating of discussion and design task |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J.Piprek, "Optoelectronic Devices", Springer-Verlag, 2005
2. J. Siuzdak, "Wstęp do współczesnej telekomunikacji światłowodowej", WKŁ, 1999
3. K.Booth, "Optoelektronika", WKŁ, 2001
4. M. Szustakowski, ”Elementy techniki światłowodowej”, (Cykl wydawniczy: „Fizyka dla przemysłu”), WNT, 1992
5. M. Marciniak, "Łączność światłowodowa", WKŁ, 1998
6. J.E. Midwinter, Y.L. Guo, „Optoelektronika i technika światłowodowa”, WKŁ 1995
7. M. Rusin, "Wizyjne przetworniki optoelektroniczne", WKŁ 1990
8. K.Perlicki, "Pomiary w Optycznych Systemach Telekomunikacyjnych", WKŁ, 2006
9. Sz. Szczeniowski, "Fizyka doświadczalna", Tom IV – "Optyka", PWN, 1983


**Secondary literature**


1. Paek Un-Chul, Oh Kyunghwan, "Silica Optical Fiber Technology for Device and Components", John Wiley, 2012

2. A.Bjarklev, S.Benedetto, A.Willner, "Optical Fiber Communication Systems", Artech House, London, 1996
3. M.Karpierz, E.Weinert-Rączka, "Nieliniowa optyka światłowodowa", WNT, 2009
4. J. Siuzdak, "Systemy i Sieci Fotoniczne", WKŁ, 2009
5. Noe Reinhold, "Essentials of Modern Optical Fiber Communication", Springer-Verlag, 2010
6. G.C.Righini, A.Tajani, A.Cutolo, "An Introduction to Optoelectronic Sensors", World Scientific Pub (London, Singapore, Taipei), 2009
7. Magazines: Elektronika praktyczna, Elektronizacja, Przegląd Telekomunikacyjny itp. and catalogues

**SUBJECT SUPERVISOR**

**Jacek.Radojewski@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

## Design and Construction of Optoelectronic Circuits

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) | K2MTR_W18 | C01, C05 | Le_01-Le_08 | ND_01-ND_04, ND_06, ND_07 |
| PEK_U01 (skills) | K2MTR_U19 | C01-C05 | Pr_01-Pr_08 | ND_03-ND_08 |
| PEK_K01 (competences) | K2MTR_K11 | C01-C05 | Pr_01-Pr_08 | ND_03-ND_08 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Podstawy konstrukcji aparatury elektronicznej** |
| Name in English: | **Foundations of electronic apparatus construction** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021005** |
| 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 | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. No requirements

## SUBJECT OBJECTIVES

C01 Mastery of theoretical knowledge specified in the field of designing and manufacturing electronic equipment

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 A general knowledge in the field of designing and manufacturing electronic equipment

**Relating to social competences**

PEK_K01 Able to set priorities and to choose optimal solutions in the design of electronic devices, also because of the impact on the environment

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction, basic types of electronic equipment | 1 |
| Le_02 | General rules for constructing electronic equipment | 2 |
| Le_03 | Computer aided the constructing process | 1 |
| Le_04 | Materials used in constructions of electronic apparatus | 1 |
| Le_05 | Modularization and standardization of electronic devices | 1 |
| Le_06 | Ergonomics, communication and control of devices | 1 |
| Le_07 | Environmental exposure affecting the electronic equipment | 2 |
| Le_08 | Heat dissipation, cooling | 1 |
| Le_09 | Completion of the course | 2 |
| Le_10 | Proecological design; recycling | 2 |
| Le_11 | Completion of the course | 1 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Lecture with multimedia presentations and discussion
ND_02 Consultation
ND_03 Self-study and preparation for test

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F | PEK_W01, PEK_U01, PEK_K01 | Final test |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. R. Kisiel, Podstawy technologii dla elektroników, Wydawnictwo BTC Korporacja, 2012

**Secondary literature**

1. Z. Krakowski, M. Wozniak, Zasady konstrukcji elektronicznej aparatury pomiarowej, Wrocław, 1976
2. J. Kijak , Konstruowanie urządzeń elektronicznych, WNT, 1975
3. T. Więckowski, Badania kompatybilności elektromagnetycznej urządzeń elektrycznych i elektronicznych, Oficyna Wydawnicza PWr, 2001
4. H.W. Denny, Grunding for the Control of EMI, Don White Consultants Inc, 1989

| **SUBJECT SUPERVISOR** |
| --- |
| **Jan.Felba@pwr.edu.pl** |

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Foundations of electronic apparatus construction**

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) | K2MTR_W04 | C01 | Le_01-Le_08 | ND_01, ND_02, ND_03 |
| PEK_K01 (competences) | K2MTR_K10, K2MTR_K14 | C01 | Le_01-Le_08 | ND_01, ND_02, ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Laboratorium Otwarte (elektroniczne)** |
| Name in English: | **Open Laboratory (Electronics)** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD021006** |
| 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. It is recommended to listen courses in semiconductor devices and electronic systems

## SUBJECT OBJECTIVES

C01 Acquiring skills of self-design, implementation and measurement of analog electronic circuits

## SUBJECT EDUCATIONAL EFFECTS

**Relating to skills**

PEK_U01 Able to design, run and test the electronic analog circuits, is able to estimate cost of the project, knows workplace health and safety rules

**Relating to social competences**

PEK_K01 Able to interact and work in a group, taking different roles, plans activities in a creative way, defines the priorities and sequence of activities

## PROGRAMME CONTENT

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Computer simulation of the system chosen for the implementation (LT SPICE) | 7 |
| La_02 | PCB Design - (EAGLE) | 5 |
| La_03 | Implementation of the PCB (printing, etching, drilling, ...) | 3 |
| La_04 | Assembly of the circuit (superficial or wired) | 3 |
| La_05 | Start-up and measurement of the circuit | 9 |
| La_06 | Report preparation | 3 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Own work - preparation for laboratory

ND_02 Consultation

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P=F1 | PEK_U01, PEK_K01 | Report. Realized (good acting) electronic circuit. |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. J. Izydorczyk, PSPICE, komputerowa symulacja układów elektronicznych, Helion, 1993
2. M. Panek, http://www.wemif.pwr.edu.pl/pp/MPanek/ltspice_instr.pdf, Internet, 2010

**Secondary literature**

1. Discussion forum LTSpice, http://tech.groups.yahoo.com/group/LTspice/, Internet, 2010

## SUBJECT SUPERVISOR

Artur Wiatrowski, PhD; e-mail: **artur.wiatrowski@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Open Laboratory (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_U01 (skills) | K2MTR_U12 | C01 | La_01-La_06 | ND_01, ND_02 |
| PEK_K01 (competences) | K2MTR_K03, K2MTR_K04 | C01 | La_01-La_06 | ND_01, ND_02 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Bezprzewodowe sieci układów bezbateryjnych** |
| Name in English: | **Wireless battery-less networks** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD021007** |
| 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) | 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. Introduction to computer or information technology and basic knowledge of programming in C
2. Basic knowledge of issues related to the functioning and design of digital electronic circuits
3. An elementary knowledge of the construction and operation of computer networks

## SUBJECT OBJECTIVES

C01 Knowledge of the wireless, battery-less networks and electronic circuits

C02 Knowledge of the principles of design and programming network protocols for low-power wireless devices

C03 Ability to design and implement the communication protocol for the network of wireless nodes

C04 Participation in conducted research in the field of security and reliability of energy efficient protocols and telecommunication interfaces in electronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the principles of design and implementation of software for battery-less systems

PEK_W02 Knows the principle of operation and criteria for selection of wireless, low-power communication modules

**Relating to skills**

PEK_U01 Able to design, select components and create a prototype of a wireless, battery-free electronic system

PEK_U02 Able to design and develop a firmware for battery-free wireless system

**Relating to social competences**

PEK_K01 Able to self-study, can prepare for classes, even beyond the issues directly addressed in the classroom

PEK_K02 Able to work in a group, fulfilling the tasks included in the program of the course

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Characteristics and application of wireless battery-less systems | 2 |
| Le_02 | Characteristics of wireless power sources | 2 |
| Le_03 | Energy management for the system | 2 |
| Le_04 | Energy consumption measurement in ULP systems | 2 |
| Le_05 | Programming of low-power microcontrollers | 4 |
| Le_06 | Power and data exchange in ISM band - LF / HF / UHF RFID and NFC | 4 |
| Le_07 | Wireless network topologies | 2 |
| Le_08 | Time synchronization of network nodes | 2 |
| Le_09 | Energy-efficient communication protocols (BLE, ZigBee, ANT, …) | 4 |
| Le_10 | Antennas in a short-range radio systems | 2 |
| Le_11 | Alternative methods of wireless transmission | 2 |
| Le_12 | Final test | 2 |
| | **TOTAL** | 30 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Organizational classes. The demonstration of laboratory equipment | 4 |
| La_02 | Measurements of current-voltage characteristics of energy harvesters | 4 |
| La_03 | Measuring of energy consumption of selected communication modules | 4 |
| La_04 | Measurement of energy consumption of the ULP microcontroller in different power-saving modes | 4 |
| La_05 | Examination of delays and packet loss in the wireless network in the presence of interferences | 4 |
| La_06 | Implementation of wireless battery-less sensor network | 4 |
| La_07 | Reserve classes | 6 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Traditional lecture with presentations and discussion<br>ND_02 Consultation<br>ND_03 Self-study - preparation for classes<br>ND_04 Computer software<br>ND_05 Training kits and laboratory equipment<br>ND_06 Manuals and training materials for laboratories and projects |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| A1 | PEK_W01 PEK_W02 | Final test |
| A2 | PEK_K01 | Preparation and demonstration of a report or presentation |
| A3 | PEK_W01 PEK_W02 | Attendance |
| B1 | PEK_U01 PEK_U02 | Evaluation of all fractional tests to verify the preparation for classes |
| B2 | PEK_U01 PEK_U02 | Reports on realization of subsequent exercises |
| B3 | PEK_U01 PEK_U02 | Semester task |
| Le | PEK_W01 PEK_W02 | 0.8*A1 + 0.1*A2 + 0.1*A3 |
| La | PEK_U01 PEK_U02 PEK_U03 | 0.4*B1 + 0.3*B2 + 0.3*B3 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. K. Holger; Protocols and architectures for wireless sensor networks, 2007
2. M. Kuorilehto; Ultra-low energy wireless sensor networks in practice: theory, realization and deployment, 2007
3. N. Zaman; Wireless sensor networks and energy efficiency : protocols, routing, and management, 2012
4. Y. Zhang; RFID and sensor networks: architectures, protocols, security, and integrations, 2010


**Secondary literature**


1. A. Rida; RFID-enabled sensor design and applications; 2010
2. H. Lehpamer; RFID design principles; 2012


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Wireless battery-less 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) | K2MTR_W03 | C01, C02 | Le_01-Le_11 | ND_01-ND_03 |
| PEK_W02 | K2MTR_W03 | C01, C02 | Le_01-Le_11 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U03 | C03, C04 | La_01-La_06 | ND_03-ND_06 |
| PEK_U02 | K2MTR_U03 | C03, C04 | La_01-La_06 | ND_03-ND_06 |
| PEK_K01 (competences) | K2MTR_K01 | C01 | Le_01-Le_11<br>La_01-La_06 | ND_03 |
| PEK_K02 | K2MTR_K03 | | La_01-La_06 | ND_04-ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Projektowanie bezbateryjnych układów elektronicznych** |
| Name in English: | **Designing of battery-less electronic circuits** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD021008** |
| 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) | 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. Introduction to computer or information technology and basic knowledge of programming in C
2. Basic knowledge of issues related to the functioning and design of digital electronic circuits
3. An elementary knowledge of the construction and operation of computer networks

## SUBJECT OBJECTIVES

C01 Knowledge of the wireless, battery-less electronic systems

C02 Knowledge of design and development of electronic systems with very small current consumption

C03 Ability to design and implement the system for battery-free wireless communication

C04 Ability to develop and present effects of work, including project documentation, of a wireless system

C05 Participation in conducted research in the field of designing energy-efficient electronic systems, including microsystems

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows and understands the principles of design specifics of the development of software for battery-less systems

PEK_W02 Knows the principle of operation and criteria for the selection of energy-saving electronic components of communication modules

**Relating to skills**

PEK_U01 Able to design, select components and create a prototype of a wireless, battery-free electronic system

PEK_U02 Able to design and develop firmware for battery-free wireless system.

PEK_U03 Able to present results of his research, acquire and analyze the information from literature, databases and other correctly selected sources

**Relating to social competences**

PEK_K01 Able to self-study, can prepare for classes, even beyond the issues directly addressed in the classroom

PEK_K02 Able to work in a group, fulfilling the tasks included in the program of the course

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Introduction. Comparison of energy sources for bartery-less systems | 2 |
| Le_02 | Characteristics of ultra-low power (ULP) electronic components | 2 |
| Le_03 | Design of passive and semi-passive battery-less systems | 2 |
| Le_04 | Energy harvesting from ambient light, vibration, thermal sources | 2 |
| Le_05 | Energy harvesting from UHF RF sources | 2 |
| Le_06 | Transfer of energy through inductive coupling (LF and HF RFID) | 2 |
| Le_07 | Features of the ULP microcontrollers | 2 |
| Le_08 | The power saving modes in the ULP microcontrollers | 2 |
| Le_09 | Energy management, voltage converters and supercapacitors | 2 |
| Le_10 | Real Time Clocks (RTC) and RC oscillators | 2 |
| Le_11 | Energy-efficient SRAM, FRAM, EEPROM and Flash | 2 |
| Le_12 | Design of firmware for battery-less systems | 2 |
| Le_13 | Energy-efficient wireless communication | 2 |
| Le_14 | Energy consumption measurement in ULP systems | 2 |
| Le_15 | Final test | 2 |
| | **TOTAL** | 30 |

| **Form of classes - Project** | | Quantity |
|---|---|---|
| Pr_01 | Presentation of the ULP evaluation kits and sample projects | 4 |
| Pr_02 | Selection of projects for implementation and definition of their functional requirements | 4 |
| Pr_03 | The report on the implementation of the power supply subsystem | 4 |
| Pr_04 | The report on the implementation of ULP microcontroller software | 4 |

| | | |
|---|---|---|
| Pr_05 | The report on the implementation of wireless communication | 4 |
| Pr_06 | System tests in laboratory environment | 10 |
| | **TOTAL** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Traditional lecture with presentations and discussion<br>ND_02 Consultation<br>ND_03 Self-study - preparation for classes<br>ND_04 Computer software<br>ND_05 Training kits and laboratory equipment<br>ND_06 Manuals and training materials for laboratories and projects |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| A1 | PEK_W01 PEK_W02 | Final test |
| A2 | PEK_K01 | Preparation and demonstration of a report or presentation |
| A3 | PEK_W01 PEK_W02 | Attendance |
| C1 | PEK_U01 PEK_U02 | Realization of a project according to the schedule |
| C2 | PEK_U01 PEK_U02 | Evaluation of project realization |
| C3 | PEK_U01-PEK_U03 | Evaluation of project documentation (reports) |
| Le | PEK_W01 PEK_W02 | 0.8*A1 + 0.1*A2 + 0.1*A3 |
| Pr | PEK_U01 PEK_U02 PEK_U03 | 0.2*C1 + 0.5*C2 + 0.3*C3 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. K. Holger; Protocols and architectures for wireless sensor networks, 2007
2. M. Kuorilehto; Ultra-low energy wireless sensor networks in practice: theory, realization and deployment, 2007
3. N. Zaman; Wireless sensor networks and energy efficiency : protocols, routing, and management, 2012
4. Y. Zhang; RFID and sensor networks: architectures, protocols, security, and integrations, 2010


**Secondary literature**


1. A. Rida; RFID-enabled sensor design and applications, 2010
2. H. Lehpamer; RFID design principles, 2012


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Designing of battery-less electronic circuits**

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) | K2MTR_W03 | C01-C03 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_W02 | K2MTR_W03 | C01-C03 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U03 | C01-C03, C05 | Pr_01-Pr_06 | ND_03-ND_06 |
| PEK_U02 | K2MTR_U03 | C01-C03, C05 | Pr_01-Pr_06 | ND_03-ND_06 |
| PEK_U03 | K2MTR_U06 | C04 | Pr_01-Pr_06 | ND_03, ND_06 |
| PEK_K01 (competences) | K2MTR_K01 | C01 | Le_01-Le_14<br>Pr_01-Pr_06 | ND_03 |
| PEK_K02 | K2MTR_K03 | | Pr_01-Pr_06 | ND_04-ND_06 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Interfejsy cyfrowe w elektronice** |
| Name in English: | **Digital interfaces in electronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD021009** |
| 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 | E | | 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. Introduction to computer or information technology and basic knowledge of programming in C
2. Basic knowledge of issues related to the functioning and design of digital electronic circuits
3. An elementary knowledge of the construction and operation of computer networks

## SUBJECT OBJECTIVES

C01 Knowledge of the digital interfaces used in mechatronics

C02 Ability to select, set up and run a digital communication interface in the mechatronic design

C03 Ability to use protocol stacks, and the implementation of dedicated software for digital communication

C04 Participation in conducted research in the field of security and reliability of telecommunication protocols and interfaces in electronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the principle of operation, the key features and criteria for the selection of digital communication interface

PEK_W02 Knows the principle of operation and applications of protocol stacks for advanced digital interfaces

**Relating to skills**

PEK_U01 Able to select, configure and test a digital communication interface for the needs of the mechatronic project

PEK_U02 Able to design software which provides digital communication

PEK_U03 Able to prepare a report on the completed exercises or project documentation

**Relating to social competences**

PEK_K01 Able to self-study, can prepare for classes, even beyond the issues directly addressed in the classroom

PEK_K02 Able to work in a group, fulfilling the tasks included in the program of the course

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Serial asynchronous transmission RS232 / RS485 / UART | 2 |
| Le_02 | AT commands. The use of GSM / GPRS modems in telemetry | 2 |
| Le_03 | SPI and I2C buses | 2 |
| Le_04 | Digital wireless short-range communication | 2 |
| Le_05 | LIN and CAN in automotive and automation | 2 |
| Le_06 | Ethernet in home automation | 2 |
| Le_07 | USB bus. HID, CDC and MSD classes | 2 |
| Le_08 | Final test | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Organizational classes. Setting up the development environment and evaluation kits | 4 |
| La_02 | Implementation of client and software for character terminal | 4 |
| La_03 | GSM / GPRS / Bluetooth: use of AT commands | 4 |
| La_04 | Use of I2C and SPI in communication between microcontroller peripherals | 4 |
| La_05 | Implementation of algorithms for RC5 infrared decoder and OOK receiver | 4 |
| La_06 | The implementation of wireless sensor network in a star topology | 4 |
| La_07 | Reserve classes | 6 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Traditional lecture with presentations and discussion<br>ND_02 Consultation<br>ND_03 Self-study - preparation for classes<br>ND_04 Computer software<br>ND_05 Training kits and laboratory equipment<br>ND_06 Manuals and training materials for laboratories and projects |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| A1 | PEK_W01 PEK_W02 | Final test |
| A2 | PEK_K01 | Preparation and demonstration of a report or presentation |
| A3 | PEK_W01 PEK_W02 | Attendance |
| B1 | PEK_W01 PEK_W02 PEK_K01 | Evaluation of all fractional tests to verify the preparation for classes |
| B2 | PEK_U03 | Reports on realization of subsequent exercises |
| B3 | PEK_U01 PEK_U02 | Semester task |
| Le | PEK_W01 PEK_W02 | 0.8*A1 + 0.1*A2 + 0.1*A3 |
| La | PEK_U01 PEK_U02 | 0.4*B1 + 0.3*B2 + 0.3*B3 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. W. Mielczarek; Szeregowe interfejsy cyfrowe, 1994
2. M. Chruściel; Programowalne moduły Ethernetowe w przykładach, 2012
3. W. Mielczarek; USB : uniwersalny interfejs szeregowy, 2005
4. M. Peczarski; Mikrokontrolery STM32 w sieci Ethernet w przykładach, 2011


**Secondary literature**


1. K. Wojtuszkiewicz; Urządzenia techniki komputerowej. Cz. 2, Urządzenia peryferyjne i interfejsy (digital file)
2. R. Chromik; RS 232 w przykładach na PC i AVR, 2010
3. T. Bilski; Interfejsy i urządzenia zewnętrzne; Wydawnictwo Politechniki Poznańskiej, 2007


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Digital interfaces in 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) | K2MTR_W01 | C01 | Le_01-Le_07 | ND_01-ND_03 |
| PEK_W02 | K2MTR_W01 | C01 | Le_01-Le_07 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U01 | C01-C04 | La_01-La_06 | ND_03-ND_06 |
| PEK_U02 | K2MTR_U01 | C01-C04 | La_01-La_06 | ND_03-ND_06 |
| PEK_U03 | K2MTR_U06 | C02 | La_01-La_06 | ND_03,ND_06 |
| PEK_K01 (competences) | K2MTR_K01 | C01 | Le_01-Le_07<br>La_01-La_06 | ND_03 |
| PEK_K02 | K2MTR_K03 | | La_01-La_06 | |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Cyfrowa wymiana danych w elektronice** |
| Name in English: | **Digital data exchange in electronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD021010** |
| 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 | E | | | 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. Introduction to computer or information technology and basic knowledge of programming in C
2. Basic knowledge of issues related to the functioning and design of digital electronic circuits
3. An elementary knowledge of the construction and operation of computer networks

## SUBJECT OBJECTIVES

C01 Knowledge of the digital interfaces used in mechatronics

C02 Ability to select, set up and use a digital communication interface in the mechatronic project

C03 Ability to use protocol stacks, and the developing of dedicated software for the implementation of digital communication

C04 Ability to develop and present effects of work, including project documentation, of a digital communication subsystem

C05 Participation in conducted research in the field of security and reliability of telecommunication protocols and interfaces in electronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the principle of operation, the key features and criteria for the selection of digital communication interface

PEK_W02 Knows the principle of construction and methods of use of protocol stacks for advanced digital interfaces

**Relating to skills**

PEK_U01 Able to design and implement an electronic system realizing data exchange using appropriate for this purpose digital interface

PEK_U02 Able to develop the software which provides digital communications

PEK_U03 Able to prepare a report on the completed practical tasks or project documentation

**Relating to social competences**

PEK_K01 Able to self-study, can prepare for classes, even beyond the issues directly addressed in the classroom

PEK_K02 Able to work in a group, fulfilling the tasks included in the program of the course

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Serial asynchronous transmission RS232/RS485/UART | 2 |
| Le_02 | Flow control and verification of data consistency in asynchronous character oriented interfaces | 2 |
| Le_03 | Character-oriented synchronous serial buses | 2 |
| Le_04 | Wireless, low-power digital communication interfaces | 2 |
| Le_05 | Digital interfaces with extended range and increased resistance to interference | 2 |
| Le_06 | IEEE 802.3 family, packet oriented interfaces - layer 1 and 2 of the ISO / OSI | 2 |
| Le_07 | Universal Serial Bus – specification, operating modes, device classes | 2 |
| Le_08 | Final test | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Project** | | Quantity |
|---|---|---|
| Pr_01 | Organizational classes. Setting up the development environment and evaluation boards | 4 |
| Pr_02 | Implementation of GUI application for communicating with a microcontroller or other device through the serial port | 6 |
| Pr_03 | Practical application of the selected wireless interface (RF or Ir) | 8 |
| Pr_04 | Implementation and use of the TCP / UDP port or USB stack in the microcontroller | 8 |
| Pr_05 | Presentation of the final project | 4 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Traditional lecture with presentations and discussion<br>ND_02 Consultation<br>ND_03 Self-study - preparation for classes<br>ND_04 Computer software<br>ND_05 Training kits and laboratory equipment<br>ND_06 Manuals and training materials for laboratories and projects |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| A1 | PEK_W01 PEK_W02 | Final test |
| A2 | PEK_K01 | Preparation and demonstration of a report or presentation |
| A3 | PEK_W01 PEK_W02 | Attendance |
| C1 | PEK_U01 PEK_U02 | Realization of a project according to the schedule |
| C2 | PEK_U01 PEK_U02 | Evaluation of project realization |
| C3 | PEK_U03 | Evaluation of project documentation (reports) |
| Le | PEK_W01 PEK_W02 | 0.8*A1 + 0.1*A2 + 0.1*A3 |
| Pr | PEK_U01 PEK_U02 PEK_U03 | 0.2*C1 + 0.5*C2 + 0.3*C3 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. W. Mielczarek; Szeregowe interfejsy cyfrowe, 1994
2. M. Chruściel; Programowalne moduły Ethernetowe w przykładach, 2012
3. W. Mielczarek; USB : uniwersalny interfejs szeregowy, 2005
4. M. Peczarski; Mikrokontrolery STM32 w sieci Ethernet w przykładach, 2011


**Secondary literature**


1. K. Wojtuszkiewicz; Urządzenia techniki komputerowej [Dokument elektroniczny]. Cz. 2, Urządzenia peryferyjne i interfejsy
2. R. Chromik; RS 232 w przykładach na PC i AVR, 2010
3. T. Bilski; Interfejsy i urządzenia zewnętrzne; Wydawnictwo Politechniki Poznańskiej, 2007


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Digital data exchange in 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) | K2MTR_W01 | C01, C02 | Le_01-Le_07 | ND_01- ND_03 |
| PEK_W02 | K2MTR_W01 | C01, C03 | Le_01-Le_07 | ND_01- ND_03 |
| PEK_U01 (skills) | K2MTR_U01 | C01, C02, C05 | Pr_01-Pr_05 | ND_03-ND_06 |
| PEK_U02 | K2MTR_U01 | C01-C03, C05 | Pr_01-Pr_05 | ND_03-ND_06 |
| PEK_U03 | K2MTR_U06 | C04 | Pr_01-Pr_05 | ND_03, ND_06 |
| PEK_K01 (competences) | K2MTR_K01 | C01 | Le_01-Le_07<br>Pr_01-Pr_05 | ND_03 |
| PEK_K02 | K2MTR_K03 | | Pr_01-Pr_05 | ND_04-ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Układy przetwarzania sygnałów** |
| Name in English: | **Signal processing systems** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021011** |
| 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. Knowledge about digital circuits design
2. Ability to program in C language
3. Knowledge about the basics of electrotechnique and semiconductor devices

## SUBJECT OBJECTIVES

C01 Familiarizing with digital signal processors and programming techniques enabling signal analysis and processing in real-time

C02 Teaching the ability to implement basic signal processing algorithms by means of digital signal processors (real-time solutions)

C03 Familiarization with basics of linear and nonlinear electronics circuits

C04 Advancing the capability of working in group

C05 Participation in research in the fields connected to MEMS/NEMS signal processing

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student gets basics about linear and nonlinear electronics circuits

PEK_W02 Student gets basic knowledge about DSP processors architecture, DSP programming techniques and hardware support for DSP algorithms

**Relating to skills**

PEK_U01 Student can implement data acquisition and digital filtering algorithms with circular buffers, interrupt control systems and direct memory access modules

PEK_U02 Students can design basic architecture of linear and nonlinear electronic circuit

**Relating to social competences**

PEK_K01 Correctly identifies, resolves and implements, while working in a group, knowledge of the design and application of electronic circuits

PEK_K02 Playing different roles, student can cooperate in a group

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Operational amplifiers-basic circuitry | 2 |
| Le_02 | Analogue to digital and digital to analogue conversters | 2 |
| Le_03 | Differential amplifiers and basic cicruitry for signal acquisition | 2 |
| Le_04 | Test no. 1 – analog systems | 1 |
| Le_05 | Microprocessor based data acquisition systems – programming aspects, interrupt control systems, direct memory access systems | 2 |
| Le_06 | Data buffering– circular and „ping-pong” buffers | 2 |
| Le_07 | Digital filtering – real-time signal processing | 2 |
| Le_08 | Direct digital synthesis– real-time processing | 1 |
| Le_09 | Test no. 2 – digital signal processing part | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Circuits with operational amplifiers | 3 |
| La_02 | Power amplifiers-basics circuits | 3 |
| La_03 | Signal filters | 3 |
| La_04 | Properties of basic phase locked loop circuits | 3 |
| La_05 | Retake laboratory term | 3 |
| La_06 | Introductory classes – introduction to Code Composer Studio environment (Texas Instruments solution) | 3 |
| La_07 | Data acquisition – interrupt control system, DMA | 3 |
| La_08 | Digital filtering – real-time solutions | 3 |
| La_09 | Direct digital synthesis – real-time solutions | 3 |
| La_10 | Retake lab term | 3 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Oral presentation with audiovisual support |
| ND_02 Lab classes with DSP development board and typical laboratory devices (generators, oscilloscopes) |
| ND_03 Consultations |
| ND_04 Home study– preparations for lectures |
| ND_05 Home study – preparations for laboratories |
| ND_06 Home study – preparation for tests |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1(lecture) | PEK_W01 | Test no. 1 |
| F2(lecture) | PEK_W01 | Test no. 2 |
| F3-F5 (lab) | PEK_U02, PEK_K01 | Assessments of lab work – preparation and performing |
| F6-F8(lab) | PEK_U01, PEK_K01 | Assessments of lab work – preparation and performing |
| P(lecture)= (F1+F2)/2 | | |
| P(lab)=(F3+F4+F5+F6+F7+F8)/4 | | |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Kuta: Układy elektroniczne, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków
2. J. Baranowski, G. Czajkowski: Układy analogowe nieliniowe i impulsowe, WNT, Warszawa
3. TMS320C67x/C67x+ DSP CPU and Instruction Set Reference Guide, Texas Instruments 2006
4. TMS320C6000 Programmer's Guide, Texas Instruments 2011
5. TMS320C6000 Peripherals Reference Guide, Texas Instruments 2001


**Secondary literature**


1. Technical documentation available at DSP processors' producers web sites


## SUBJECT SUPERVISOR


**Teodor.Gotszalk@pwr.edu.pl, Grzegorz.Jozwiak@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Signal processing 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 (wiedza) | K2MTR_W16 | C03, C05 | Le_01-Le_04 | ND_01, ND_03, ND_04, ND_06 |
| PEK_W02 | K2MTR_W16 | C01, C02, C05 | Le_05-Le_09 | ND_01, ND_03, ND_04, ND_06 |
| PEK_U01 (umiejętności) | K2MTR_U17 | C02, C05 | La_06-La_10 | ND_02, ND_05 |
| PEK_U02 | K2MTR_U17 | C03, C05 | La_01-La_05 | ND_02,ND_05 |
| PEK_K01 (kompetencje) | K2MTR_K09 | C04, C05 | La_01-La_10 | ND_02,ND_05 |
| PEK_K02 | K2MTR_K03 | C04, C05 | La_01-La10 | ND_01-ND_06 |

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Projektowanie układów przetwarzania sygnałów** |
| Name in English: | **Design of signal processing systems** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD021012** |
| 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. Knowledge about digital circuits design
2. Ability to program in C language
3. Knowledge about the basics of electrotechnique and semiconductor devices

## SUBJECT OBJECTIVES

C01 Familiarizing with digital signal processors and programming techniques enabling signal analysis and processing in real-time

C02 Teaching the ability to implement basic signal processing algorithms by means of digital signal processors (real-time solutions)

C03 Familiarization with basics of linear and nonlinear electronics circuits

C04 Advancing the capability of working in group

C05 Participation in research in the fields connected to MEMS/NEMS signal processing

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student gets basics about linear and nonlinear electronics circuits

PEK_W02 Student gets basic knowledge about DSP processors architecture, DSP programming techniques and hardware support for DSP algorithms

**Relating to skills**

PEK_U01 Student can implement data acquisition and digital filtering algorithms with circular buffers, interrupt control systems and direct memory access modules

PEK_U02 Students can design basic architecture of linear and nonlinear electronic circuit

**Relating to social competences**

PEK_K01 Correctly identifies, resolves and implements, while working in a group, knowledge of the design and application of electronic circuits

PEK_K02 Playing different roles, student can cooperate in a group.

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Design of circuits basing on operational amplifiers-basic circuitry | 2 |
| Le_02 | Analogue to digital and digital and analogue converters-classification, properties and applications | 2 |
| Le_03 | Design and construction of differential basic circuits for data acquistion | 2 |
| Le_04 | Test no. 1 – analog systems, construction and applications | 1 |
| Le_05 | Design of digital signal processing systems – from a problem the solution | 2 |
| Le_06 | Data acquisition and a microprocessor's peripherals: common technical solutions | 2 |
| Le_07 | Optimization of data acquisition process – methods of data buffering | 2 |
| Le_08 | Methods of signal processing and analysis – algorithms, complexity issues, hardware support | 1 |
| Le_09 | Test no. 2 – digital signal processing part | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Project** | | Quantity |
|---|---|---|
| Pr_01 | Design and construction of circuits with operational amplifiers | 3 |
| Pr_02 | Applications and characteristics of circuits using operational amplifiers | 3 |
| Pr_03 | Design of signal filters | 3 |
| Pr_04 | Applications of basic phase locked loop (PLL) circuits | 3 |
| Pr_05 | Retake laboratory-project term | 3 |
| Pr_06 | Introduction to programming IDE, establishing design groups, determination of design problems | 3 |
| Pr_07 | Discussion and design of data acquisition part of the design problem | 3 |
| Pr_08 | Discussion and design of signal processing part of the design problem | 3 |
| Pr_09 | Testing of developed solutions, verification of design requirements and optimization | 3 |
| Pr_10 | Presentation and assessment of developed solutions | 3 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Oral presentation with audiovisual support |
| ND_02 Lab classes with DSP development board and typical laboratory devices (generators, oscilloscopes) |
| ND_03 Consultations |
| ND_04 Home study– preparations for lectures |
| ND_05 Home study – preparations for laboratories |
| ND_06 Home study – preparation for tests |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1(lecture) | PEK_W01 | Test no. 1 |
| F2(lecture) | PEK_W02 | Test no. 2 |
| F3 (design) | PEK_U02, PEK_K01 | Assessment of a developed solution to a design problem |
| F4(design) | PEK_U01, PEK_K01 | Assessment of a developed solution to a design problem |
| P(lecture)= (F1+F2)/2 | | |
| P(lab)=(F3+F4)/2 | | |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Kuta: Układy elektroniczne, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków.
2. J. Baranowski, G. Czajkowski: Układy analogowe nieliniowe i impulsowe, WNT, Warszawa
3. TMS320C67x/C67x+ DSP CPU and Instruction Set Reference Guide, Texas Instruments 2006
4. TMS320C6000 Programmer's Guide, Texas Instruments 2011
5. TMS320C6000 Peripherals Reference Guide, Texas Instruments 2001


**Secondary literature**


1. Technical documentation available at DSP processors' producers web sites.


## SUBJECT SUPERVISOR


**Teodor.Gotszalk@pwr.edu.pl, Grzegorz.Jozwiak@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Design of signal processing 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 (wiedza) | K2MTR_W16 | C03, C05 | Le_01-Le_04 | ND_01, ND_03, ND_04, ND_06 |
| PEK_W02 | K2MTR_W16 | C01, C02, C05 | Le_05-Le_09 | ND_01, ND_03, ND_04, ND_06 |

| | | | | |
|---|---|---|---|---|
| PEK_U01 (umiejętności) | K2MTR_U17 | C02, C05 | Pr_06-Pr_10 | ND_02, ND_05 |
| PEK_U02 | K2MTR_U17 | C03, C05 | Pr_01-Pr_05 | ND_02,ND_05 |
| PEK_K01 (kompetencje) | K2MTR_K09 | C04, C05 | Pr_01-Pr_10 | ND_02,ND_05 |
| PEK_K02 | K2MTR_K03 | C04, C05 | Pr_01-Pr10 | ND_01-ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Technika Światłowodowa** |
| Name in English: | **Fiber Optics Technology** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD022001** |
| 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 | E | | 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 and optics

## SUBJECT OBJECTIVES

C01 Making students familiar with the most important properties and parameters of waveguides

C02 Acquiring knowledge about the basic techniques of manufacturing of optical waveguides and waveguide elements

C03 Acquiring basic skills for measurements and fabrication of waveguide elements

C04 Participation in research in the field of optical fiber technique

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has well organized and theoretically founded knowledge in the field of fiber optics technology, including knowledge necessary to understand physical fundamentals of operation of optical waveguides and optical communication systems

**Relating to skills**

PEK_U01 Knows and applies the principles of occupational health and safety rules when working with lasers and optical fibres

PEK_U02 Can operate basic measurement equipment and assemble measurement systems in the field of fiber optic technology

**Relating to social competences**

PEK_K01 Works independently and in a team

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction – classification and application of optical waveguide | 2 |
| Le_02 | Fundamental properties of optical waveguides | 2 |
| Le_03 | Wave analysis of light propagation in optical waveguides | 2 |
| Le_04 | Fabrication of planar optical waveguides | 2 |
| Le_05 | Fabrication of optical fibers | 2 |
| Le_06 | Fiber optic and optoelectronic packaging | 2 |
| Le_07 | Optical communications | 2 |
| Le_08 | Test – colloquium | 1 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Measurement of numerical aperture | 3 |
| La_02 | Measurement of attenuation of planar optical fibres | 3 |
| La_03 | Preparation and measurements of optical connector | 3 |
| La_04 | Measurement of optical connection line with optical reflectometer | 3 |
| La_05 | Fabrication and measurements of planar optical waveguides | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Classical lecture with presentation and discussion

ND_02 Lectures supported with e-learning tools

ND_03 Laboratory: short tests at the beginning of classes, exercises to be performed in a group

ND_04 Students' own work, preparation of selected issues for the lecture

ND_05 Students' own work, preparation for the lab exercises

ND_06 Students' own work, self-study and preparation for the colloquium

ND_07 Consultations

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 (Lecture) | PEK_W01 | Test or colloquium (final score) |
| F1 (Lecture) | PEK_W01 | Discussions, consultations, on-line tests (forming score) |
| P1 (Labs) | PEK_U01, PEK_U02 | Short tests, assessment of the lab exercise (final score) |
| F1 (Labs) | PEK_U01, PEK_U02 | Discussions, consultations, short tests (forming score) |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. Lecture notes: S. Patela, Podstawy techniki światłowodowej

**Secondary literature**

1. M. Szustakowski, Elementy techniki światłowodowej. Wydaw. Nauk.-Techn., 1992

## SUBJECT SUPERVISOR

**Sergiusz.Patela@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Fiber Optics Technology**

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) | K2MTR_W12 | C01, C02 | Le_01-Le_08 | ND_01, ND_02, ND_04, ND_06, ND_07 |
| PEK_U01 (skills) | K2MTR_U13 | C01-C04 | La_01 | ND_03, ND_05 |
| PEK_U02 | K2MTR_U13 | C03, C04 | La_01-La_05 | ND_03, ND_05, ND_07 |
| PEK_K01 (competences) | K2MTR_K03 | C01-C03 | La_01-La_05 | ND_02, ND_03, ND_07 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Czujniki chemiczne i światłowodowe** |
| Name in English: | **Chemical and optoelectronic sensors** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD022002** |
| 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 | | 90 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 1 | | 3 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 3 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | 2.1 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basic chemistry
2. Completed the appropriate physics course
3. Completed the course of Materials Science and Engineering
4. Completed Fiber Optic I and II courses
5. Basic knowledge about geometrical and wave optics

## SUBJECT OBJECTIVES

C01 To gain knowledge about structures, chemical, biochemical sensors and electrochemical noses

C02 To gain knowledge about electrolytes, especially solid-state electrolytes and electrochemical sensors for gas concentration measurement

C03 To gain knowledge about specific properties of water and method for determining the moisture

C04 To gain knowledge about fiber optic sensors system which are used to measure selected physical and chemical quantities

C05 Participating in research of sensors developed at the Faculty

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has the knowledge on detection methods of volatile substances and gases, necessary to understand the phenomena used in humidity sensors, electrochemical biosensors and electronic noses

PEK_W02 Has the knowledge about geometrical and wave optics, necessary to understand the phenomena used in the operation of optical fiber sensors such as reflection, absorption, scattering, interference

**Relating to skills**

PEK_U01 Able to determine the appropriate type of sensor and use it to determine the concentration of various chemicals substances and to carry out a discussion of the measurement process indicating the sensitivity and accuracy of measurement

PEK_U02 Able to determine the discussion of the measurement results indicating the sensitivity and accuracy of measurement of fiber optic sensors systems and propose improvements of fiber optics constructions

**Relating to social competences**

PEK_K01 Understand the need of sensors for measurement the various chemical and biochemical substances to protect the environment and/or use them in medicine

PEK_K02 Openness in innovative solutions for measuring the physical and chemical parameters important for modern technology and medicine

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | Chemical sensors, definition, types, manufacturing techniques, application areas | 2 |
| Le_02 | The physicochemical processes occurs in chemical gas sensors and sensor parameters | 2 |
| Le_03 | Physical and chemical properties of water and humidity detection method | 1 |
| Le_04 | Electronic noses and biosensors | 2 |
| Le_05 | General information about optical fiber sensors | 2 |
| Le_06 | Modulation methods of light wave parameters used in optical fiber sensors | 2 |
| Le_07 | Apply fiber Bragg grating in sensor systems | 1 |
| Le_08 | Fiber-optic sensor systems in chemical industry, energy industry, medicine and protection of natural environment | 2 |
| Le_09 | Test | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Introduction to laboratory | 3 |
| La_02 | Characterization of resistive gas sensors | 3 |
| La_03 | Characterization of humidity sensors | 3 |
| La_04 | Characterization of the electrochemical sensor with a solid-state electrolyte | 3 |
| La_05 | Characterization of the liquid conductivity sensor | 3 |
| La_06 | Fiber-optic linear displacement sensor | 3 |
| La_07 | Fiber-optic angle displacement sensor | 3 |
| La_08 | Measurement transducer characteristic of fiber microbend sensor | 3 |

| | | |
|---|---|---|
| La_09 | Sensing principles of fibber Bragg grating | 3 |
| La_10 | Term corrective | 3 |
| | **TOTAL** | 30 |

| **TEACHING TOOLS USED** | |
|---|---|
| ND_01 | Traditional lecture presentations |
| ND_02 | Answer before lab |
| ND_03 | Consultation on the content presented in the lecture and the measurement results obtained during laboratory exercises |
| ND_04 | Own work - preparation for laboratory classes including a positive write quizzes and efficient conduct measurements under the guidance of the teacher |
| ND_05 | Own work - self-study exam preparation. |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (lecture) | PEK_W01<br>PEK_W02<br>PEK_W03 | Discussions and consultations<br>Exam |
| F2 (labs) | PEK_U01<br>PEK_U02<br>PEK_U03 | Answer before lab<br>Reports from laboratories |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. L. Hozer, Półprzewodnikowe materiały ceramiczne z aktywnymi granicami ziaren, PWN, 1998
2. Okada, Christopher T., Humidity Sensors : Types, Nanomaterials, and Environmental Monitoring, 2011
3. W. Jakubowski, Przewodniki superjonowe, Właściwości fizyczne i zastosowania, WNT 1988
4. W. Gopel, J. Hesse, J. N. Zemel, Sensors, VCH Publ. INC, New York 1989
5. Francis T. S. Yu, Shizhuo Yin, Marcel Dekker, Fiber Optic Sensors, Inc. 2002
6. J. Dakin, B. Culshaw, Optical Fiber Sensors: principles and components, vol. one, Artech House 1988
7. J. Dakin, B. Culshaw, Optical Fiber Sensors: systems and applications, vol. two, Artech House 1988
8. Z. Kaczmarek, Światłowodowe czujniki i przetworniki pomiarowe, Agenda Wydawnicza PAK, Warszawa 2006
9. P. Ciureanu, S. Middelhoek, Thin film resistive sensors, Inst. Of Phisics Publ


**Secondary literature**


1. Proc. of International Conference *Eurosensors*
2. Proc. of National Conference *Czujniki Optoelektroniczne i Elektroniczne*


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Chemical and optoelectronic sensors**

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) | K2MTR_W15 | C01-C04 | Le_01-Le_04 | ND_01, ND_03, ND_04, ND_05 |
| PEK_W02 | K2MTR_W15 | C01-C04 | Le_05-Le_08 | ND_01, ND_03, ND_04, ND_05 |
| PEK_U01 (skills) | K2MTR_U16 | C01-C05 | La_01-La_05, La_10 | ND_01-ND_04 |
| PEK_U02 | K2MTR_U16 | C01-C05 | La_01, La_06-La_10 | ND_01-ND_04 |
| PEK_K01 (competences) | K2MTR_K08 | C01-C05 | Le_01-Le_08, La_01-La_10 | ND_01-ND_05 |
| PEK_K02 | K2MTR_K08 | C01-C05 | Le_01-Le_08, 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: | **Nowoczesna diagnostyka materiałowa** |
| Name in English: | **Novel diagnostic methods** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD022004** |
| Group of courses: | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | 45 | | |
| Number of hours of total student workload (CNPS) | 60 | | 120 | | |
| Form of crediting | E | | Z | | |
| Number of ECTS points | 2 | | 4 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 4 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | 2.8 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has knowledge of metrology and the use of measurement equipment
2. Student knows and understands the methods of measurement of physical quantities and characteristics of the measured objects
3. Student has ordered and theoretical underpinnings of knowledge in the field of advanced microelectronic technologies, processes instrumented production of thin-and thick-film electronic components and systems
4. Student has a basic knowledge of design of electronic circuits

## SUBJECT OBJECTIVES

C01 Student has ordered knowledge of modern research methods used for the diagnosis of electronic materials and structures

C02 Student can choose the appropriate test method for the diagnosis of materials and electronic structures

C03 Participation in research concerning diagnostic of materials properties

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student has ordered knowledge of modern research methods used for the diagnosis of electronic materials and structures

**Relating to skills**

PEK_U01 Student can choose the appropriate test method for the diagnosis of electronic materials and structures

**Relating to social competences**

PEK_K01 Student is able to work in a group in the implementation of research

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction to materials diagnostics – basic tasks and the role of diagnostic methods in characterization of materials and structures used in micro – and nanoelectronics | 2 |
| Le_02 | Classification and systematization of novel diagnostic methods in terms of electronic materials and structures characterization | 2 |
| Le_03 | Measurements of conductivity and polarization in dielectrics using impedance spectroscopy | 2 |
| Le_04 | AC electric methods in diagnostics of piezoelectrics, ferromagnetucs and devices made of these materials | 2 |
| Le_05 | Diagnosis of mono- and polycrystalline materials using X-ray diffraction methods | 2 |
| Le_06 | Investigations of micro- and nanostructures using focused electron and ions beams | 2 |
| Le_07 | Investigations of nanostructures using integrated scanning probe, electron and ion microscopy methods | 2 |
| Le_08 | Measurements of electrical parameters of semiconductors - EC-V, C-V | 2 |
| Le_09 | Optical characterization methods of semiconductors parameters in room and liquid nitrogen temperatures (photoluminescence) of surface resistance | 2 |
| Le_10 | Contactless electrical parameters measurement methods - microwave probe, mapping | 2 |
| Le_11 | Application of scanning electron microscopy and energy dispersive X-Ray spectroscopy in diagnostics of semiconductor materials and structures | 2 |
| Le_12 | Investigation methods of materials for transparent electronics | 2 |
| Le_13 | Methods of multifunctional properties investigation of oxide coatings | 2 |
| Le_14 | Application of X-ray test methods for evaluation of electronic assemblies | 2 |
| Le_15 | Final exam | 2 |
| | **TOTAL** | 30 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Preliminary laboratory | 3 |
| La_02 | Piezoelectric materials: direct and converse piezoelectric effect | 3 |
| La_03 | Impedance spectroscopy: measurement and analysis of impedance spectra | 3 |
| La_04 | Measurements of soft ferrite properties | 3 |

| | | |
|---|---|---|
| La_05 | The use of X-ray diffraction in the diagnosis of mono- and polycrystalline materials | 3 |
| La_06 | Investigations of micro- and nanostructures using focused electron and ions beams | 3 |
| La_07 | Investigations of nanostructures using integrated scanning probe, electron and ion microscopy methods | 3 |
| La_08 | Measurements of electrical parameters of semiconductors - EC-V, C-V | 3 |
| La_09 | Optical characterization methods of semiconductors parameters in room and liquid nitrogen temperatures (photoluminescence) of surface resistance | 3 |
| La_10 | Contactless electrical parameters measurement methods - microwave probe, mapping | 3 |
| La_11 | Application of scanning electron microscopy and energy dispersive X-Ray spectroscopy in diagnostics of semiconductor materials and structures | 3 |
| La_12 | Determination of basic parameters of multifunctional optical coatings based on transmission and reflection measurements and optical profilometry | 3 |
| La_13 | Determination of antistatic properties and surface resistance of various materials | 3 |
| La_14 | Determination of photocatalytic properties of nanocrystalline materials | 3 |
| La_15 | Application of X-ray test methods for evaluation of electronic assemblies | 3 |
| | **TOTAL** | 45 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Traditional lecture with presentations and discussion |
| ND_02 Consultations |
| ND_03 Own work, preparation for classes |
| ND_04 Laboratory equipment |
| ND_05 Instructions |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P | PEK_W01 | Final test in writing |
| F1 | PEK_U01 | Presence on classes |
| F2 | PEK_U01 | Reports of laboratory classes |
| L | PEK_U01 | =(F1 + F2)/2 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. T. Gotszalk, „Systemy mikroskopii bliskich oddziaływań w badaniach mikro- i nanostruktur”, Oficyna Wydawnicza Politechniki Wrocławskiej, 2004
2. Domaradzki J., Powłoki optyczne na bazie TiO2, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2010
3. Kaczmarek D., Modyfikacja wybranych właściwości cienkich warstw TiO2, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2008
4. P. Matkowski, T. Fałat, „Zastosowanie tomografii komputerowej do oceny jakości mikrostruktur elektronicznych” 2012, Elektronika R. 53, nr 2, s. 48-51
5. Mikroskopia elektronowa, under supervision of Andrzej Barbacki

**Secondary literature**


1. Schröder D., Semiconductor material and device characterization, J. Wiley & Sons, INC., USA, 1998
2. R. Czerniak, "Nowe algorytmy rekonstrukcji obrazu z projekcji z zastosowaniem sieci neuronowych typu Hopfielda",Wydawnictwo Politechniki Częstochowskiej, 2006
3. W. Zhou, Z. Lin Wang (ed.), Scanning Microscopy for Nanotechnology: Techniques and Applications, Springer 2006


**SUBJECT SUPERVISOR**


**Przemyslaw.Matkowski@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Novel diagnostic 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) | K2MTR_W06 | C01 | Le_01-Le_14 | ND_01 ND_02 |
| PEK_U01 (skills) | K2MTR_U04 | C02, C03 | La_01-La_14 | ND_03-ND_05 |
| PEK_K01 (competences) | K2MTR_K03 | | La_01-La_14 | |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Wirtualne przyrządy pomiarowe** |
| Name in English: | **Virtual instruments** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD022005** |
| 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 electric metrology knowledge
2. Ability to read English technical documentation

## SUBJECT OBJECTIVES

C01 Presentation of modern computer controlled measuring devices and measurement systems and principles of virtual instruments composing

C02 Presentation of most common methods for virtual instruments programming

C03 Practical training in virtual instruments creating and programming

C04 Skill development of ability to work in group

C05 Participation in research utilizing virtual instruments

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student is familiar with modern measuring devices design and operation, ways of their controlling and data exchange with computer and principles of virtual instruments design and programming

**Relating to skills**

PEK_U01 Student is able to design, assemble and program the virtual instrument

**Relating to social competences**

PEK_K01 Student sees the positive aspects of the use of virtual control and measuring instruments in engineering practice

PEK_K02 Student is able to cooperate with others during completing the tasks

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Principles of construction and using of modern measuring devices and virtual measurement systems | 3 |
| Le_02 | Interfaces, buses and protocols used in virtual devices | 3 |
| Le_03 | IEEE 488 and SCPI standards | 3 |
| Le_04 | Virtual instruments programming in LabVIEW | 3 |
| Le_05 | Other programming interfaces to communicate with measurement devices | 3 |
| Le_06 | Quiz | 1 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Introduction to the course, basics of LabVIEW | 3 |
| La_02 | Assembling the measurement system, basic devices configuration and data exchange with computer | 3 |
| La_03 | User interface and error handling in LabVIEW | 3 |
| La_04 | Project, assembling and programming of simple virtual instrument | 9 |
| La_05 | Project, assembling and programming of complex virtual instrument | 12 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Lecture with presentations and discussion

ND_02 Supplementary materials for the lecture and laboratory

ND_03 Consultations

ND_04 Own work

ND_05 Grades related to the progress of work during the laboratory classes

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 (lecture) | PEK_W01 | Quiz |
| P2 (laboratory) | PEK_U01 | Tasks evaluation during the classes |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Wiesław Winiecki, Wirtualne przyrządy pomiarowe, Oficyna Wydawnicza Politechniki Warszawskiej (2003)
2. Chruściel Marcin, LabVIEW w praktyce, Wydawnictwo BTC 2008
3. Dariusz Świsulski, Komputerowa technika pomiarowa: oprogramowanie wirtualnych przyrządów pomiarowych w LabVIEW, Agenda Wydawnicza PAK 2005
4. Augustyn Chwaleba, Metrologia Elektryczna, Wydawnictwa Naukowo-Techniczne 2010
5. Thomas J. Bress, Effective LabVIEW Programming, NTS Press 2013


**Secondary literature**


1. Agilent 34401A 6½ Digit Multimeter Users Guide, Agilent Technolgies
2. Agilent 33220A 20 MHz Function / Arbitrary Waveform Generator Users Guide, Agilent Technologies
3. Agilent E364xA Dual Output DC Power Supplies Users Guide, Agilent Technologies
4. Agilent 3000 Series Oscilloscopes Programmer's Reference, Agilent Technologies


## SUBJECT SUPERVISOR


**Tomasz.Piasecki@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Virtual instruments**

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) | K2MTR_W19 | C01, C02, C05 | Le_01-Le_06 | ND_01-ND_04 |
| PEK_U01 (skills) | K2MTR_U20 | C03, C05 | La_01-La_05 | ND_02-ND_05 |
| PEK_K01 (competences) | K2MTR_K12 | C03, C05 | La_01-La_05 | ND_02-ND_05 |
| PEK_K02 | K2MTR_K03 | C04, C05 | La_01-La_05 | ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Programowanie wirtualnych przyrządów pomiarowych** |
| Name in English: | **Virtual instruments programming** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD022006** |
| 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 electric metrology knowledge
2. Basic of object oriented programming languages
3. Ability to read English technical documentation

## SUBJECT OBJECTIVES

C01 Presentation of modern computer controlled measuring devices and measurement systems and principles of virtual instruments composing

C02 Presentation of most common methods for virtual instruments programming

C03 Practical training in virtual instruments programming

C04 Skill development of ability to work in group

C05 Participation in research utilizing virtual instruments

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student is familiar with modern measuring devices design and operation, ways of their controlling and data exchange with computer and principles of virtual instruments design and programming

**Relating to skills**

PEK_U01 Student is able to program the virtual instrument

**Relating to social competences**

PEK_K01 Student sees the positive aspects of the use of virtual control and measuring instruments in engineering practice

PEK_K02 Student is able to cooperate with others during completing the tasks

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Virtual instruments – principles of assembling, data exchange with components and programming | 3 |
| Le_02 | IEEE 488 and SCPI standards in data exchange between computer and components of virtual instruments | 3 |
| Le_03 | Basics of LabVIEW and virtual instruments programming in this environment | 3 |
| Le_04 | Data and signal processing in LabVIEW | 3 |
| Le_05 | Virtual instruments programming in C, C++ and C# using VISA libraries | 3 |
| Le_06 | Quiz | 1 |
| | **TOTAL** | 15 |

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Introduction to the course, basics of LabVIEW | 3 |
| Pr_02 | Basic data exchange between computer and components of the virtual instruments | 3 |
| Pr_03 | User interface and error handling in LabVIEW | 3 |
| Pr_04 | Project and programming of virtual instrument in LabVIEW | 6 |
| Pr_05 | Basic of instrument handling using C# and VISA libraries | 3 |
| Pr_06 | User interface and error handling in virtual instruments programmed in C# | 3 |
| Pr_07 | Project and programming of virtual instrument in C# using VISA libraries | 9 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Lecture with presentations and discussion

ND_02 Supplementary materials for the lecture and laboratory

ND_03 Consultations

ND_04 Own work

ND_05 Grades related to the progress of work during the project classes

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 (lecture) | PEK_W01 | Quiz |
| P2 (labs) | PEK_U01 | Tasks evaluation during the classes |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Wiesław Winiecki, Wirtualne przyrządy pomiarowe, Oficyna Wydawnicza Politechniki Warszawskiej (2003)
2. Chruściel Marcin, LabVIEW w praktyce, Wydawnictwo BTC 2008
3. Dariusz Świsulski, Komputerowa technika pomiarowa: oprogramowanie wirtualnych przyrządów pomiarowych w LabVIEW, Agenda Wydawnicza PAK 2005
4. Dawid Fabianiec, Microsoft Visual Studio 2012, programowanie w C#, Wydawnictwo Helion 2013
5. Augustyn Chwaleba, Metrologia Elektryczna, Wydawnictwa Naukowo-Techniczne 2010
6. Thomas J. Bress, Effective LabVIEW Programming, NTS Press 2013
7. VISA COM Online Reference, Agilent Technologies


**Secondary literature**


1. Agilent 34401A 6½ Digit Multimeter Users Guide, Agilent Technolgies
2. Agilent 33220A 20 MHz Function / Arbitrary Waveform Generator Users Guide, Agilent Technologies
3. Agilent E364xA Dual Output DC Power Supplies Users Guide, Agilent Technologies
4. Agilent 3000 Series Oscilloscopes Programmer's Reference, Agilent Technologies


## SUBJECT SUPERVISOR


**Tomasz.Piasecki@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Virtual instruments 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) | K2MTR_W19 | C01, C02, C05 | Le_01-Le_06 | ND_01-ND_04 |
| PEK_U01 (skills) | K2MTR_U20 | C03, C05 | Pr_01-Pr_05 | ND_02-ND_05 |
| PEK_K01 (competences) | K2MTR_K12 | C03, C05 | Pr_01-Pr_05 | ND_02-ND_05 |
| PEK_K02 | K2MTR_K03 | C04, C05 | Pr_01-Pr_05 | ND_05 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Komunikacja w mikrokontrolerach** |
| Name in English: | **Communication in microcontrollers** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD022007** |
| 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. Completion of any course related to programming of microcontrollers

## SUBJECT OBJECTIVES

C01 Gaining the ability of independent development and use of microprocessors and microcontrollers for engineering purposes

C02 Gaining the ability to communicate the microprocessor with other digital circuits

C03 Participation in conducted research on communication in microcontrolers

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has knowledge of microprocessor architectures and programming

**Relating to skills**

PEK_U01 Is able to program a microcontroller and to evaluate its functionality

**Relating to social competences**

PEK_K01 He can appropriately define priorities for implementing a specific task

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction to the topic | 2 |
| Le_02 | Structure, operation and programming of an AVR microcontroller | 2 |
| Le_03 | Structure, operation and programming of an AVR microcontroller - continuation | 2 |
| Le_04 | Communication protocols (I2C) | 2 |
| Le_05 | Communication protocols (SPI) | 2 |
| Le_06 | Communication protocols (USART,USB) | 2 |
| Le_07 | Internal devices of an AVR microcontroller | 2 |
| Le_08 | Internal devices of an AVR microcontroller - continuation | 1 |
| | **TOTAL** | 15 |

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Organizational classes / introduction to the topic | 3 |
| Pr_02 | Microcontroller in *Sleep* modes | 3 |
| Pr_03 | *Two Wire Interface* bus | 3 |
| Pr_04 | *Serial Peripheral Interface* bus | 3 |
| Pr_05 | RS-232- compatible communication buses, USB | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Self-work – preparing to classes

ND_02 Completion of a project on a laboratory model

ND_03 Traditional lecture with use of a digital projector

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F | PEK_W01 | Individual work evaluation |
| F | PEK_U01 | Individual work evaluation |
| F | PEK_K01 | Individual work evaluation |

| | | |
|---|---|---|
| P | PEK_U01 | Final test |
| P | PEK_W01 | Final test |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Atmel AVR XMEGA AU Manual
2. Kardaś M., Mikrokontrolery AVR - język C: podstawy programowania
3. The Atmel AVR Microcontroller: MEGA and XMEGA in Assembly and C, Han-Way Huang


**Secondary literature**


1. Francuz T., Język C dla mikrokontrolerów AVR: od podstaw do zaawansowanych aplikacji
2. Doliński J., Mikrokontrolery AVR w praktyce


## SUBJECT SUPERVISOR


**Piotr.Markowski@pwr.edu.pl, Michal.Krysztof@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Communication in microcontrollers**

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) | K2MTR_W05 | C01-C03 | La_01-La_05, Le_01-Le_05 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U05 | C01-C03 | La_01-La_05, Le_01-Le_05 | ND_01-ND_03 |
| PEK_K01 (competences) | K2MTR_K14 | C01-C03 | La_01-La_05, Le_01-Le_05 | ND_01-ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Sterowanie mikroprocesorowe** |
| Name in English: | **Microprocessor control** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD022008** |
| 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. Completion of any course related to programming of microcontrollers

## SUBJECT OBJECTIVES

C01 Gaining the ability of independent development and use of microprocessors and microcontrollers for engineering purposes

C02 Gaining the ability to communicate the microprocessor with other digital circuits

C03 Participation in conducted research using microprocessor with other digital circuits

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has knowledge of microprocessor architectures and programming

**Relating to skills**

PEK_U01 Is able to program a microcontroller and to evaluate its functionality

**Relating to social competences**

PEK_K01 He can appropriately define priorities for implementing a specific task

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction to the topic, structure and operation of an AVR microcontroller | 2 |
| Le_02 | AVR microcontroller programming in C | 2 |
| Le_03 | Peripherals | 2 |
| Le_04 | Peripherals - continuation | 2 |
| Le_05 | Digital communication buses | 2 |
| Le_06 | Digital communication buses - continuation | 2 |
| Le_07 | Digital communication buses - continuation | 2 |
| Le_08 | Summary | 1 |
| | **TOTAL** | 15 |

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Organizational classes / introduction to the topic | 3 |
| Pr_02 | Power saving mode in microcontroller | 3 |
| Pr_03 | Communication between microcontroller and peripherals (I2C/TWI) | 3 |
| Pr_04 | Communication between microcontroller and peripherals (SPI) | 3 |
| Pr_05 | Communication between microcontroller and computer (USART, USB) | 3 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Self-work – preparing to classes

ND_02 Completion of a project on a laboratory model

ND_03 Traditional lecture with use of a digital projector

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F | PEK_W01 | Individual work evaluation |
| F | PEK_U01 | Individual work evaluation |
| F | PEK_K01 | Individual work evaluation |

| | | |
|---|---|---|
| P | PEK_U01 | Final test |
| P | PEK_W01 | Final test |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Atmel AVR XMEGA AU Manual
2. Kardaś M., Mikrokontrolery AVR - język C: podstawy programowania
3. The Atmel AVR Microcontroller: MEGA and XMEGA in Assembly and C, Han-Way Huang


**Secondary literature**


1. Francuz T., Język C dla mikrokontrolerów AVR : od podstaw do zaawansowanych aplikacji
2. Doliński J., Mikrokontrolery AVR w praktyce


## SUBJECT SUPERVISOR


**Piotr.Markowski@pwr.edu.pl, Michal.Krysztof@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Microprocessor control**

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) | K2MTR_W05 | C01-C03 | Pr_01-Pr_05, Le_01-Le_05 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U05 | C01-C03 | Pr_01-Pr_05, Le_01-Le_05 | ND_01-ND_03 |
| PEK_K01 (competences) | K2MTR_K14 | C01-C03 | Pr_01-Pr_05, Le_01-Le_05 | ND_01-ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Zastosowania systemów wbudowanych w elektronice** |
| Name in English: | **Applications of embedded systems in electronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD022009** |
| 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) | 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. Introduction to computer or information technology and basic knowledge of programming in C
2. Basic knowledge of issues related to the functioning and design of digital electronic circuits
3. An elementary knowledge of the construction and operation of computer networks

## SUBJECT OBJECTIVES

C01 Knowledge of the construction, applications and methods of use of embedded systems in mechatronics

C02 Knowledge of development and testing of high reliability software

C03 Ability to design or adapt an existing embedded system in order to provide required functionality of the final system

C04 Participation of students in conducted research in the field of the methodology for producing reliable software for use in embedded systems, taking into account the safety aspects of the system

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the design methodology and programming of embedded systems in mechatronics
PEK_W02 Understands the principle of operation and the necessity of the use of embedded systems in mechatronics

**Relating to skills**

PEK_U01 Is able to adapt the available embedded systems to the needs of the mechatronic project
PEK_U02 Is able to design an embedded system meeting the increased requirements of reliability

**Relating to social competences**

PEK_K01 Able to self-study, can prepare for classes, even beyond the issues directly addressed in the classroom
PEK_K02 Able to work in a group, fulfilling the tasks included in the program of the course

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction. Applications and implementations of embedded systems | 2 |
| Le_02 | Characteristics of microcontrollers and microprocessors for their applications in various types of embedded systems | 2 |
| Le_03 | Programming languages for embedded systems. Tools and techniques to support the creation of a reliable firmware | 2 |
| Le_04 | Designing of event-driven and interrupt-driven applications | 2 |
| Le_05 | The use of state machines and their implementation in microprocessor systems and programmable gate arrays | 2 |
| Le_06 | Overview and characteristics of peripheral circuits | 2 |
| Le_07 | Floating-point vs. fixed-point calculations | 2 |
| Le_08 | The algorithm of discrete Proportional-Integral-Differential controller | 2 |
| Le_09 | Characteristics of embedded file systems: a comparison of FAT / ext / NTFS | 2 |
| Le_10 | Implementation of the communication with the Internet in embedded systems | 2 |
| Le_11 | Applications of the real-time operating systems | 2 |
| Le_12 | The procedure for preparing the Linux system image for single-board computer | 2 |
| Le_13 | The use of embedded Linux system as a graphical user interface | 2 |
| Le_14 | Characteristics, programming and integration of Android with electronic devices | 2 |
| Le_15 | Final test | 2 |
| | **TOTAL** | 30 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Organizational classes | 4 |
| La_02 | Electronic lock with keypad, display and proximity card reader | 4 |
| La_03 | Implementation of the thermostat with PID control | 4 |
| La_04 | Measurement data logger supporting embedded FAT file system | 4 |
| La_05 | Automation system controller with embedded web server for smart building | 4 |

| | | |
|---|---|---|
| La_06 | Implementation of software for graphical touch panel device | 4 |
| La_07 | Reserve classes | 6 |
| | **TOTAL** | 30 |

| **TEACHING TOOLS USED** |
|---|
| ND_01 Traditional lecture with presentations and discussion<br>ND_02 Consultation<br>ND_03 Self-study - preparation for classes<br>ND_04 Computer software<br>ND_05 Training kits and laboratory equipment<br>ND_06 Manuals and training materials for laboratories and projects |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| A1 | PEK_W01 PEK_W02 | Final test |
| A2 | PEK_K01 | Preparation and demonstration of a report or presentation |
| A3 | PEK_W01 PEK_W02 | Attendance |
| B1 | PEK_U01 PEK_U02 | Evaluation of all fractional tests to verify the preparation for classes |
| B2 | PEK_U01 PEK_U02 | Reports on realization of subsequent exercises |
| B3 | PEK_U03 | Semester task |
| Le | PEK_W01 PEK_W02 | 0.8*A1 + 0.1*A2 + 0.1*A3 |
| La | PEK_U01 PEK_U02 PEK_U03 | 0.4*B1 + 0.3*B2 + 0.3*B3 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Ł. Skalski, Linux : podstawy i aplikacje dla systemów embedded, 2012
2. M. Bis, Linux w systemach embedded, 2011
3. R. Dubey, Introduction to Embedded System Design Using Field Programmable Gate Arrays, 2010
4. B.P. Douglass, Design patterns for embedded systems in C [Dokument elektroniczny]: an embedded software engineering toolkit, 2011
5. R. Zurawski, Embedded systems handbook. [vol. 1], Embedded systems design and verification, 2009
6. R. Zurawski, Embedded systems handbook. [vol. 2], Networked embedded systems, 2009
7. J. Lehtimaki, Android UI. Podręcznik dla projektantów, 2013


**Secondary literature**


1. M. Riley, Inteligentny dom: automatyzacja mieszkania za pomocą platformy Arduino, systemu Android i zwykłego komputera, 2013
2. G. Stringham, Hardware/firmware interface design : best practices for improving embedded systems development, 2010
3. R. Sass, Embedded systems design with platform FPGAs [Dokument elektroniczny] : principles and practices, 2010


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Applications of embedded systems in 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) | K2MTR_W02 | C01, C02 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_W02 | K2MTR_W02 | C01, C02 | Le_01-Le_14 | ND_01-ND_03 |
| PEK_U01 (skills) | K2MTR_U02 | C03, C04 | La_01-La_06 | ND_03-ND_06 |
| PEK_U02 | K2MTR_U02 | C03, C04 | La_01-La_06 | ND_03-ND_06 |
| PEK_K01 (competences) | K2MTR_K01 | C01 | Le_01-Le_14<br>La_01-La_06 | ND_03 |
| PEK_K02 | K2MTR_K03 | | La_01-La_06 | ND_04-ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Projektowanie systemów wbudowanych w elektronice** |
| Name in English: | **Designing of embedded systems in electronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD022010** |
| 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) | 40 | | | 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. Introduction to computer or information technology and basic knowledge of programming in C
2. Basic knowledge of issues related to the functioning and design of digital electronic circuits
3. An elementary knowledge of the construction and operation of computer networks

## SUBJECT OBJECTIVES

C01 Knowledge of the construction, applications and methods of use of embedded systems in mechatronics

C02 Knowledge of development and testing of high reliability software

C03 Ability to design or adapt an existing embedded system in order to provide required functionality of the final system

C04 Ability to develop and present effects of work, including project documentation, of an embedded system

C05 Participation of students in conducted research in the field of the methodology for producing reliable software for use in embedded systems, taking into account the safety aspects of the system

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the design methodology and programming of embedded systems in mechatronics
PEK_W02 Understands the principle of operation and the necessity of the use of embedded systems in mechatronics and electronics

**Relating to skills**

PEK_U01 Is able to design, construct and start an embedded system
PEK_U02 Is able to design an embedded system meeting the increased requirements of reliability
PEK_U03 Is able to prepare a report from realized practical tasks and project's documentation

**Relating to social competences**

PEK_K01 Able to self-study, can prepare for classes, even beyond the issues directly addressed in the classroom
PEK_K02 Able to work in a group, fulfilling the tasks included in the program of the course

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction. Applications and implementations of embedded systems | 2 |
| Le_02 | Microcontrollers and microprocessors in embedded systems | 2 |
| Le_03 | Embedded C and MISRA-C. Static and dynamic code analysis | 2 |
| Le_04 | Event-Driven Programming | 2 |
| Le_05 | The implementation of a state machine in the microcontroller and FPGA | 2 |
| Le_06 | Applications and programming methods of peripherals | 2 |
| Le_07 | Floating-point vs. fixed-point calculations | 2 |
| Le_08 | The microprocessor-based PID controller implementation | 2 |
| Le_09 | Embedded FAT filesystem | 2 |
| Le_10 | Embedded TCP / IP stack and webserver | 2 |
| Le_11 | Applications of real-time operating systems | 2 |
| Le_12 | Running the Linux on single-board computer | 2 |
| Le_13 | Programming of GUI application in embedded Linux system | 2 |
| Le_14 | Android | 2 |
| Le_15 | Final test | 2 |
| | **TOTAL** | 30 |

| Form of classes - Project | | Quantity |
|---|---|---|
| Pr_01 | Selection of the project subject and initial assumptions | 4 |
| Pr_02 | The concept of solution: choice of hardware, operating system and software | 8 |
| Pr_03 | Development of missing system components in the OpenLab | 10 |
| Pr_04 | Development and launching of an embedded system | 8 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED |
|---|
| ND_01 Traditional lecture with presentations and discussion<br>ND_02 Consultation<br>ND_03 Self-study - preparation for classes<br>ND_04 Computer software<br>ND_05 Training kits and laboratory equipment<br>ND_06 Manuals and training materials for laboratories and projects |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| A1 | PEK_W01 PEK_W02 | Final test |
| A2 | PEK_K01 | Preparation and demonstration of a report or presentation |
| A3 | PEK_W01 PEK_W02 | Attendance |
| C1 | PEK_U01 PEK_U02 | Realization of a project according to the schedule |
| C2 | PEK_U01 PEK_U02 | Evaluation of project realization |
| C3 | PEK_U03 | Evaluation of project documentation (reports) |
| Le | PEK_W01 PEK_W02 | 0.8*A1 + 0.1*A2 + 0.1*A3 |
| Pr | PEK_U01 PEK_U02 PEK_U03 | 0.2*C1 + 0.5*C2 + 0.3*C3 |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Ł. Skalski, Linux : podstawy i aplikacje dla systemów embedded, 2012
2. M. Bis, Linux w systemach embedded, 2011
3. R. Dubey, Introduction to Embedded System Design Using Field Programmable Gate Arrays, 2010
4. B.P. Douglass, Design patterns for embedded systems in C [Dokument elektroniczny]: an embedded software engineering toolkit, 2011
5. R. Zurawski, Embedded systems handbook. [vol. 1], Embedded systems design and verification, 2009
6. R. Zurawski, Embedded systems handbook. [vol. 2], Networked embedded systems, 2009
7. J. Lehtimaki, Android UI. Podręcznik dla projektantów, 2013


**Secondary literature**


1. M. Riley, Inteligentny dom: automatyzacja mieszkania za pomocą platformy Arduino, systemu Android i zwykłego komputera, 2013
2. G. Stringham, Hardware/firmware interface design: best practices for improving embedded systems development, 2010
3. R. Sass, Embedded systems design with platform FPGAs: principles and practices [Dokument elektroniczny], 2010


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Designing of embedded systems in 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) | K2MTR_W02 | C01, C02 | Le_01-Le_14 | ND_01-ND_03, ND_06 |
| PEK_W02 | K2MTR_W02 | C01, C02 | Le_01-Le_14 | ND_01-ND_06 |
| PEK_U01 (skills) | K2MTR_U02 | C03-C05 | Pr_01-Pr_04 | ND_04-ND_06 |
| PEK_U02 | K2MTR_U02 | C03-C05 | Pr_01-Pr_04 | ND_01-ND_06 |
| PEK_U03 | K2MTR_U06 | C04 | Pr_01-Pr_04 | ND_03, ND_06 |
| PEK_K01 (competences) | K2MTR_K01 | C01, C02 | Le_01-Le_15<br>Pr_01-Pr_04 | ND_03 |
| PEK_K02 | K2MTR_K03 | | Pr_01-Pr_04 | ND_04-ND_06 |

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | | |
|---|---|---|
| Name in Polish: | **MOEMSy** | |
| Name in English: | **MOEMS** | |
| Main field of studies: | **Mechatronics** | |
| Level and form of studies: | **II level** | **/ Full time** |
| Kind of subject: | **Obligatory** | **/ Faculty** |
| Subject code: | **MCD022013** | |
| 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 | | 90 | | |
| Form of crediting | Z | | Z | | |
| Number of ECTS points | 2 | | 3 | | |
| Including number of ECTS points for practical (P) classes | 0 | | 3 | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 1.2 | | 2.1 | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge on the microsystem technique would be appreciated

## SUBJECT OBJECTIVES

C01 The main goal is to present a family of new microsystem components and instruments with optical functions known as micro-optic-electromechanical systems (MOEMS). Student will understand technology and work of MOEMS as well as their technical applications

C02 Participation in conducted research on MOEMS

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Student knows construction, technology and rules of applications of modern mcire-optoe0electro-mechanical Systems (MOEMS)

**Relating to skills**

PEK_U01 Student is able to properly select MEOMS for specific application. She/he can plan experimental works, use properly selected measurement systems and devices and interpret results of measurements

**Relating to social competences**

PEK_K01 Student is able to cooperate in the group

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Convergence of MEMS-MOEMS construction and technology, classification of MEOMS, fields of application, market and producers, history and future | 2 |
| Le_02 | Static micro-optical components; couplers and micro lenses, 1-D, 2-D diffraction grades, optical microbenches, etc. | 2 |
| Le_03 | Modulators and filters, LIGA spectrometers. Confocal and SNOM integrated microscopes. Movable micro optic components; mirrors, adaptive optical microcomponents; DMD projectors, SNOM/confocal integrated microscopes, mechano-optical memory | 2 |
| Le_04 | Physical and chemical MOEMS sensors for micro-analytical purposes. Photometric microsensors VIS/NIR for chemistry, biology and medicine | 2 |
| Le_05 | Fluorymetric microsensors; scale factor, chromophores, light sources and detectors. Applications in DNA lab-chips and another analytical instruments | 2 |
| Le_06 | Micro atomic clock on-chip with CPT effect | 2 |
| Le_07 | Optical micromagnetometers and interferometers on-chip | 2 |
| Le_08 | Summary and test | 1 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Introduction – specific of experiments | 3 |
| La_02 | Fibre-optic MOEMS switcher | 3 |
| La_03 | DMD projector with micro-matrix | 3 |
| La_04 | Microspectrometer integrated VIS-NIR | 3 |
| La_05 | Absorbance MOEMS fluidic analyser VI-NIR | 3 |
| La_06 | Fluorymetric MOEMS analyser | 3 |
| La_07 | Optical cesium microcell for atomic microclock | 3 |
| La_08 | MOEMS pressure/radiation sensor | 3 |
| La_09 | DNA microsystem with optical detection CCD | 3 |
| La_10 | Additional term | 3 |
| | **TOTAL** | 30 |

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

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 | PEK_W01 | Final colloquium |
| P1 | PEK_U01, PEK_U02 | Notes from each laboratory excise. |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. Manouchehr E. Motamedi; MOEMS, SPIE Press, 2005

**Secondary literature**

1. Stephen A. Campbell; The Science and Engineering of Microelectronic Fabrication, Oxford University Press, 2001

## SUBJECT SUPERVISOR

**Jan.Dziuban@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**MOEMS**

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) | K2MTR_W11 | C01, C02 | Le_01-Le_08 | ND_01, ND_02 |
| PEK_U01 (skills) | K2MTR_U10<br>K2MTR_U11 | C01, C02 | La_01-La_10 | ND_02 |
| PEK_K01 (competences) | K2MTR_K03 | C01, C02 | La_01-La_10 | ND_02 |

Attachment no. 4 to ZW 33/2012

**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: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD023002** |
| 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. Knowledge of basic physics ECTS credit no greater than it is due to the resolution of the Council of the Faculty

## SUBJECT OBJECTIVES

C01 The student's self-presentation skills qualification from the scope of the knowledge, skills and social competence

C02 Persisting the ability to work in a group

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 The student has an ordered and structured, underpinned by the theory of general and detailed knowledge required for the field of Mechatronics

**Relating to skills**

PEK_U01 The student can submit the results of their research, to obtain and analyze information from the literature, databases, and other properly selected sources; to present their skills in the field of knowledge, skills and social competences typical for the field 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, student understands the need for continuing their education process and knows the educational possibilities

| **Form of classes - Seminar** | | Quantity |
|---|---|---|
| Se_01 | Introduction. Information about diploma work and diploma exam - requirements | 2 |
| Se_02 | Overview and scope of the topics diploma works foreseen and the rules for creating the correct technical and scientific texts | 2 |
| Se_03 | Overview and scope of the topics diploma works foreseen and the rules for creating the correct technical and scientific texts | 2 |
| Se_04 | Multimedia presentations, CV (expanded version), discussion | 2 |
| Se_05 | Multimedia presentations, CV (expanded version), discussion | 2 |
| Se_06 | Discussion of the issues concerning diploma exam, comments | 2 |
| Se_07 | Discussion of the issues concerning diploma exam, comments | 2 |
| Se_08 | Discussion of the issues concerning diploma exam, comments | 2 |
| Se_09 | Discussion of the issues concerning diploma exam, comments | 2 |
| Se_10 | Multimedia presentations of the diploma works, discussion | 2 |
| Se_11 | Multimedia presentations of the diploma works, discussion | 2 |
| Se_12 | Multimedia presentations of the diploma works, discussion | 2 |
| Se_13 | Presentation and preparations for the diploma exam | 2 |
| Se_14 | Presentation and preparations for the diploma exam | 2 |
| Se_15 | 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 |
|---|---|---|
| P = F | PEK_W01,<br>PEK_U01,<br>PEK_K01 | The ability to discuss the issues raised in the discussion, activity in the course classes |

## 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) | K2MTR_W07 | C01 | Se_02-Se_14 | ND_01, ND_02, ND_04 |
| PEK_U01 (skills) | K2MTR_U06 | C01, C02 | Se_02-Se_14 | ND_01, ND_02, ND_04 |
| PEK_K01 (competences) | K2MTR_K01 | C02 | Se_02-Se_14 | ND_01, ND_02, 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: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD023003** |
| Group of courses: | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | | | | 150 | |
| Number of hours of total student workload (CNPS) | | | | 540 | |
| Form of crediting | | | | Z | |
| Number of ECTS points | | | | 18 | |
| Including number of ECTS points for practical (P) classes | | | | 18 | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | | | | 12.6 | |

## 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 field of study of Mechatronics

C02 Writing by a student "thesis" (as work) and to present an oral presentation concerning the issues of the scope of the study Mechatronics, on the basis of the information from the literature and the results of their own work

C03 Persisting the ability to work independently and in a team

C04 Participation in research in an area related to the areas of need for relevant to the field of study of Mechatronic (e.g., electronics, photonics, microsystems, sensors, informatics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 The student executed thesis, based on a knowledge obtained during studying in the field of the Mechatronics

**Relating to skills**

PEK_U01 Student can create technical texts ("thesis") and multimedia presentations, presenting the results of their research; to obtain and analyze information from the literature, databases, and other proper sources, in the field of the Mechatronics

**Relating to social competences**

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

## PROGRAMME CONTENT

| | **Form of classes – Project** | Quantity |
|---|---|---|
| Pr_01 | Collecting the literature of the subject and to become acquainted with it | |
| Pr_02 | Own work – critical assessment and interpretation of laboratory results | |
| Pr_03 | Writing a thesis as a works | |
| | **TOTAL** | |

## 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 |
|---|---|---|
| | PEK_W01<br>PEK_U01,<br>PEK_K01 | Work in a semester, the delivery of thesis as a works, accepted and appreciated |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. Specialist subject 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) | K2MTR_W08 | C01, C04 | Pr_01 | ND_01, ND_02, ND_04 |
| PEK_U01 (skills) | K2MTR_U07 | C02, C04 | Pr_02, Pr_03 | ND_01, ND_03, ND_04 |
| PEK_K01 (competences) | K2MTR_K02 | C03, C04 | Pr_01-Pr_03 | ND_01, ND_02, ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

## SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Modelowanie mikrosystemów** |
| Name in English: | **Modelling of microsystems** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD023007** |
| 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 | | 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 on physics and mathematics
2. Basic knowledge on numerical methods
3. Basic knowledge on computer skills

## SUBJECT OBJECTIVES

C1 Getting familiarize with numerical prototyping of electronic microsystems using finite element method
C2 Gaining skills for computer software focused on numerical modelling based on finite element method as ANSYS, FlexPDE, etc.
C3 Getting familiarize with typical problems connected with numerical prototyping in macro and micro scale as optimization, design of experiments, etc.
C4 Consolidation of skills for self and team work based on supplied instruction materials

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W1 Has basic, structured and theoretically founded knowledge in the field of numerical modelling with finite element method used in macro and micro scale in order to support an engineer during prototyping, especially directed towards numerical modelling of microsystems

**Relating to skills**

PEK_U1 Is capable of selecting appropriate engineering tools for computer aided design, use them for practical cases and operate properly with such computer software as ANSYS, FlexPDE, etc. in order to solve typical problems connected with the numerical prototyping

**Relating to social competences**

PEK_K1 Can properly prioritize tasks in order to finalize a specified work
PEK_K2 Takes into account the need to use numerical methods in the design of electronic systems

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_1 | Modelling of microsystems - introduction | 2 |
| Le_2 | Introduction to finite element method | 2 |
| Le_3 | Modelling of the mechanical problems | 2 |
| Le_4 | Modelling of the thermodynamical problems | 2 |
| Le_5 | Modelling of the thermomagnetic problems | 2 |
| Le_6 | Modelling of the fluid dynamics | 2 |
| Le_7 | Modelling of the coupled fields | 2 |
| Le_8 | Exam | 1 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_1 | Introduction to numerical modelling and FlexPDE software package | 2 |
| La_2 | Diffusion equation and analysis in 2D | 2 |
| La_3 | Laplace equation and analysis in 3D | 2 |
| La_4 | Analysis of heat energy transport and temperature distribution | 2 |
| La_5 | Analysis of stress and strain state | 2 |
| La_6 | Analysis of thermomechanical stresses and strains | 2 |
| La_7 | Analysis of laminar and turbulent flows | 2 |
| La_8 | Electro-thermo-mechanical analysis | 2 |
| La_9 | Analysis of electric capacity | 2 |
| La_10 | Analysis of magnetic field | 2 |
| La_11 | Analysis of thermomechanical actuator | 2 |
| La_12 | Analysis of electromagnetic sensor | 2 |
| La_13 | Individual project - 1 | 2 |
| La_14 | Individual project - 2 | 2 |
| La_15 | Rehearsal laboratory / Grades | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

| | |
|---|---|
| ND_1 | Traditional lecture with multimedia presentations and discussions |
| ND_2 | Laboratory: 5-minutes introduction and 5-minutes test at the beginning of the lecture |
| ND_3 | Consultations |
| ND_4 | Self work – preparation for the lectures for given problems |
| ND_5 | Self work – preparation for the laboratory exercises |
| ND_6 | Self work – self study and preparation for the final test |
| ND_7 | Self work – preparation of the laboratory reports |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 (lecture) = F1 | PEK_W01 | Positive grade of the final test |
| P2 (laboratory) = (F2+F3)/2 | PEK_U01, PEK_K01 | Average grade from tests and reports |
| F1 (lecture) | PEK_W01 | Discussions and final test |
| F2 (laboratory) | PEK_U01, PEK_K01 | Tests during the laboratories |
| F3 (laboratory) | PEK_U01, PEK_K01 | Laboratory reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Zienkiewicz O.C., Taylor R.L., "The Finite Element Method: Volumes 1-3", Butterworth-Heinemann, London, 2000
2. Thompson E., "Introduction to the Finite Element Method", John Wiley and Sons, 2005
3. Kreyszig E., „Advanced Engineering Mathematics", John Wiley and Sons, 2006
4. Kittel C. "Wstęp do fizyki ciała stałego", PWN, 1976
5. Pang T. "An Introduction to Computational Physics", Cambridge University Press, 2006


**Secondary literature**


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


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Modelling of 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) | K2MTR_W13 | C01, C03 | Le_01-Le_07 | ND_01, ND_03, ND_04, ND_06 |
| PEK_U01 (skills) | K2MTR_U14 | C02, C04 | La_01-La_14 | ND_02, ND_05 |
| PEK_K01 (competences) | K2MTR_K14 | C04 | Le_01-Le_08, La_01-La_15 | ND_07 |
| PEK_K02 | K2MTR_K06 | C01-C03 | Le_01-Le_08, La_01-La_15 | ND_01-ND_07 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Niezawodność w mechatronice** |
| Name in English: | **Reliability in mechatronics** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCD023008** |
| 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 foundations of mathematics in the field of mathematical analysis, probability and mathematical statistics

## SUBJECT OBJECTIVES

C01 Acquaint students with the issues in the diagnosis and reliability of components and equipment included in the complex mechatronic systems

C02 Acquisition of the ability to analyze problems related to damages and reliability of mechatronic systems

C03 Preliminary preparation to conduct research using reliability analysis components used in mechatronics

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Possessing the knowledge of the theory of reliability, testing and diagnostics, and damage models in mechatronics systems

**Relating to skills**

PEK_U01 Ability to self-solving problems related to reliability, diagnostics failures, analysis of measurement data

**Relating to social competences**

PEK_K01 Understanding the need to use mathematical knowledge to analyze technical

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction to issues related to reliability theory and exploitation of mechatronic systems | 2 |
| Le_02 | The basic indicators describing reliability. Mathematical models of non-renewable mechatronic systems | 2 |
| Le_03 | Reliability of binary, serial and parallel mechatronic systems | 2 |
| Le_04 | Methods for testing the reliability of mechatronic systems and the analysis of the experimental characteristics | 2 |
| Le_05 | Classification of damages, physical phenomena affecting the damages. The impact of working conditions on the reliability | 2 |
| Le_06 | Reliability of renewable mechatronic systems | 2 |
| Le_07 | Simulation models of the reliability of mechatronic systems | 2 |
| Le_08 | Test | 1 |
| | **TOTAL** | 15 |

| Form of classes - Classes | | Quantity |
|---|---|---|
| La_01 | Solving tasks in the field of basic reliability problems occurring in technical issues part I | 2 |
| La_02 | Solving tasks in the field of basic reliability problems occurring in technical issues part II | 2 |
| La_03 | Solving tasks related to typical characteristics and calculations of reliability parameters | 2 |
| La_04 | Solving tasks related to serial and parallel and mixed mechatronic systems | 2 |
| La_05 | Solving tasks in the field of the analysis of experimental data | 2 |
| La_06 | Solving tasks related to analysis of ageing processes | 2 |
| La_07 | Additional term to work out of arrears | 2 |
| La_08 | Summary of the course | 1 |
| | **TOTAL** | 15 |

## TEACHING TOOLS USED

ND_01 Traditional lecture

ND_02 Laboratories - self-solving tasks related to the reliability of modern mechatronic systems

ND_03 Consultations

ND_04 Own work - prepare to the lectures

ND_05 Own work - prepare to the laboratories and self-solving selected tasks

ND_06 Own work – self-studies and prepare to tests

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F1 (lecture) | PEK_W01 | Final test |
| F2 (labs) | PEK_U01<br>PEK_K01 | Discussions, solving of tasks independently and in a group |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. F. Grabski, J. Jaźwiński, Funkcje o losowych argumentach w zagadnieniach niezawodności, bezpieczeństwa i logistyki, WKŁ, W-wa 2009
2. H. Gładysz, E. Peciakowski, Niezawodność elementów elektronicznych, WKŁ, W-wa 1984


**Secondary literature**


1. F. Grabski, J. Jaźwiński, Metody bayesowskie w niezawodności i diagnostyce, WKŁ, W-wa 2001
2. S. Firkowicz, Statystyczne badanie wyrobów, WNT, W-wa
3. G. Onwubolu, Mechatronics Principles and Applications, Elsevier Science, 2005


## SUBJECT SUPERVISOR


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


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Reliability in mechatronics**

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) | K2MTR_W14 | C01-C03 | Le_01-Le_07 | ND_01, ND_03, ND_04, ND_06 |
| PEK_U01 (skills) | K2MTR_U15 | C01-C03 | La_01-La_06 | ND_01, ND_02, ND_03, ND_05 |
| PEK_K01 (competences) | K2MTR_K07 | C01-C03 | Le_01-Le_07<br>La_01-La_06 | ND_01-ND_06 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Modelowanie nanosystemów** |
| Name in English: | **Modelling of nanosystems** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCD023009** |
| 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 | | 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 on physics and mathematics
2. Basic knowledge on numerical methods
3. Basic knowledge on computer skills

## SUBJECT OBJECTIVES

C1 Getting familiarize with numerical prototyping of electronic microsystems using quantum and molecular modelling techniques

C2 Gaining skills for computer software focused on numerical modelling based on quantum and molecular modelling as Material Studio, etc.

C3 Getting familiarize with typical problems connected with numerical prototyping in meso and nano scale as optimization, design of experiments, etc.

C4 Consolidation of skills for self and team work based on supplied instruction materials

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W1 Has basic, structured and theoretically founded knowledge on methods, techniques and numerical tools used in the area of numerical modelling at quantum and molecular scale and additionally on meso scale

**Relating to skills**

PEK_U1 Is capable of selecting appropriate tools for engineering designs, use them for practical cases and operate properly with such computer software as Material Studio, etc.

**Relating to social competences**

PEK_K1 Can properly prioritize tasks in order to finalize a specified work by himself or others

PEK_K2 Takes into account the need to use numerical methods in the design of electronic systems

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_1 | Numerical modelling at the quantum and molecular level | 2 |
| Le_2 | Quantum mechanics versus electronic systems | 2 |
| Le_3 | Examples and applications of the quantum numerical methods in electronic systems | 2 |
| Le_4 | Molecular mechanics versus electronic systems | 2 |
| Le_5 | Examples and applications of the molecular numerical methods in electronic systems | 2 |
| Le_6 | Meso scale numerical methods versus electronic systems | 2 |
| Le_7 | Examples and applications of the meso scale numerical methods in electronic systems | 2 |
| Le_8 | Exam | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_1 | Introduction to molecular modelling and Lammps software package | 2 |
| La_2 | Schroedinger's equation | 2 |
| La_3 | Hydrogen atom | 2 |
| La_4 | Energy levels | 2 |
| La_5 | Molecular mechanics – statics | 2 |
| La_6 | Molecular mechanics - dynamics | 2 |
| La_7 | Water particle | 2 |
| La_8 | Polymer materials | 2 |
| La_9 | Analysis of material electrical properties | 2 |
| La_10 | Analysis of material mechanical properties | 2 |
| La_11 | Analysis of material thermal properties | 2 |
| La_12 | Modelling in meso scale | 2 |
| La_13 | Individual project - 1 | 2 |
| La_14 | Individual project - 2 | 2 |
| La_15 | Rehearsal laboratory / Grades | 2 |
| | **TOTAL** | 30 |

| TEACHING TOOLS USED | |
|---|---|
| ND_1 | Traditional lecture with multimedia presentations and discussions |
| ND_2 | Laboratory: 5-minutes introduction and 5-minutes test at the beginning of the lecture |
| ND_3 | Consultations |
| ND_4 | Self work – preparation for the lectures for given problems |
| ND_5 | Self work – preparation for the laboratory exercises |
| ND_6 | Self work – self study and preparation for the final test |
| ND_7 | Self work – preparation of the laboratory reports |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P1 (lecture) = F1 | PEK_W01 | Positive grade of the final test |
| P2 (laboratory) = (F2+F3)/2 | PEK_U01, PEK_K01 | Average grade from tests and reports |
| F1 (lecture) | PEK_W01 | Discussions and final test |
| F2 (laboratory) | PEK_U01, PEK_K01 | Tests during the laboratories |
| F3 (laboratory) | PEK_U01, PEK_K01 | Laboratory reports |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Kittel C. “Wstęp do fizyki ciała stałego”, PWN, 1976
2. Pang T. “An Introduction to Computational Physics”, Cambridge University Press, 2006
3. Kreyszig E., „Advanced Engineering Mathematics”, John Wiley and Sons, 2006


**Secondary literature**


1. William D., Callister Jr., “Materials Science and Engineering an Introduction”, John Wiley and Sons, 2007
2. Montgomery D., Runger G., “Applied Statistics and Probability for Engineers”, John Wiley and Sons, 2007


## SUBJECT SUPERVISOR


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

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Modelling of nanosystems**

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) | K2MTR_W13 | C01, C03 | Le_01-Le_07 | ND_01, ND_03, ND_04, ND_06 |
| PEK_U01 (skills) | K2MTR_U14 | C02, C04 | La_01-La_14 | ND_02, ND_05 |
| PEK_K01 (competences) | K2MTR_K14 | C04 | Le_01-Le_08, La_01-La_15 | ND_07 |
| PEK_K02 | K2MTR_K06 | C01-C03 | Le_01-Le_08, La_01-La_15 | ND_01-ND_07 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Zarządzanie małą firmą** |
| Name in English: | **Small Enterprise Management** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCM023002** |
| 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 | 0 | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has general knowledge of the social and economic systems
2. Is able to critically assess organizational schemes

## SUBJECT OBJECTIVES

C01 Understanding the principles of starting a business, the fundamentals of management and marketing

C02 Acquiring the ability to plan business

C03 Obtaining a conviction of the reasonableness of starting business

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows basic law, accounting and organizational concepts, which are necessary for running a business

PEK_W02 Knows the rules how to manage an organization

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Small and medium-sized enterprise in a market economy | 2 |
| Le_02 | The legal and accounting principles of running a business | 2 |
| Le_03 | Principles of organization management | 2 |
| Le_04 | Problems of leadership and its influence on the functioning of the company | 2 |
| Le_05 | Rules for the preparation of contracts | 2 |
| Le_06 | Company organization - the human and global dimension | 2 |
| Le_07 | People management | 2 |
| Le_08 | Wealth Management | 2 |
| Le_09 | Indicators of financial and economic condition of the company | 2 |
| Le_10 | Sources of business financing | 2 |
| Le_11 | Principles of preparing a business plan | 2 |
| Le_12 | Importance of marketing | 2 |
| Le_13 | Rules of negotiation - negotiation techniques | 2 |
| Le_14 | Issues of communication and persuasion | 2 |
| Le_15 | Colloquium | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Lecture with problem topics

ND_02 Multimedia presentation

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F1 | PEK_W01, PEK_W02 | Colloquium |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**

1. Niezbędnik przedsiębiorcy. Group work; Agora 2009

**Secondary literature**

1. W. Sasin; Zarządzanie małą firmą; AW InterFart Łódź 1994

| **SUBJECT SUPERVISOR** |
| --- |
| **Leszek.Nakonieczny@pwr.edu.pl** |

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Small Enterprise Management**

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) | K2MTR_W21, K2MTR_W22 | C01-C03 | Le_01-Le_14 | ND_01, ND_02 |
| PEK_W02 | K2MTR_W21, K2MTR_W22 | C01-C03 | Le_01-Le_14 | ND_01, ND_02 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Zarządzanie przedsięwzięciem** |
| Name in English: | **Enterprise Management** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Optional / Faculty** |
| Subject code: | **MCM023003** |
| 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 | 0 | | | | |
| Including number of ECTS points for direct teacher-student contact (BK) classes | 0.6 | | | | |

## PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge of management, design and testing of processes and technical systems
2. Has knowledge of spreadsheet, such as Excel

## SUBJECT OBJECTIVES

C01 Understanding the issues related to making strategic and operational decisions in the development and functioning of the external supply chains, operating in a competitive market environment

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Has knowledge of the basic concepts of the theory and techniques of management systems and operational processes

PEK_W02 Has knowledge of innovative problem solving, conceptual design, or the rules of solution's selection

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction to project management - basic definitions | 2 |
| Le_02 | The introduction of process management in logistics | 2 |
| Le_03 | Designing business processes - types of projects, principles of design, project participants | 2 |
| Le_04 | Designing business processes - project management tool | 2 |
| Le_05 | Designing business processes - process mapping | 2 |
| Le_06 | Planning the project | 2 |
| Le_07 | Strategies for improving processes | 2 |
| Le_08 | Control of operational processes | 2 |
| Le_09 | Control of logistics processes | 2 |
| Le_10 | Supply chain management. Basic methods, tools and concepts in the area of relationship with customers management | 2 |
| Le_11 | Supply chain management. Basic methods, tools and concepts in the field of time management and quality | 2 |
| Le_12 | Benchmarking in the enterprise | 2 |
| Le_13 | Reengineering in the enterprise | 2 |
| Le_14 | Directions and concepts of supply chain management improvement | 2 |
| Le_15 | Development trends of supply chains | 2 |
| | **TOTAL** | 30 |

## TEACHING TOOLS USED

ND_01 Multimedia presentation
ND_02 Problematic discussion
ND_03 Self-study and preparation for the final test

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F1 | PEK_W01, PEK_W02 | Written exam, with the possibility of additional verbal answer |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Bozarth C.C., Handfield R.B., Wprowadzenie do zarządzania operacjami łańcuchem dostaw: kompletny podręcznik logistyk i zarządzania dostawami, Helion, Gliwice 2007
2. Christopher M., Logistyka i zarządzanie łańcuchem podaży. Jak obniżyć kosztyi poprawić jakość obsługi, Wydawnictwo Profesjonalnej Szkoły Biznesu, Kraków 1998
3. Christopher M., Strategia zarządzania dystrybucją. Praktyka logistyki biznesu,Agencja Wydawnicza "Placet", Warszawa 1996
4. Coyle J.J., Bardi E.J., Langley Jr C.J., Zarządzanie logistyczne, PWE, Warszawa 2002
5. Kisperska-Moroń D. (red.), Pomiar funkcjonowania łańcuchów dostaw, Wydawnictwo AE w Katowicach, Katowice 2006
6. Zarządzanie procesami w przedsiębiorstwie :aspekty teoretyczno-praktyczne/ Agnieszka Bitkowska [et al.], Warszawa : Difin, 2011
7. Model biznesu w zarządzaniu przedsiębiorstwem /red. nauk. Małgorzata Duczkowska-Piasecka. Warszawa: Szkoła Główna Handlowa w Warszawie - Oficyna Wydawnicza, 2012
8. Zmienność zarządzania strategicznego przedsiębiorstwem /Piotr Banaszyk; Uniwersytet Ekonomiczny w Poznaniu. Poznań : Wydawnictwo Uniwersytetu Ekonomicznego, 2011
9. Prognozowanie w zarządzaniu sprzedażą i finansami przedsiębiorstwa /Paweł Dittmann [et al.]. Warszawa: Oficyna a Wolters Kluwer business, 2011
10. Zarządzanie projektami :zastosowania w biznesie, inżynierii i nowoczesnych technologiach /John M. Nicholas, Herman Steyn; [przekł. Joanna Borowska, Marta Skorek, Magdalena Lany]. Warszawa: Oficyna Wolters Kluwer business, 2012


**Secondary literature**


1. Zarządzanie wieloma projektami /Ewa Sońta-Drączkowska. Warszawa: Polskie Wydawnictwo Ekonomiczne, 2012
2. Zagadnienie czasu i kosztów w zarządzaniu projektami :wybrane metody planowania i kontroli /Dorota Kuchta. Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej, 2011


## SUBJECT SUPERVISOR


**Sylwia.Werbinska@pwr.edu.pl**


MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Enterprise Management**

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) | K2MTR_W21, K2MTR_W22 | C01 | Le_01-Le_15 | ND_01-ND_03 |
| PEK_W02 | K2MTR_W21, K2MTR_W22 | C01 | Le_01-Le_15 | ND_01-ND_03 |

Attachment no. 4 to ZW 33/2012

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Modelowanie i symulacja komputerowa zespołów mechatronicznych** |
| Name in English: | **Modelling and computer simulation of mechatronic assemblies** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCM021006** |
| 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 | E | | 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. Knowledge of FEM
2. Basic knowledge of mechanics in terms of statics and dynamics, strength of materials
3. An elementary knowledge of the programming language and any CAD program

## SUBJECT OBJECTIVES

C01 Acquiring the skills of analysis of mechatronic systems, their modelling and determining their characteristics

C02 Gaining knowledge of the theoretical basis of numerical FEM simulations

C03 Acquiring the ability to conduct numerical simulations

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the theoretical basis for the numerical FEM simulation

PEK_W02 Knows the principles of construction of models for numerical simulation

PEK_W03 Has knowledge of the methods of determining the characteristics of model's elements

**Relating to skills**

PEK_U01 Acquired the ability to build models for the numerical simulation, define the characteristics of the elements of the model and conditions in the simulations and analysis of results

PEK_U02 Acquired the ability to perform calculations in numerical simulations

PEK_U03 Acquired the ability to use the programs CAD/FEM and selected experimental methods for determining the characteristics of the model's elements for numerical simulation

## PROGRAMME CONTENT

| Form of classes - Lecture | | Quantity |
|---|---|---|
| Le_01 | Introduction to FEM theory and numerical simulations, examples of applications | 1 |
| Le_02 | The motion's equations and methods of solving equations in the dynamics | 3 |
| Le_03 | Finite elements, the classification. The choice of the finite elements and type of the model | 3 |
| Le_04 | Methods for determining the characteristics of model's elements for numerical simulation; methods of verification of strength in the design process of mechatronic mechanisms | 2 |
| Le_05 | Derivation of stiffness matrix, determination of mass and attenuation matrix | 2 |
| Le_06 | Formulation of equations of non-mechanical systems | 2 |
| Le_07 | Methodology of model building for FEM numerical simulations | 2 |
| | **TOTAL** | 15 |

| Form of classes - Laboratory | | Quantity |
|---|---|---|
| La_01 | Solving the equations of motion - the introduction, the calculation system with one degree of freedom | 3 |
| La_02 | Build a model with many degrees of freedom, determination of model parameters, the wave phenomena | 3 |
| La_03 | Simulation of an electromagnetic multi-drive system, conduction of a test on a real system, determination of the characteristics of system's element | 3 |
| La_04 | Simulation of braking (start) of machine chassis rotation in different system load conditions, the optimization of the characteristics of the drive rotation control system to minimize overload in the drive and bearing system | 3 |
| La_05 | Simulation of the overload clutch with electromagnetic control, modelling of the system for numerical simulation with mechanical, hydraulic (pneumatic) and electromagnetic components | 3 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Problem classes<br>ND_02 Problem discussion<br>ND_03 Lab experiment<br>ND_04 Multimedia presentation |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F1 (lecture) | PEK_W01, PEK_W02 | Colloquium, verbal assessment |
| P = F2 (labs) | PEK_U01-PEK_U03 | Participation in discussions of problem, verbal assessment |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. Rusiński E., Metoda elementów skończonych. System COSMOS/M, WKiŁ Warszawa 1994
2. Rusinski E., Czmochowski J., Smolnicki T.: Zaawansowana metoda elementów skończonych w konstrukcjach nośnych, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000
3. Zienkiewicz O.C.: Metoda elementów skończonych, Arkady 1972


**Secondary literature**


1. Gawroński W., Kruszewski J., Ostachowicz W., Tarnowski K., Wittbrodt E.: Metoda elementów skończonych w dynamice konstrukcji, Arkady, Warszawa 1984
2. Jaszczuk W., Pochanke A.: Badania dynamiki układu napędowego z elektromagnesem przy zastosowaniu metod komputerowych. IX Sympozjum Mikromaszyny i Serwonapędy. Instytut Elektrotechniki i Politechnika Warszawska. Kraków 1994
3. Jaszczuk W., Wierciak J., Bodnicki M.: Napędy elektromechniczne urządzeń precyzyjnych. Oficyna Wydawnicza Politechniki Warszawskiej. Warszawa 2000


## SUBJECT SUPERVISOR


**Marcin.Kowalczyk@pwr.edu.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Modelling and computer simulation of mechatronic assemblies**

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) | K2MTR_W24 | C02 | Le_01-Le_07 | ND_01, ND_02, ND_04 |
| PEK_W02 | K2MTR_W24 | C01 | Le_03-Le_07 | ND_01-ND_04 |
| PEK_W03 | K2MTR_W24 | C01 | Le_04-Le_06 | ND_01-ND_04 |
| PEK_U01 (skills) | K2MTR_U23 | C01 | La_01-La_05 | ND_01-ND_03 |
| PEK_U02 | K2MTR_U24 | C03 | La_01-La_05 | ND_01, ND_02 |
| PEK_U03 | K2MTR_U25 | C01 | La_01-La_05 | ND_01-ND_03 |

**Faculty of Microsystem Electronics and Photonics**

# SUBJECT CARD

| | |
|---|---|
| Name in Polish: | **Technologie laserowe** |
| Name in English: | **Laser Technology** |
| Main field of studies: | **Mechatronics** |
| Level and form of studies: | **II level / Full time** |
| Kind of subject: | **Obligatory / Faculty** |
| Subject code: | **MCM021203** |
| 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 optics and influence of optical systems on the propagation of the light beam
2. Basic knowledge of interaction of electromagnetic radiation with matter
3. Knowledge of the subject of heat treatment and its influence on the changes taking place in the material

## SUBJECT OBJECTIVES

C01 Gaining knowledge of the design and operation of systems for laser processing
C02 Acquiring the ability to select the appropriate laser system to a designated task
C03 Independent acquisition of information and its use for solving engineering problems
C04 Participation in research connected with laser technique

## SUBJECT EDUCATIONAL EFFECTS

**Relating to knowledge**

PEK_W01 Knows the principle of operation and construction of high-power lasers
PEK_W02 Has knowledge in the field of laser beam forming systems and the interaction of radiation with matter
PEK_W03 Knows the range of lasers application in the manufacturing processes

**Relating to skills**

PEK_U01 Can select a suitable laser system for a given treatment process
PEK_U02 Acting in an appropriate manner with the specialized equipment laser
PEK_U03 Is able to select the appropriate beam forming system according to the process requirements

**Relating to social competences**

PEK_K01 Is able to explain and justify his own point of view using the knowledge of laser technology
PEK_K02 Can find the necessary information and evaluate them
PEK_K03 Is aware of the importance of preserving the safety rules while working with laser

## PROGRAMME CONTENT

| **Form of classes - Lecture** | | Quantity |
|---|---|---|
| Le_01 | The basic principles of high-power lasers operation | 2 |
| Le_02 | The interaction of the laser beam with matter | 2 |
| Le_03 | Systems forming the laser beam and laser safety rules | 2 |
| Le_04 | Application of lasers for cutting | 2 |
| Le_05 | Application of lasers for welding | 2 |
| Le_06 | Fabrication of functional coatings | 2 |
| Le_07 | Laser micromachining | 2 |
| Le_08 | Examination | 1 |
| | **TOTAL** | 15 |

| **Form of classes - Laboratory** | | Quantity |
|---|---|---|
| La_01 | Organizational matters. Overview of laser light sources | 2 |
| La_02 | Laser cutting | 2 |
| La_03 | Laser welding | 2 |
| La_04 | Fabrication process of functional coatings | 2 |
| La_05 | Monitoring of laser processes | 2 |
| La_06 | Application of laser scanning heads for machining | 2 |
| La_07 | Application of laser for hardening | 2 |
| La_08 | Additional term and assessment | 1 |
| | **TOTAL** | 15 |

| TEACHING TOOLS USED |
|---|
| ND_01 Multimedia presentation |
| ND_02 Self-study - preparation for laboratory |
| ND_03 Self-study and exam preparation |
| ND_04 Demonstration of laser processes |
| ND_05 Consultation |

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| P = F1 (lecture) | PEK_W01-PEK_W03 | Written and verbal exam |
| P = F2 (labs) | PEK_U01-PEK_U03, PEK_K01-PEK_K03 | Entrance test, verbal assessment |

## PRIMARY AND SECONDARY LITERATURE

**Primary literature**


1. J. Kusiński: ”Lasery i ich zastosowanie w inżynierii materiałowej”, Wydawnictwo Naukowe Akapit, 2000
2. E. Kannatey-Asibu: “Principles of Laser Materials Processing”, Wiley, 2009


**Secondary literature**


1. J.C. Ion: „Laser Processing of Engineering Materials”, Elsevier, 2005
2. W.M. Steen:, “Laser Material Processing”, Springer-Verlag, 1998


## SUBJECT SUPERVISOR


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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Laser Technology**

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) | K2MTR_W20 | C01 | Le_01 | ND_01-ND_03, ND_05 |
| PEK_W02 | K2MTR_W20 | C01 | Le_02, Le_03 | ND_01-ND_03, ND_05 |
| PEK_W03 | K2MTR_W20 | C02 | Le_04-Le_07 | ND_01-ND_03, ND_05 |
| PEK_U01 (skills) | K2MTR_U21, K2MTR_U22 | C02-C04 | La_01-La_07 | ND_04, ND_05 |
| PEK_U02 | K2MTR_U22 | C01, C03, C04 | La_01-La_07 | ND_04, ND_05 |
| PEK_U03 | K2MTR_U21, K2MTR_U22 | C01, C03, C04 | La_02-La_04, La_07 | ND_04, ND_05 |
| PEK_K01 (competences) | K2MTR_K13 | C03 | La_01-La_07 | ND_02, ND_03 |
| PEK_K02 | K2MTR_K13 | C03 | La_01-La_07 | ND_01-ND_05 |
| PEK_K03 | K2MTR_K13 | C01 | La_01 | ND_01, ND_03_ND_05 |