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 of **29.09.2015**

In effect since ***01.10.2015***

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

Location of the field of study in the area of education

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, ie. 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.

The description of educational effects for the second level study in the field of *Mechatronics* does not concern all educational effects listed in the description of the second level qualifications related to the area of technical sciences;
knowledge: T2A_W10, T2A_W11,

The second level studies graduate has to acquire the competences specified by the below mentioned educational effects. However, it does not mean that the each one effect must be acquired by completion of the program of the second level studies; part of them can be achieved during the first level studies and also - in a limited range - can be achieved by non-formal education.

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
T2A – educational effects in the area of technical sciences for the second level study
01, 02, 03 and further – number of educational effects

Field of study educational effects for the 2nd level studies in *Mechatronics*	**DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of *Mechatronics***	**Correlation with educational effects for 2nd level study in area of technical sciences**
KNOWLEDGE		
Field of study effects	Content of the effect	Educational effects in the area of technical sciences
K2MTR_W01	The student knows the principle of operation of popular digital telecommunication interfaces used in mechatronics	T2A_W03 T2A_W04 T2A_W05 T2A_W07
K2MTR_W02	The student knows the methodology of design and programming of electronic embedded systems for applications used in mechatronics	T2A_W03 T2A_W04 T2A_W05 T2A_W07
K2MTR_W03	The student has actual knowledge about principles of operation and design methods of battery-less and wireless systems	T2A_W03 T2A_W04 T2A_W05 T2A_W07
K2MTR_W04	The student has theoretically grounded general knowledge concerning designing and construction of electronic apparatus	T2A_W06
K2MTR_W05	The student has precise knowledge concerning construction, principles of operation and application area of microprocessors integrated circuits	T2A_W04 T2A_W05
K2MTR_W06	The student has theoretically grounded knowledge concerning material's diagnostic methods applied in electronics	T2A_W07
K2MTR_W07	The student 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	T2A_W02 T2A_W03 T2A_W04 T2A_W05

K2MTR_W08	The student has completed the diploma thesis, basing on the acquired during the studies knowledge, specific for studied field of study in *Mechatronics*	T2A_W07
K2MTR_W09	The student has knowledge concerning manufacturing processes and application of novel optoelectronic elements and devices in microsystems	T2A_W05 T2A_W07
K2MTR_W10	The student knows the application principles of micromechanisms and microdrives in the technology and daily life	T2A_W02 T2A_W04 T2A_W07
K2MTR_W11	The student knows the construction, technology and application possibilities of micro-opto-electro mechanical systems (MOEMS) in modern technique	T2A_W02 T2A_W04 T2A_W07
K2MTR_W12	The student has theoretically grounded knowledge concerning optical fibre technique, including knowledge necessary to understand physical principles of operation of optical fibres and optical telecommunication systems	T2A_W03 T2A_W04 T2A_W07
K2MTR_W13	The student has theoretically grounded and practical knowledge concerning numerical methods and tools for electronic micro- and nanosystems modelling and designing	T2A_W01 T2A_W04
K2MTR_W14	The student 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	T2A_W06 T2A_W07
K2MTR_W15	The student 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	T2A_W03
K2MTR_W16	The student 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	T2A_W02
K2MTR_W17	The student 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	T2A_W03 T2A_W04 T2A_W05

K2MTR_W18	The student knows and understands the area of application and characteristics of optoelectronic systems and basic concepts concerning construction of electronic elements, especially the optoelectronic elements	T2A_W04 T2A_W05
K2MTR_W19	The student 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.	T1A_W05
K2MTR_W20	The student 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.	T2A_W04
K2MTR_W21	The student has knowledge concerning enterprise management, in particular projects and management of interdisciplinary teams, that implements mechatronic projects	T2A_W08
K2MTR_W22	The student 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	T2A_W09
K2MTR_W23	The student 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.)	T2A_W04
K2MTR_W24	The student has knowledge of the dynamics modelling of mechatronic systems, taking into account the definition of the finite element of mechanical, electrical, electrohydraulic objects, etc.	T2A_W04
K2MTR_W25	The student has knowledge concerning probability theory, mathematical statistics and probability distributions, particularly related to mechatronics	T2A_W01
SKILLS		
K2MTR_U01	The student is able to choose and configure digital communication interface, according to mechatronic project requirements	T2A_U07 T2A_U08 T2A_U09 T2A_U10 T2A_U15 T2A_U16 T2A_U17 T2A_U18 T2A_U19

K2MTR_U02	The student is able to design, program and construct an embedded system, which is an integral part of a mechatronic system	T2A_U07 T2A_U08 T2A_U09 T2A_U10 T2A_U15 T2A_U16 T2A_U17 T2A_U18 T2A_U19
K2MTR_U03	The student is able to design and program a wireless and battery-less electronic system	T2A_U07 T2A_U08 T2A_U09 T2A_U10 T2A_U12 T2A_U15 T2A_U16 T2A_U17 T2A_U18 T2A_U19
K2MTR_U04	The student is able to assess and choose adequate diagnostic methods for materials and technologies applied in electronics	T2A_U09 T2A_U10 T2A_U12 T2A_U18
K2MTR_U05	The student is able to choose and program a microprocessor or microcontroller for application in a specialised mechatronic project	T2A_U08 T2A_U12
K2MTR_U06	The student 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*	T2A_U03 T2A_U07

K2MTR_U07	The student 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	T2A_U01 T2A_U03 T2A_U05 T2A_U08 T2A_U09 T2A_U10 T2A_U11 T2A_U16 T2A_U17 T2A_U19
K2MTR_U08	The student is able to design and use a microsystem with optoelectronic elements and assess its functional capabilities and also can propose possible upgrades	T2A_U12 T2A_U16
K2MTR_U09	The student is able to correctly choose micomachines and microdrives in practical applications	T2A_U08 T2A_U11 T2A_U12
K2MTR_U10	The student is able to design a measurement experiment, can use correctly chosen measuring units and systems, calculate measurement uncertainty and compile the measurements results	T2A_U08 T2A_U11 T2A_U12
K2MTR_U11	The student is able to correctly choose MOEMS for practical application	T2A_U08 T2A_U11 T2A_U12
K2MTR_U12	The student 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	T2A_U08 T2A_U11 T2A_U13 T2A_U14
K2MTR_U13	The student knows and uses the workplace health and safety rules in work with lasers and optical fibres. The student is able to use basic measurement devices and build a measuring system for application in optical fibre technique	T2A_U07 T2A_U18
K2MTR_U14	The student 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.)	T2A_U08 T2A_U09

K2MTR_U15	The student 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	T2A_U18
K2MTR_U16	The student is able to design specific chemical and optical fibre sensor and prepare concepts of its construction and parameters. The student is able to use appropriate constructions in designed sensing systems	T2A_U10
K2MTR_U17	The student 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. The student is able to assess the usefulness and application possibilities of novel solutions concerning signal processing systems and methods	T2A_U10 T2A_U18
K2MTR_U18	The student 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	T2A_U12
K2MTR_U19	The student 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	T2A_U09 T2A_U14 T2A_U18
K2MTR_U20	The student 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	T2A_U11
K2MTR_U21	The student is able to use, parameterise and investigate the operation results of a mechatronic devices in different manufacturing technologies	T2A_U08 T2A_U09
K2MTR_U22	The student is able to choose laser beam parameters for specific process, is able to use specialised equipment used in laser micromachining processes	T2A_U12
K2MTR_U23	The student 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	T2A_U08
K2MTR_U24	The student is able to perform computer simulation of hydraulic system’s operation, analyse dynamic processes. The student is able to analyse and construct a hydrotronic system	T2A_U09
K2MTR_U25	The student 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	T2A_U09

K2MTR_U26	The student 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	T2A_U02 T2A_U03 T2A_U04 T2A_U06
K2MTR_U27	The student understands and is able to use the basic concepts of probability theory and mathematical statistics in mechatronic practice	T2A_U08 T2A_U09 T2A_U11 T2A_U18
COMPETENCES		
K2MTR_K01	The student 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	T2A_K01 T2A_K02 T2A_K03 T2A_K05 T2A_K06
K2MTR_K02	The student is able to work by self and in a group, undertaking different roles in the group	T2A_K03 T2A_K04 T2A_K06
K2MTR_K03	The student is able to co-work and work in a group, undertaking different roles in the group	T2A_K03
K2MTR_K04	The student plans his or her actions in a creative way, is able to specify priorities and the order of tasks	T2A_K04 T2A_K06
K2MTR_K05	The student 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	T2A_K01 T2A_K02 T2A_K03
K2MTR_K06	The student takes into account the necessity for application of numerical methods in electronic system design	T2A_K06
K2MTR_K07	The student 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	T2A_K06
K2MTR_K08	The student 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	T2A_K07
K2MTR_K09	The student, while working in a group, properly identifies, solves and implements knowledge concerning the design and application of electronic circuits	T2A_K01 T2A_K03

K2MTR_K10	The student understands the influence of applied technologies on the environment and is conscious of limits that are connected with it	T2A_K02
K2MTR_K11	The development of skills connected with working in group and taking responsibility for results of own work	T2A_K02 T2A_K03
K2MTR_K12	The student is able to see positive aspects of virtual control and measuring apparatus application in engineering practice	T2A_K07
K2MTR_K13	The student 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	T2A_K02
K2MTR_K14	The student is able to specify the priorities concerning the completion of a task specified by himself or others	T2A_K04
K2MTR_K15	The student is able to search and use the literature, acquire knowledge by himself, works systematically and develops skills; is able to work in a group	T2A_K01 T2A_K03
K2MTR_K16	The student thinks that the conscious and systematic physical activity during studies and after graduation, helps in improvement of life quality	T2A_K01 T2A_K03
K2MTR_K17	The student can working in a team, according to the specified rules and fair play rules, during participation in different forms of physical activity	T2A_K03

Attachment no. 2 to Programme of Education

PROGRAMME OF STUDIES

1. Description

Number of semesters: ***3***	*Number of ECTS points necessary to obtain qualifications:* ***90***
Prerequisites: *1. The order of admission is determined by the value of the recruitment factor W_{II}.* *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* ***Recruitment factor W_{II} = D x 10 + RK + OD*** ***D – grade in diploma*** ***RK – interview*** *The faculty reserves the right to interview the candidates if the number of candidates exceeds the accepted limits of places.* *If the interview is not carried out than the RK value is zero.* ***OD – achievement rating*** *Achievement rating will not be carried out – OD = 0*	*Upon completion of studies graduate obtains* *professional degree of: **M. Sc. engineer*** *2-nd level qualifications*
Possibility of continuing of the studies: ***Graduate is prepared for the 3-rd level study***	*Graduate profile, employability:* ***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:***

	• ***has knowledge and skills to use modern, innovative electronic, optoelectronic and microsystems devices,*** • ***has knowledge in the field of control and measurements devices application in the control and automatic regulation systems,*** • ***fluently uses modern informatics tools (inter-system communication, embedded systems, modelling, programming of manufacturing processes and microcontrollers),*** • ***is able to design, participate and supervise the manufacturing processes and use the automated measurement and control equipment in the field of mechatronics,*** • ***knows foreign language at intermediate level in field of mechatronics' specialization.*** ***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:

Wroclaw University of 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 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 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 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 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 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 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 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 Technology, the Development Plan of the Faculty of

Microsystem Electronics and Photonics of Wrocław University of 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 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 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 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, 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 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

4.1.2 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	MAP001403W	Statistics and probability	1					K2MTR_W25 K2MTR_K15	15	30	1	0,6	T	Z	O		PD	Ob
2	MAP001403P	Statistics and probability				1		K2MTR_U27 K2MTR_K15	15	60	2	1,4	T	Z	O	P	PD	Ob
		Total	1			1			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			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	MCD042003W	MOEMS	1					K2MTR_W11	15	30	1	0,6	T	Z			K	Ob
17	MCD022003L	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 K2MTR_K03	45	120	4	2,8	T	Z		P	K	Ob
20	MCD023001W	Reliability in mechatronics	1					K2MTR_W14 K2MTR_K07	15	30	1	0,6	T	Z			K	Ob
21	MCD023001C	Reliability in mechatronics		1				K2MTR_U15 K2MTR_K07	15	60	2	0,7	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 K2MTR_U22 K2MTR_K13	15	30	1	0,7	T	Z		P	K	Ob
		Total	15	1	13	1	0		450	1050	35	22,7						

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	1	13	1	0	450	1050	35	22,7

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	9	3	1,8	T	Z			KO	W
2	MCM023002W	Enterprise Management	2					K2MTR_W21 K2MTR_W22	30	30	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	JZL100400BK	Foreign language B2+		1					15	30	1	0,7	T	Z	O	P	KO	W
2	JZL100400BK	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						

4.2.1.3 *Sporting classes* module

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol**)**	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	WFW000000BK	Sport		1					15	30	1	1	T	Z	O	P	KO	W
		Total	0	0	1	0	0	0	15	30	`1	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	5	0	0	0	105	210	7	4,9

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 K2MTR_K03 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 K2MTR_K03 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 K2MTR_K03 K2MTR_K12	30	60	2	1,4	T	Z		P	K	W
	MCD022002BK	**Microprocessors and microcontrollers**																
18	MCD022007W	Communication in microcontrollers	1					K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,6	T	Z			K	W
19	MCD022007L	Communication in microcontrollers			1			K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
20	MCD022008W	Microprocessor control	1					K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,6	T	Z			K	W
21	MCD022008P	Microprocessor control				1		K2MTR_W05 K2MTR_U05 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 K2MTR_K01	30	60	2	1,2	T	Z			K	W
23	MCD022011L	Applications of embedded systems in electronics			2			K2MTR_U02 K2MTR_K01 K2MTR_K03	30	90	2	1,4	T	Z		P	K	W
24	MCD022012W	Designing of embedded systems in electronics	2					K2MTR_W02 K2MTR_K01	30	60	2	1,2	T	Z			K	W
25	MCD022012P	Designing of embedded systems in electronics				2		K2MTR_U02 K2MTR_U06 K2MTR_K01 K2MTR_K03	30	90	2	1,4	T	Z		P	K	W
	MCD023001BK	**Numerical modeling methods**	**1**		**1**				**30**	**60**	**2**	**1,3**						
26	MCD023004W	Modelling of microsystems	1					K2MTR_W13 K2MTR_K06 K2MTR_K14	15	30	1	0,6	T	Z			K	W
27	MCD023004L	Modelling of microsystems			1			K2MTR_U14 K2MTR_K06 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
28	MCD023005W	Modelling of nanosystems	1					K2MTR_W13 K2MTR_K06 K2MTR_K14	15	30	1	0,6	T	Z			K	W

29	MCD023005L	Modelling of nanosystems			1			K2MTR_U14 K2MTR_K06 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
		Total	9		10	4				750	25	16,5						

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				
11		10	4		375	750	25	16,5

4.2.4 List of specialization modules

4.2.4.2 *Diploma dissertation* module

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	MCD023002S	Diploma seminar					2	K2MTR_W07 K2MTR_U06 K2MTR_K01	30	60	2	1,4	T	Z		P	K	Ob
2	MCD023006D	Diploma thesis						K2MTR_W08 K2MTR_U07 K2MTR_K02	180	600	18	12,6	T	Z		P	K	W
		Total		12					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				
	12			2	210	600	20	14

4.2 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**

4.3 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: - analytical, (analysis, e.g. numerical, properties) - technological (Technology of epitaxial growth) - project (Project of a sensor) - design (Laboratory stand for annealing by RTS method) - application (Assessment of applicability) - usage (Application of a heterostructure in construction) - research (Testing, characterization) - survey (Current state of knowledge concerning the growth mechanisms)		
Number of BK1 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 defence
seminar	participation in discussion, multimedia topic presentation
training	employer assessment, report from training
diploma dissertation	prepared diploma dissertation, presentation of the issues in diploma seminar, review, defence 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 BK1)

   59,9 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	30
Number of ECTS points for optional subjects	38
Total number of ECTS points	68

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)
   3 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. 3)

Opinion of the Student Council of the Faculty

....

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

....

Date Dean's signature

Attachment no. 3 do Programme of Education

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 from **29.09.2015**

In effect from **1.10.2015**

Faculty: **Microsystem Electronics and Photonics** Faculty Council resolution from: **29.09.2015**
Field of study: **Mechatronics** In effect from: **01.10.2015**
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						
27	Modelling and computer simulation of mechatronic assemblies			Sport	**1C**	01000			
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**		Embedded systems in electronics					
22	Digital communication interfaces								
21	10200/10020**E**			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 Foundations of electronic apparatus construction	**1W**	10000	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			MCD022003	**1W + 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			MCD023001	**1W + 2C**	11000
5	MCD021001	**1W + 2L**	20100**E**	MCD022001	**1W + 1L**	10100**E**	Reliability in mechatronics		
4	Micromachines and Microactuators			Fiber Optics Technology			MCD023001BK	**1W + 1L**	10100
3	MAP001403	**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	
Specialization courses	
Obligatory courses	
Optional courses	MCD

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

Semester 1

Obligatory courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	MAP001403W	Statistics and probability	1					K2MTR_W25 K2MTR_K15	15	30	1	0,6	T	Z	O		PD	Ob
2	MAP001403P	Statistics and probability				1		K2MTR_U27 K2MTR_K15	15	60	2	0,7	T	Z	O	P	PD	Ob
3	MCD021001W	Micromachines and Microactuators	2					K2MTR_W10	30	30	1	0,6		E			K	Ob
4	MCD021001L	Micromachines and Microactuators			1			K2MTR_W10 K2MTR_U09 K2MTR_U10 K2MTR_K03	15	60	2	1,4		Z		P	K	Ob
5	MCD021002W	Advanced microelectronic technologies	2					K2MTR_W17 K2MTR_K10	30	30	1	0,6		Z			K	Ob
6	MCD021002L	Advanced microelectronic technologies			1			K2MTR_U18 K2MTR_K10	15	60	2	1,4		Z		P	K	Ob
7	MCD021003W	Applied optoelectronics	1					K2MTR_W09	15	30	1	0,6		E			K	Ob
8	MCD041003L	Applied optoelectronics			1			K2MTR_U08 K2MTR_K05	15	30	1	0,7		Z		P	K	Ob
9	MCD021004W	Design and Construction of Optoelectronic Circuits	1					K2MTR_W18	15	30	1	0,6		Z			K	Ob
10	MCD021004P	Design and Construction of Optoelectronic Circuits				1		K2MTR_U19 K2MTR_K11	15	60	2	1,4		Z		P	K	Ob
11	MCD021005W	Foundations of electronic apparatus construction	1					K2MTR_W04 K2MTR_K10 K2MTR_K14	15	30	1	0,6		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		4	1	1		225	510	17	10,5						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1		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 K2MTR_K03 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 K2MTR_K01	30	60	2	1,2		Z			K	W
4	MCD021007L	Wireless battery-less networks			2			K2MTR_U03 K2MTR_K01 K2MTR_K03	30	60	2	1,4		Z		P	K	W
5	MCD021008W	Designing of battery-less electronic circuits	2					K2MTR_W03 K2MTR_K01	30	60	2	1,2		Z			K	W
6	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**																
7	MCD021009W	Digital interfaces in electronics	1					K2MTR_W01 K2MTR_K01	15	30	1	0,6		E			K	W
8	MCD021009L	Digital interfaces in electronics			2			K2MTR_U01 K2MTR_U06 K2MTR_K01 K2MTR_K03	30	60	2	1,4		Z		P	K	W
9	MCD021010W	Digital data exchange in electronics	1					K2MTR_W01 K2MTR_K01	15	30	1	0,6		E			K	W
10	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**																
11	MCD021011W	Signal processing systems	1					K2MTR_W16	15	30	1	0,6		Z			K	W
12	MCD021011L	Signal processing systems			2			K2MTR_U17 K2MTR_K03 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 K2MTR_K03 K2MTR_K09	30	60	2	1,4		Z		P	K	W
		Total	4		6	2			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		10	3	1	420	900	30	19,2

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	MCD022001W	Fiber Optics Technology	1					K2MTR_W12	15	30	1	0,6	T	E			K	Ob
2	MCD022001L	Fiber Optics Technology			1			K2MTR_U13 K2MTR_K03	15	30	1	0,7	T	Z		P	K	Ob
3	MCD022002W	Chemical and optoelectronic sensors	1					K2MTR_W15 K2MTR_K08	15	30	1	0,6	T	Z			K	Ob
4	MCD022002L	Chemical and optoelectronic sensors			2			K2MTR_U16 K2MTR_K08	30	90	3	2,1	T	Z		P	K	Ob
5	MCD042003W	MOEMS	1					K2MTR_W11	15	30	1	0,6	T	Z			K	Ob
6	MCD022003L	MOEMS			2			K2MTR_U10 K2MTR_U11 K2MTR_K03	30	90	3	2,1	T	Z		P	K	Ob
7	MCD022004W	Novel diagnostic methods	2					K2MTR_W06	30	60	2	1,4	T	E			K	Ob
8	MCD022004L	Novel diagnostic methods			3			K2MTR_U04 K2MTR_K03	45	120	4	2,8	T	Z		P	K	Ob
		Total	6		9				225	540	18	12,3						

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		Foreign Language A1/A2		3					45	60	2	1,4	T	Z	O	P	KO	W
2	WFW000000BK	Sport		1					15	30	1	1	T	Z	O	P	KO	W
	MCD022001BK	**Virtual control instruments**																
3	MCD022005W	Virtual instruments	1					K2MTR_W19	15	30	1	0,6	T	Z			K	W
4	MCD022005L	Virtual instruments			2			K2MTR_U20 K2MTR_K03 K2MTR_K12	30	60	2	1,4	T	Z		P	K	W
5	MCD022006W	Virtual instruments programming	1					K2MTR_W19	15	30	1	0,6	T	Z			K	W
6	MCD022006P	Virtual instruments programming				2		K2MTR_U20 K2MTR_K03 K2MTR_K12	30	60	2	1,4	T	Z		P	K	W
	MCD022002BK	**Microprocessors and microcontrollers**																

7	MCD022007W	Communication in microcontrollers	1					K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,6	T	Z			K	W
8	MCD022007L	Communication in microcontrollers			1			K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
9	MCD022008W	Microprocessor control	1					K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,6	T	Z			K	W
10	MCD022008P	Microprocessor control				1		K2MTR_W05 K2MTR_U05 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
	MCD022004BK	**Embedded systems in electronics**																
11	MCD022011W	Applications of embedded systems in electronics	2					K2MTR_W02 K2MTR_K01	30	60	2	1,2	T	Z			K	W
12	MCD022011L	Applications of embedded systems in electronics			2			K2MTR_U02 K2MTR_K01 K2MTR_K03	30	90	2	1,4	T	Z		P	K	W
13	MCD022012W	Designing of embedded systems in electronics	2					K2MTR_W02 K2MTR_K01	30	60	2	1,2	T	Z			K	W
14	MCD022012P	Designing of embedded systems in electronics				2		K2MTR_U02 K2MTR_U06 K2MTR_K01 K2MTR_K03	30	90	2	1,4	T	Z		P	K	W
		Total	4	3	3	2			180	360	12	8						

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	12	2		405	900	30	20,3

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	MCD023001W	Reliability in mechatronics	1					K2MTR_W14 K2MTR_K07	15	30	1	0,6	T	Z			K	Ob
2	MCD023001C	Reliability in mechatronics		1				K2MTR_U15 K2MTR_K07	15	60	2	0,7	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	1	1		2		90	210	7	4						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	MCD023006D	Diploma thesis						K2MTR_W08 K2MTR_U07 K2MTR_K02		600	18	12,6	T	Z		P	K	W
	MCM023001BK	**Management and Logistics**																
2	MCM023002W	Small Enterprise Management	2					K2MTR_W21 K2MTR_W22	30	30	3	1,8	T	Z			KO	W
3	MCM023002W	Enterprise Management	2					K2MTR_W21 K2MTR_W22	30	30	3	1,8	T	Z			KO	W
	MCD023001BK	**Numerical modeling methods**																
4	MCD023004W	Modelling of microsystems	1					K2MTR_W13 K2MTR_K06 K2MTR_K14	15	30	1	0,6	T	Z			K	W
5	MCD023004L	Modelling of microsystems			1			K2MTR_U14 K2MTR_K06 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
6	MCD023005W	Modelling of nanosystems	1					K2MTR_W13 K2MTR_K06 K2MTR_K14	15	30	1	0,6	T	Z			K	W
7	MCD023005L	Modelling of nanosystems			1			K2MTR_U14 K2MTR_K06 K2MTR_K14	15	30	1	0,7	T	Z		P	K	W
		Total	3		1				60	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	1	2	0	2	150	900	30	19,7

2. Set of exams in semestral arrangement

Course code	Name of course credited by examination	Semester
MCD021003W MCD021001W MCD021003BK	Applied optoelectronics Micromachines and Microactuators Digital communication interfaces	1
MCD022004W MCD022001W	Novel diagnostic methods 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:**	**29.09.2015**
Field of study:	**Mechatronics**	**In effect from:**	**01.10.2015**
Studies:	**2nd level, full-time**		

COURSE CATALOG

Subject cards for humanities, management, sport and language courses are posted on the Wrocław University of 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:	**MAP001403**
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. 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 La_01	ND_02-ND_04
PEK_K02	K2MTR_K15	C01, C02	Le_01-Le_05 La_01	ND_01-ND_04
PEK_K03	K2MTR_K15	C01, C02	La_01	ND_01-ND_04

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 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 La_01-La_05	ND_01 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 ND_02 Multimedia presentation ND_03 Consultation ND_04 Laboratory experiment 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

Janusz.Markowski@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

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 ND_02 Consultation ND_03 Self-study - preparation for classes ND_04 Computer software ND_05 Training kits and laboratory equipment 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 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 ND_02 Consultation ND_03 Self-study - preparation for classes ND_04 Computer software ND_05 Training kits and laboratory equipment 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 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 ND_02 Consultation ND_03 Self-study - preparation for classes ND_04 Computer software ND_05 Training kits and laboratory equipment 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 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 ND_02 Consultation ND_03 Self-study - preparation for classes ND_04 Computer software ND_05 Training kits and laboratory equipment 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 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

Attachment No. 4 to ZW 33/2012

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 PEK_W02 PEK_W03	Discussions and consultations Exam
F2 (labs)	PEK_U01 PEK_U02 PEK_U03	Answer before lab 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:	**MOEMS**	
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:	**MCD022003**	
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. 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 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 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:	**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

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 ND_02 Consultation ND_03 Self-study - preparation for classes ND_04 Computer software ND_05 Training kits and laboratory equipment 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 La_01-La_06	ND_03
PEK_K02	K2MTR_K03		La_01-La_06	ND_04-ND_06

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 ND_02 Consultation ND_03 Self-study - preparation for classes ND_04 Computer software ND_05 Training kits and laboratory equipment 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 Pr_01-Pr_04	ND_03
PEK_K02	K2MTR_K03		Pr_01-Pr_04	ND_04-ND_06

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:	**MCD023001**
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 Participation in conducted 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 Seeing aspects of the reliability of mechatronic systems and statistical presentation of measurement data in various fields of engineering practice, understanding the need to use mathematical knowledge to analyze technical issues

PROGRAMME CONTENT

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

Form of classes - Classes		Quantity
Cl_01	Solving tasks in the field of random and pseudo-random events occurring in technical issues part I	2
Cl_02	Solving tasks in the field of random and pseudo-random events occurring in technical issues part II	2
Cl_03	Solving tasks related to typical characteristics and calculations of reliability parameters	2
Cl_04	Solving tasks in the field of the analysis of experimental data	2
Cl_05	Solving tasks related to binary, serial and parallel mechatronic systems	2
Cl_06	Solving tasks in the field of the reliability of mechatronic systems	2
Cl_07	Solving tasks in the field of reliability tests	2
Cl_08	Written test	1
	TOTAL	15

TEACHING TOOLS USED
ND_01 Traditional lecture
ND_02 Classes - 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 classes 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 (classes)	PEK_U01 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. Godfrey 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	Cl_01-Cl_07	ND_01, ND_02, ND_03, ND_05
PEK_K01 (competences)	K2MTR_K07	C01-C03	Le_01-Le_07 Cl_01-Cl_07	ND_01-ND_06

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, PEK_U01, 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)				180	
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 PEK_U01, 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:	**MCD023004**
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 on physics and mathematics
2. Basic knowledge on numerical methods
3. Basic knowledge on computer skills

SUBJECT OBJECTIVES

C01 Getting familiarize with numerical prototyping of electronic microsystems using finite element method
C02 Gaining skills for computer software focused on numerical modelling based on finite element method as ANSYS, FlexPDE, etc.
C03 Getting familiarize with typical problems connected with numerical prototyping in macro and micro scale as optimization, design of experiments, etc.
C04 Consolidation of skills for self and team work based on supplied instruction materials

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 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_U01 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_K01 Can properly prioritize tasks in order to finalize a specified work

PEK_K02 Takes into account the need to use numerical methods in the design of electronic systems

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Modelling of microsystems - introduction	2
Le_02	Introduction to finite element method	2
Le_03	Modelling of the mechanical problems	2
Le_04	Modelling of the thermodynamical problems	2
Le_05	Modelling of the thermomagnetic problems	2
Le_06	Modelling of the fluid dynamics	2
Le_07	Modelling of the coupled fields	2
Le_08	Exam	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Analysis of stress and strain distribution	2
La_02	Analysis of thermal energy dissipation and temperature distribution	2
La_03	Analysis of electrostatic field distribution	2
La_04	Analysis of laminar and turbulent fluid flow	2
La_05	Analysis of stresses for bi-material structures	2
La_06	Prototyping with parametric numerical models	2
La_07	Analysis of electro-thermo-mechanical problems	2
La_08	Grading	1
	TOTAL	15

TEACHING TOOLS USED	
ND_01	Traditional lecture with multimedia presentations and discussions
ND_02	Laboratory: 5-minutes introduction and 5-minutes test at the beginning of the lecture
ND_03	Consultations
ND_04	Self work – preparation for the lectures for given problems
ND_05	Self work – preparation for the laboratory exercises
ND_06	Self work – self study and preparation for the final test
ND_07	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_07	ND_02, ND_05
PEK_K01 (competences)	K2MTR_K14	C04	Le_01-Le_08, La_01- La_08	ND_07
PEK_K02	K2MTR_K06	C01-C03	Le_01-Le_08, La_01- La_08	ND_01-ND_07

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**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:	**MCD023005**
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 on physics and mathematics
2. Basic knowledge on numerical methods
3. Basic knowledge on computer skills

SUBJECT OBJECTIVES

C01 Getting familiarize with numerical prototyping of electronic microsystems using quantum and molecular modelling techniques

C02 Gaining skills for computer software focused on numerical modelling based on quantum and molecular modelling as Material Studio, etc.

C03 Getting familiarize with typical problems connected with numerical prototyping in meso and nano scale as optimization, design of experiments, etc.

C04 Consolidation of skills for self and team work based on supplied instruction materials

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 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_U01 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_K01 Can properly prioritize tasks in order to finalize a specified work by himself or others

PEK_K02 Takes into account the need to use numerical methods in the design of electronic systems

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Numerical modelling at the quantum and molecular level	2
Le_02	Quantum mechanics versus electronic systems	2
Le_03	Examples and applications of the quantum numerical methods in electronic systems	2
Le_04	Molecular mechanics versus electronic systems	2
Le_05	Examples and applications of the molecular numerical methods in electronic systems	2
Le_06	Meso scale numerical methods versus electronic systems	2
Le_07	Examples and applications of the meso scale numerical methods in electronic systems	2
Le_08	Exam	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introduction to modelling methods in Material Studio	2
La_02	Quantum mechanic – hydrogen atom	2
La_03	Quantum mechanics – energy levels	2
La_04	Molecular mechanics – statics and dynamics	2
La_05	Molecular mechanics – material properties	2
La_06	Modelling in meso scale	2
La_07	Individual project	2
La_08	Grading	1
	TOTAL	15

TEACHING TOOLS USED	
ND_01	Traditional lecture with multimedia presentations and discussions
ND_02	Laboratory: 5-minutes introduction and 5-minutes test at the beginning of the lecture
ND_03	Consultations
ND_04	Self work – preparation for the lectures for given problems
ND_05	Self work – preparation for the laboratory exercises
ND_06	Self work – self study and preparation for the final test
ND_07	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_07	ND_02, ND_05
PEK_K01 (competences)	K2MTR_K14	C04	Le_01-Le_08, La_01- La_08	ND_07
PEK_K02	K2MTR_K06	C01-C03	Le_01-Le_08, La_01- La_08	ND_01-ND_07

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**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 ND_02 Problem discussion ND_03 Lab experiment 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

Tomasz.Baraniecki@pwr.edu.pl

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