PROGRAMME OF EDUCATION

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

MAIN FIELD OF STUDY: ***Electronics and Telecommunications***

in area of technical science

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

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

PROFILE: ***general academic***

SPECIALIZATION: ***Electronics, Photonics, Microsystems***

LANGUAGE OF STUDY: ***English***

Content:

Microsystem Electronics and Photonics Faculty Council resolution no. ***122/11/2016-2020 of 17.05.2017***

In effect since ***01.10.2017***

Attachment no. 1 to Programme of Education

Field of study educational effects
for *Electronics and Telecommunications*
second level studies – general academic

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

Location of the field of study in the area of education

The field of study *Electronics and Telecommunications* (EiT) belongs to the area of education in technical sciences and is connected with such fields of study as *Informatics, Mechatronics and Automatics and Robotics.*

A person applying for the second level study at the Faculty of Microsystem Electronics and Photonics of Wrocław University of Science and Technology at the specialization of EiT should possess the first level qualifications and competences necessary for continuing education at the second level study in this specialization – the competences which encompass the following:

1. knowledge in the field of physics and mathematics enabling understanding of physical basis of electronics and telecommunication as well as formulating and solving simple project tasks from this area,
2. knowledge and skills from the field of analog and digital electronic circuits, metrology, semiconductor devices, signal processing, fundamentals of telecommunication, enabling measurements, analysis, simulation and design of simple elements and electronic and communication systems,
3. skill of using analytical, simulation and experimental methods for formulating and solving engineering tasks,
4. knowledge and skills concerning architecture and software of computer systems,
5. knowledge and skills on methodology and techniques of programming, enabling formulation of an algorithm for a simple engineering task and developing a software program in a chosen high level language with the use of suitable informatics tools,
6. skills connected with interpretation, presentation and documentation of experimental results and presentation and documentation of a project-like task.

Legend:

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

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

Field of study educational effects for the 2nd level studies in *Electronics and Telecommunications*	**DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of *Electronics and Telecommunications* the graduate:**	**Correlation of educational effects with universal characteristics of PQF, with second stage characteristics of PQF for qualifications on the 7th level, with second stage characteristics of PQF for engineering competences on the 7th level**
KNOWLEDGE		
K2eit_W01	has extended and deepened knowledge in the area of sciences and disciplines (physics, chemistry, biology, informatics, materials engineering) necessary to understand the essence of phenomena/properties being the result of size reduction, which are used in nanotechnology	P7U_W P7S_WG
K2eit_W02	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics and theoretical and experimental bases of specific phenomena from the area of electronics and photonics, necessary to understand the phenomena (photoelectronic, electro-acoustic, super-conductivity)	P7U_W P7S_WG
K2eit_W03	has basic knowledge concerning theory and methods of linear and nonlinear programming used in optimization procedures	P7S_WG
K2eit_W04	has theoretically grounded knowledge concerning typical techniques and numerical algorithms applied in engineering, such as: numerical differentiation and integration, experiment design, optimization applied to solving equations or equation systems, both linear and nonlinear, numerical interpolation or optimization and systems of differential equations	P7U_W P7S_WG
K2eit_W05	knows and understands the elements of mathematical statistics in terms of possibilities of its application in engineering practice and scientific research	P7U_W

K2eit_W06	has basic knowledge concerning ordinary and partial differential equations, integral equations, theory of stochastic processes (stationary, Markow, renewal, gaussian processes), Hilbert spaces, necessary to understand mathematical problems in sciences of engineering character	P7U_W
K2eit_W07	has knowledge concerning reliability theory, methods of elements and devices testing, diagnostic methods, basic characteristics in theory of reliability, typical distributions, reliability of systems, estimation of reliability parameters, experiment design, testing and diagnostics as well as failure models	P7S_WG P7S_WG_NT P7S_WG_INŻ
K2eit_W08	has knowledge concerning basis of operation of force and deflection sensors basing on piezoresistive and piezoelectric effects, methods of calculation of measurement sensitivity and resolution of piezoresistive sensors and designs of MEMS systems	P7S_WG
K2eit_W09	has ordered, theoretically grounded, general and detailed knowledge in the range of exact and technical sciences in the areas related to the field of study	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
K2eit_W10	has knowledge on the basic concepts of production management systems useful for managers of small or middle enterprises; knows modern production systems and production management systems as well as information about finances, market analysis, logistics, people management, which are necessary in strategic management of enterprises	P7S_WK P7S_WK_NT P7S_WK_INŻ
K2eit_W11	has knowledge necessary to understand economic, legal, social and beyond technical factors of engineering activities and their using in engineering practice	P7S_WK P7S_WK_NT P7S_WK_INŻ
K2eit_W12	has basic knowledge concerning management, quality management and running a business	P7S_WK P7S_WK_NT P7S_WK_INŻ
K2eit_W13	has knowledge concerning sensor technologies, including the knowledge necessary to understand the physical and mechanical principles of operation of sensors and actuators; knows relations between their functional parameters and structure; has basic knowledge on sensor and actuators technologies	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
	achieves results in KNOWLEDGE category in one of the following specializations: • Microsystems – EMS • Optoelectronics and Waveguide Technology – EOT • Electronics, Photonics, Microsystems – EPM	

SKILLS		
K2eit_U01	is able to assess and use devices/objects with nanometric dimensions (especially semiconductor devices and other ones, made using different technologies)	P7S_UW P7S_UW1_NT P7S_UW2_NT P7S_UW3_NT P7S_UW1_INŻ P7S_UW2_INŻ P7S_UW3_INŻ
K2eit_U02	is able to assess and use the phenomena occurring in solid state materials in quantum electronics applications	P7S_UW P7S_UW1_NT P7S_UW2_NT P7S_UW3_NT P7S_UW1_INŻ P7S_UW2_INŻ P7S_UW3_INŻ
K2eit_U03	using the methods of linear and nonlinear programming, is able to solve problems and tasks, optimizing the goal	P7U_U P7S_UW P7S_UW2_NT P7S_UW1_INŻ P7S_UW2_INŻ
K2eit_U04	is able to use the learned numerical methods for solving typical engineering tasks	P7U_U P7S_UW P7S_UW2_NT P7S_UW1_INŻ P7S_UW2_INŻ
K2eit_U05	has basic practical skills concerning presentation, analysis and interpretation of data and application of statistical methods in the analysis of various physical phenomena	P7U_U P7S_UK P7S_UW2_NT P7S_UW2_INŻ
K2eit_U06	is able to correctly and effectively use the knowledge concerning differential and integral equations, as well as stochastic processes, for qualitative and quantitative analysis of mathematical problems related to the studied engineering discipline	P7U_U P7S_UW2_NT P7S_UW2_INŻ
K2eit_U07	is able to solve problems concerning calculation of reliability characteristics, calculation of parameters using measurement data, planning of testing methods, planning of diagnostic methods	P7U_U P7S_UW2_NT P7S_UW2_INŻ

K2eit_U08	is able to explain the operating principle and basic characteristics and designs of deflection actuators using piezoelectric and electrostatic actuation	P7U_U P7S_UK
K2eit_U09	is able, using literature information and basing on the result of own work, integrating, interpreting and critically evaluating, to prepare and give an oral presentation relevant to the field of study	P7U_U P7S_UW P7S_UK P7S_UU P7S_UW1_NT P7S_UW2_NT P7S_UW3_NT
K2eit_U10	is able to use the acquired knowledge on modern production systems, processes of production management, market analysis, logistics and people management	P7U_U P7S_UO P7S_UW4_NT P7S_UW4_INŻ
K2eit_U11	is able to formulate and test the hypotheses connected with engineering problems and simple research work	P7S_UW1_NT P7S_UW1_INŻ
K2eit_U12	is able to assess the usefulness and possibilities of application of modern achievements in the fields of technique and technology connected with the current field of study	P7S_UW2_NT P7S_UW2_INŻ
K2eit_U13	is able to perform critical analysis of the way of functioning and assess novel technical solutions, especially connected with the current field of study, such as devices, objects, systems, processes, services	P7S_UW2_NT P7S_UW3_NT P7S_UW2_INŻ P7S_UW3_INŻ
K2eit_U14	is able to suggest rationalization proposal/improvements to existing technical solutions	P7S_UW3_NT P7S_UW3_INŻ
K2eit_U15	is able to assess and use semiconductor devices and other devices fabricated using various techniques/technologies	P7S_UW2_NT P7S_UW2_INŻ
K2eit_U16	is able to define the fields of further education and follow the process of self-learning	P7S_UU
	achieves results in SKILLS category in one of the following specializations: • Microsystems – EMS • Optoelectronics and Waveguide Technology – EOT • Electronics, Photonics, Microsystems – EPM	
SOCIAL COMPETENCES		
K2eit_K01	shows curiosity about new innovative design solutions and production processes	P7S_KK
K2eit_K02	perceives the aspects connected with collecting and presentation of measurement data in various areas of engineering practice and the need of using statistical methods for their description	P7U_K P7S_KK P7S_KR

K2eit_K03	perceives the necessity of undertaking and putting into practice optimization measures in various areas of life	P7U_K P7S_KK P7S_KO
K2eit_K04	takes into account the need of using numerical methods in design process	P7S_KK
K2eit_K05	can think and act in a creative and entrepreneurial way	P7S_K P7S_KK
K2eit_K06	properly recognizes, solves, and acting in a team, puts into practice the knowledge concerning analysis of mathematical problems	P7S_KK P7S_KO P7S_KR
K2eit_K07	is able to properly define priorities for realization of a task defined by himself/herself or other person; can safely perform measurements and work out results of measurements	P7U_K P7S_KR
K2eit_K08	is conscious of importance of the issues connected with implementation and functioning in engineering activity of modern production systems, production management systems, logistics and people management	P7U_K P7S_KK
K2eit_K09	realizes the need of formulating and sharing in society, also with the use of mass media, the information and opinions concerning achievements in the field of study, and other aspects of electronic engineer's activity, in a clear, commonly understandable way, justifying various points of view	P7U_K P7S_KO P7S_KR
K2eit_K10	is conscious of importance and realizes beyond technical aspects and consequences of engineering activity, including its impact on environment and associated with it responsibility for taken decisions	P7U_K P7S_KO P7S_KR
K2eit_K11	is able to define priorities for realization of a particular task	P7U_K
K2eit_K12	properly recognizes and settles dilemmas connected with professional activity	P7S_KR
	achieves results in COMPETENCES category in one of the following specializations: • Microsystems – EMS • Optoelectronics and Waveguide Technology – EOT • Electronics, Photonics, Microsystems – EPM	

EDUCATIONAL EFFECTS FOR EPM SPECIALIZATION

Faculty: Microsystem Electronics and Photonics
Field of study: Electronics and Telecommunications
Level of studies: second level, full time study
Specialization: Electronics, Photonics, Microsystems (EPM)

Specialization educational effects at the 2nd level study in *Electronics, Photonics, Microsystems*	**DESCRIPTION OF EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of *Electronics and Telecommunications* within the *Electronics, Photonics, Microsystems* specialization the graduate:**	**Correlation of educational effects with universal characteristics of PQF, with second stage characteristics of PQF for qualifications on the 7th level, with second stage characteristics of PQF for engineering competences on the 7th level**
KNOWLEDGE		
S2epm_W01	has extended and deepened knowledge concerning technological processes applied in widely understood thin-film microelectronics, with the use of knowledge on the phenomena occurring in plasma processes conducted at reduced pressure	P7U_W P7S_WG
S2epm_W02	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary to understand the operation of optical telecommunications systems and optical recording and processing of information	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ

S2epm_W03	has deepened and ordered knowledge concerning applications and design of optical fiber measurement systems used in contemporary technique	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
S2epm_W04	has extended deepened and ordered knowledge, from the field of physics and basis of chemistry, necessary to understand the principles of operation of supplying systems in microsystems (principle of operation, technological and design solutions, exploitation parameters)	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
S2epm_W05	has ordered and theoretically grounded knowledge related to the structure, operation principles, properties and applications of physical and chemical sensors as well as microsystems made using thick-film and LTCC (*Low Temperature Cofired Ceramics*) technology; knows trends in the development of LTCC microsystems	P7S_WG
S2epm_W06	has theoretically grounded knowledge concerning physico-chemical, and technological bases, design, fabrication, operation and applications of analytical microsystems, microreactors, bio-chips and lab-on-chips	P7S_WG P7S_WG_NT P7S_WG_INŻ
S2epm_W07	has extended and deepened knowledge concerning theoretical and practical aspects of the application of numerical methods for modeling and design in the area of microsystems	P7U_W P7S_WG
S2epm_W08	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics, including the knowledge necessary to understand the physical phenomena having an important impact on the properties of novel materials and operation of advanced photonic devices	P7U_W P7S_WG
S2epm_W09	has knowledge concerning the principles of designing electronic devices with the use of optoelectronic and optical fiber subsystems, satisfying presumed input parameters	P7U_W P7S_WG
S2epm_W10	has knowledge on the structure and principles of operation of contemporary operating systems, with special emphasis on Linux family and embedded systems; knows the principles of using of low-level system functions as well as programming and configuration of embedded systems intended, among others, for microcontrollers	P7U_W P7S_WG
S2epm_W11	has deepened, theoretically grounded knowledge from the field of photonics, including the knowledge necessary to understand the operation of optical telecommunication systems and optical recording and processing of information; has ordered knowledge concerning the devices being components of teleinformatic networks, including the wireless ones	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ

S2epm_W12	knows the issues concerning the basic optical phenomena in solid state, the structure and technology of device structures, band-gap engineering and the energetic structure on the level of energetic sub-bands with a precise control of built-in potentials, technology of quantum structures and methods of controlling their energetic properties; knows the parameters, structures and operation principles of semiconductor light sources, including the VCSEL or QCL laser structures and the lasers with multidimensional photonic crystals	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
S2epm_W13	has ordered, theoretically grounded general and detailed knowledge in the field of exact and technical sciences relevant to the studied specialization; knows basic principles of editing of research projects and diploma thesis	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
S2epm_W14	has knowledge in the field of packaging technologies, testing and assessment the quality of bonding of electronic sub-assemblies on printed wire boards; recognizess the physical bacgrounds of soldering process, the soldering technologies applied on industrial scale; has knowledge on industrial safety rules in the bonding and de-bonding process	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
S2epm_W15	has theoretically grounded knowledge concerning physico-mechanical, technological, design, fabrication, operation and application bases of microsystems of MEMS and MOEMS type	P7U_W P7S_WG
S2epm_W16	has ordered and theoretically grounded knowledge on photovoltaics, including the knowledge necessary to understand physical basis of photovoltaic elements operation as well as designing and quality assessment of photovoltaic systems	P7U_W P7S_WG P7S_WG_NT P7S_WG_INŻ
SKILLS		
S2epm_U01	is able to design a technological process of thin-film deposition, including the processes occurring in gas discharge	P7U_U P7S_UW P7S_UW1_NT P7S_UW1_INŻ
S2epm_U02	is able to choose and assess optical fiber and optoelectronic elements used in designing of photonic systems and optical fiber networks; is familiar with the techniques of measurements of waveguides, waveguide couplers and possibilities of their application in waveguide systems	P7S_UW
S2epm_U03	is able to plan a process of testing of a complex electronic circuit and electronic or photonic system; is able to design electronic circuits and systems intended for different applications, including monolithic and hybrid electronic and photonic circuits	P7S_UW1_NT P7S_UW1_INŻ
S2epm_U04	is able to correctly and effectively use the knowledge about differential and integral equations as well as stochastic processes for qualitative and quantitative analysis of mathematical problems relevant to the studied specialization	P7U_U P7S_UW2_NT P7S_UW2_INŻ

S2epm_U05	is able to select and apply, depending on requirements as well as available solutions and exploitation parameters, a proper supplying source for a microsystem	P7S_UW2_NT P7S_UW2_INŻ
S2epm_U06	is able to design specific sensors, actuators and microsystems; is able to develop prerequisites concerning design of chosen devices and develop an algorithm of technological process for their fabrication	P7S_UW4_NT P7S_UW4_INŻ
S2epm_U07	is able to describe, assess and compare the operation of analytic gaseous and fluidic microsystems; knows the principles of design, fabrication, operation and application of microsystems in chemistry and microchemistry	P7S_UW P7S_UW2_NT P7S_UW2_INŻ
S2epm_U08	is able to use the acquired knowledge for carrying out the studies of the components of analytical microsystems (valves, metering units, mixers and detectors); is familiar with the operation principles of advanced analytical microsystems (e.g. integrated gas chromatograph)	P7S_UW P7S_UW1_NT P7S_UW2_NT P7S_UW1_INŻ P7S_UW2_INŻ
S2epm_U09	is able to plan and safely carry out measurements and work out the measurement results	P7S_UW1_NT P7S_UW1_INŻ
S2epm_U10	is able - while formulating and solving tasks associated with modeling and design of microsystems - to integrate knowledge coming from different sources	P7S_UW
S2epm_U11	is able to develop detailed documentation of the results of experiment, a design or research project; is able to prepare a report containing discussion of the results	P7S_UK
S2epm_U12	is able to develop a system solution and define the physical phenomenon from the field of optoelectronics and waveguide technology, satisfying the given project task; is able to plan a design process, is able to develop electronic schemes of a device, design printed wire boards and casing, and asses the cost of fabrication of the device	P7S_UW P7S_UW4_NT P7S_UW4_INŻ
S2epm_U13	has a skill of using low-level system functions as well as program and configure embedded systems intended for microcontrollers	P7S_UW
S2epm_U14	is able to work individually and in a team; is able to assess time consumption for task execution; is able to manage a small team in a way ensuring completion of the task in due time; is able to prepare and give a presentation on realization of a task or research project and conduct a discussion concerning the presentation; is able to use English at the level sufficient for communication, also in professional issues, reads with understanding professional literature and is able to prepare and give a short oral presentation on realization of a task or research project	P7U_U P7S_UW P7S_UK P7S_UO P7S_UU
S2epm_U15	is familiar with the techniques and measuring stands for characterization of epitaxial device structures and can use them in practice; knows and is able to apply optical spectroscopic methods, such as photoluminescence, photo reflection or electronic reflection, for the characterization quantum properties of semiconductor structures	P7S_UW P7S_UW1_NT P7S_UW1_INŻ

S2epm_U16	is able to implement the regulations of WEEE and RoHS directives; is able to recognize and eliminate the bonding faults described in IPC standards	P7S_UW P7S_UW2_NT P7S_UW3_NT P7S_UW2_INŻ P7S_UW3_INŻ
S2epm_U17	has a sikll of manual soldering using resistance and gas soldering tools; is able to carry out reflow soldering process and manual debonding, using a professional service station; is able to match the parameters of soldering process to the applied materials	P7S_UW P7S_UW2_NT P7S_UW3_NT P7S_UW2_INŻ P7S_UW3_INŻ
S2epm_U18	is able, using literature information and basing on the results of own work, while integrating, interpreting and making critical evaluation, to prepare diploma thesis and give an oral presentation relevant to the field of study	P7U_U P7S_UW P7S_UK P7S_UU
S2epm_U19	is able to identify and formulate specification of complex engineering tasks (relevant to the field of study) taking into account their beyond technical aspects	P7S_UW
S2epm_U20	is able to solve problems concerning: calculation of reliability characteristics, calculation of parameters with the use of measurement data, planning of testing methods, planning of diagnostics methods	P7S_UW P7S_UW_nt P7S_UW1_INŻ
SOCIAL COMPETENCES		
S2epm_K01	is able to work individually and in a team	P7U_K
S2epm_K02	is open to novel innovative design solutions and production processes applied in electronics and photonics	P7S_KK
S2epm_K03	is able to think and act in innovative and entrepreneurial way	P7U_K P7S_KK
S2epm_K04	perceives the necessity of functionality assessment of optoelectronic systems in different areas of life and is able to take effective measures to put such solutions in practice	P7U_K P7S_KK P7S_KO
S2epm_K05	properly identifies, solves and puts into practice, co-operating in a team, the knowledge connected with the analysis of engineering problems	P7S_KK P7S_KO P7S_KR
S2epm_K06	takes into account the necessity to use numerical methods in the design process of photonic and microelectronic structures	P7S_KK
S2epm_K07	is able to properly define the priorities for realization of a task defined by himself/herself or other person; is able to perform measurements safely and work out results of measurements	P7U_K

S2epm_K08	is conscious of the importance and understands the necessity of putting into practice renewable energy sources	P7U_K P7S_KK
S2epm_K09	is able to work individually and in a team	P7U_K P7S_KR

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 Electronics and Telecommunication 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,* • *applied mathematics,* • *mechatronics,* • *mechanical engineering,* • *teleinformatics,* • *optics.* ***Recruitment factor W_{II} = D x 10 + RK + OD***	*Upon completion of studies graduate obtains* *professional degree of:* ***M. Sc. engineer*** *2-nd level qualifications*

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*	
Possibility of continuing of the studies: ***Graduate is prepared for the 3-rd level study***	*Graduate profile, employability:* ***Graduate is able, with the use of modern technologies, to design and apply analog and digital integrated electronic circuits, lasers, optical fibers and photovoltaic cells. Is able to design and operate telecommunication and teleinformatic networks, manufacture and apply micro- and nanosystems e.g. microsensors and microrobots applied in medicine, pharmacy, automotive and aircraft industry and building access and security systems. Graduate has knowledge enabling quick adaptation to the dynamically changing informatics reality as well as the knowledge on new materials and technologies. The specialization EPM offered within the field "Electronics and Telecommunication" give the possibility of versatile preparation of the graduates in the areas encompassing electronics, photonics, informatics, optoelectronics and telecommunication, which is a great advantage on the contemporary labor market. Concrete practical knowledge acquired thanks to the access to the newest computer and network hardware and software, knowledge of foreign languages, enable the graduate to continue the education on the 3-rd level studies at local universities and universities in the area of European Union. The graduate has the ability to undertaking individual engineering activities as well as participating in team work and managing people.***

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

Wrocław University of Science and Technology is a pubic academy with a status of technical university, acting on the basis of the Act of July 27, 2005 "Law on Higher Education" and University Statute. In the plan of development of Wrocław University of Science and Technology there is a statement "The expression of mission underlines the role of university in maintaining and developing the competences associated with the culture of experimentation. The competences are the foundations of contemporary civilization, they determine its existence and are the main factor of its development. At the time when experimentations tend to be replaced by procedures and when pretences are considered as more important than facts, the mission is of fundamental importance.

- Stress on creativity which changes the trajectories of future
- Stress on professionalism and real skills which are the condition of technosphere functioning
- Stress on partnership and cooperation with local and external partners, which enhances the effects of activities and facilitates their achievement."

This expression has been directly transferred to the Plan of Development of the Faculty of Electronic Microsystems and Photonics, but there, the word "University" has been replaced by "Faculty". It means that if an academic unit is to play the role of an intellectual center, it must understand the contemporary world and have a vision of the future. As an important technical university, Wrocław University of Science and Technology "links high theoretical, research and expert competences with the

educational and didactic activities". For this reason, the main feature of the Faculty of Microsystem Electronics and Photonics of Wrocław University of Science and Technology" is its high external usefulness" The already mentioned plan of Faculty development says that "at the Faculty, the dominant role play design and technological research works associated with ***micro- and nanoelectronics, micro- and nanosystems*** *and* ***micro- and nanophotonics.*** *This research subject is transferred into the educational profile, especially at the 2-nd and 3-rd levels. The educational profile is supplemented with the university-wide subjects, encompassing liberal-managerial subjects which create the basis of engineer's cultural education, and are available for the whole students' community". So outlined mission and vision of University/Faculty has been incorporated into the educational model, proposed by the Faculty, i.e. "interactive, discursive and experimental shaping of students' skills". Currently, the Faculty of Microsystem Electronics and Photonics educates B. Sc. engineers and M.Sc. engineers, the specialists in the field of electronics, photonics, informatics and telecommunications. The Faculty graduate is able to design and apply electronic integrated circuits - both analog and digital. Knows how to design and apply lasers, optical fibers and photovoltaic cells in solar power plants. Is able to design and operate telecommunication and teleinformatic networks. Is able to design, manufacture and apply micro- and nanosystems, i.e. microrobots used in medicine, automotive and aircraft industry, pharmacy, environment protection, building security systems and armaments industry. In the perspective of 2020, the Faculty is planning to lead or co-lead with other units of Wrocław University of Science and Technology, the following fields of study: "****Electronics – 1-st and 2-nd levels*** *(the 2-nd level oriented to* ***Micro- and Nanoengineering)****,* ***Optoelectronics*** *(and possibly* ***Photonics) - 1-st and 2-nd level, Materials Engineering – 1-st level****." This is associated with interdisciplinary character of conducted in the Faculty research and development works. We are going to lead, "within our competences, post-graduate study and the studies of II and III age." In the currently prepared and developed concept there is included the education of specialists and innovators, which takes into account individual student's abilities. We would like to stimulate the skills enhancing competitiveness on the labor market and teach cooperation as well as provide international contacts. The way to realize this goal is, among the others, to follow the development of faculties which lead similar subjects in the world and adapt the reasonable solutions to our specificity. Student, who fulfill particular conditions may get an individual tutor and study according to interdisciplinary paths, shaped in accordance with their individual interests (the idea is possible to realize in the Faculty due to the favorable ratio of the number of students and the number of academic teachers). We are doing our best to balance our educational programme so as it contained, in suitable proportion, the knowledge enabling further professional adaptation and the knowledge building a rational image of the world.*

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

Area: technical sciences

Discipline: electronics

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.

4. List of education modules

4.1. List of obligatory modules

4.1.1. List of general education modules

4.1.1.1. *Liberal-managerial subjects* 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.	FLD129580W	Philosophy of Science and Technology	1						15	60	2	1.2	T	Z	O		KO	Ob.
2.	ZMZ000134W	Contemporary Management	2						30	90	3	1.8	T	Z	O		KO	Ob.
		Total	3	0	0	0	0		45	150	5	3						

Altogether for general education modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
3	0	0	0	0	45	150	5	3

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.	MAT001449W	Mathematics	2					K2eit_W06	30	60	2	1.2	T	E	O		PD	Ob.
2.	MAT001449C	Mathematics		2				K2eit_U06 K2eit_K02	30	60	2	1.4	T	Z	O	P	PD	Ob.
		Total	2	2	0	0	0		60	120	4	2.6						

4.1.2.1. *Physics* module

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1.	ETD008084W	Solid State Electronics	2					K2eit_W02	30	60	2	1.2	T	Z			PD	Ob.
		Total	2	0	0	0	0		30	60	2	1.2						

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				
4	2	0	0	0	90	180	6	3.8

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.	ETD008081W	Statistics for EPM	1					K2eit_W05	15	30	1	0.6	T	Z			K	Ob.
2.	ETD008081C	Statistics for EPM		1				K2eit_U05 K2eit_K02	15	60	2	1.4	T	Z		P	K	Ob.
3.	ETD008082W	Numerical Methods	1					K2eit_W04 InzA_W02 K2eit_K07 InzA_K01	15	30	1	0.6	T	Z			K	Ob.
4.	ETD008082L	Numerical Methods			1			K2eit_U04 InzA_U01 K2eit_K07 InzA_K01	15	60	2	1.4	T	Z		P	K	Ob.
5.	ETD008083W	Optimization Methods	1					K2eit_W03	15	30	1	0.6	T	Z			K	Ob.
6.	ETD008083C	Optimization Methods		1				K2eit_U03 K2eit_K03	15	60	2	1.4	T	Z		P	K	Ob.
7.	ETD008085W	Nanotechnology	1					K2eit_W01	15	30	1	0.6	T	Z			K	Ob.
8.	ETD008085S	Nanotechnology					2	K2eit_U01 K2eit_K01	30	60	2	1.4	T	Z		P	K	Ob.
9.	ETD009078W	Sensors and Actuators	1					K2eit_W13	15	30	1	0.6	T	Z			K	Ob.
10.	ETD009079W	Diagnostics and Reliability	1					K2eit_W07	15	30	1	0.6	T	Z			K	Ob.
11.	ETD009079P	Diagnostics and Reliability				1		K2eit_U07 K2eit_K06	15	60	2	1.4	T	Z		P	K	Ob.
		Total	6	2	1	1	2		180	480	16	10.6						

Altogether for main-field-of-study modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
6	2	1	1	2	180	480	16	10.6

4.1.3. List of specialization modules

4.1.3.1. *Obligatory specialization subjects* modules

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1.	ETD008567W	MOEMS	1					S2epm_W06	15	60	2	1.2	T	Z			S	Ob.
2.	ETD008567L	MOEMS			1			S2epm_U11 S2epm_K01	15	60	2	1.4	T	Z		P	S	Ob.
3.	ETD008564W	Optical Fibers	2					S2epm_W02	30	60	2	1.2	T	E			S	Ob.
4.	ETD008564L	Optical Fibers			2			S2epm_U02 S2epm_K01	30	60	2	1.4	T	Z		P	S	Ob.
5.	ETD008568W	Vacuum and Plasma Techniques	2					S2epm_W01	30	30	1	0.6	T	Z			S	Ob.
6.	ETD008566W	Autonomous Power Supplying Systems	1					K2eit_W11	15	60	2	1.2	T	Z			S	Ob.
7.	ETD009584W	Advanced Optoelectronics	1					S2epm_W12	15	30	1	0.6	T	E	O		S	Ob.
8.	ETD009584L	Advanced Optoelectronics			1			S2epm_U15 S2epm_K04	15	30	1	0.7	T				S	Ob.
9.	ETD009584P	Advanced Optoelectronics				2		S2epm_U15 S2epm_K04	30	60	2	1.4	T			P	S	Ob.
10.	ETD009571W	Optical-Fiber Networks	1					S2epm_W02	15	30	1	0.6	T				S	Ob.
11.	ETD009571P	Optical-Fiber Networks				1		S2epm_U02 S2epm_K09	15	30	1	0.7	T			P	S	Ob.
12.	ETD009572W	Operating Systems	1					S2epm_W10	15	30	1	0.6	T				S	Ob.
13.	ETD009572L	Operating Systems			1			S2epm_U13 S2epm_K01	15	30	2	1.4	T			P	S	Ob.
14.	ETD009583W	Design and Construction of Optoelectronics Circuits	1					S2epm_W09	15	30	1	0.6	T				S	Ob.
15.	ETD009583P	Design and Construction of Optoelectronics Circuits				1		S2epm_U02 S2epm_U12 S2epm_K09	15	60	2	1.4	T			P	S	Ob.
16.	ETD009574W	Photovoltaics	2					S2epm_W16	30	60	2	1.2	T				S	Ob.
17.	ETD009574L	Photovoltaics			2			S2epm_U11 S2epm_K01	30	60	2	1.4	T			P	S	Ob.
18.	ETD009575W	Microsystem Modeling	1					S2epm_W07	15	30	1	0.6	T				S	Ob.
19.	ETD009575L	Microsystem Modeling			2			S2epm_U10 S2epm_K09	30	60	2	1.4	T			P	S	Ob.
20.	ETD009576W	Analytical Microsystems	1					S2epm_W06	15	30	1	0.6	T				S	Ob.
21.	ETD009576L	Analytical Microsystems			1			S2epm_U07 S2epm_K01	15	30	2	1.4	T				S	Ob.
22.	ETD009582W	Ceramic Microsystems	2					S2epm_W05 S2epm_U06	30	60	2	1.2	T	E			S	Ob.

23.	ETD009582P	Ceramic Microsystems				1		S2epm_U06 S2epm_K02	15	30	1	0.7	T			P	S	Ob.
24.	ETD009585W	Packaging of EPM	1					S2epm_W14	15	30	1	0.6	T	Z			S	Ob.
25.	ETD009585L	Packaging of EPM			2			S2epm_U17 S2epm_K07	30	30	1	0.7	T	Z		P	S	Ob.
		Total	17	0	12	5	0		510	1080	38	24.8						

Altogether for specialization modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
17	0	12	5	0	510	1080	38	24.8

4.2. List of optional modules

4.2.1. List of general education modules

4.2.1.1. *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.	ZL100709BK	Foreign language B2+		1					15	30	1	0.7	T	Z	O	P	KO	W
2.	JZL100710BK	Foreign language A1/A2		3					45	60	2	1.4	T	Z	O	P	KO	W
		Total	0	4	0	0	0		60	90	3	2.1						

Altogether for general education modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
0	4	0	0	0	60	90	3	2.1

4.2.2. List of basic sciences modules

4.2.3. List of main-field of science modules

4.2.3.4. *Diploma dissertation* module

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1.	ETD009586S	Diploma Seminar					2	K2eit_W01-K2eit_W12, S2epm_W01-S2epm_W14 K2eit_U01-K2eit_U16, S2epm_U01-S2epm_U19 S2epm_K01, S2epm_K03	30	60	2	1,4	T	Z		P	S	W
2.	ETD009581D	MSc Thesis Work						K2eit_W01-K2eit_W12, S2epm_W01-S2epm_W14 K2eit_U01-K2eit_U16, S2epm_U01-S2epm_U19 K2eit_K01-K2eit_K12, S2epm_K01-S2epm_K09	180	600	20	14	T	Z		P	S	W
		Total	0	0	0	0	2		210	660	22	15.4						

Altogether for diploma dissertation:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
0	0	0	0	2	210	600	22	15.4

4.2 Training module

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 defense
seminar	participation in discussion, multimedia topic presentation
diploma dissertation	prepared diploma dissertation, review, defense of diploma dissertation

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

58,7 ECTS

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

Number of ECTS points for obligatory subjects	6
Number of ECTS points for optional subjects	0
Total number of ECTS points	6

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	12
Number of ECTS points for optional subjects	42
Total number of ECTS points	54

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)
   14 ECTS

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

11. **Range of diploma examination**

EiT (II level studies) – exam questions for the field of study

1. Errors of numerical methods – types and causes.
2. Define what is the nanotechnology? Describe the influence of this field on the development of electronic devices technology.
3. Define what is the spintronics? Describe exemplar spintronic electronic devices.
4. Molecular Electronics - present selected elements and their principle of operation.
5. Classification of MEMS pressure sensors.
6. Classification of diodes – comparison, properties, applications.
7. Classification of nanostructures – describe basic nanostructures applied in electronics.
8. Classification of transistors – comparison, properties, applications.
9. Quantum computer and optical computer – describe the principle of operation and compare with the traditional computer.
10. Approximation, interpolation and extrapolation methods applied in the experimental research.
11. Methods of optimization and Design of Experiment (DOE) in scientific tasks and technology.
12. Self-assembled structures – methods of manufacturing.

13. Micromachnies – describe selected solutions for design and construction.
14. Describe and explain the basics of the Statistical Process Control.
15. High-temperature superconductivity – model, materials and applications.
16. Describe the dangers of the nanotechnology that concern the human health, civilization and the natural environment.
17. Describe the Monte Carlo method applied for solving of a design task.
18. Describe the actuation methods applied in the MEMS.
19. Describe the detection methods applied in the MEMS.
20. Describe the different types of the electron emission from the solid-state matter.
21. Describe the influence of the environmental working conditions on the reliability of the electronic components.
22. Characterize the superconductivity in the case of the conventional superconductors.
23. Describe the numerical methods applied in the engineering tasks for solving of the differential equations.
24. Describe selected quantum effects.
25. Describe the reliability models for the electronic elements.
26. Describe the principle of operation of the QWr-FET (Quantum Wire Field Effect Transistor) and SET (Single Electron Transistor).
27. List and discuss the failure mechanisms of the electronic components.
28. List and discuss the methods of the statistical analysis applied in scientific works and research.
29. List and discuss the numerical methods for differentiation and integration.
30. List and discuss the methods for hypothesis testing.

EiT (II level studies) – exam questions for EPM specialization

1. Analytical microsystems – basic concept, technology and applications.
2. Basic errors of numerical computing.
3. Basic numerical modeling methods of MEMS.
4. Characterization, classification and applications of embedded operating systems.
5. Classification and short characterization of fabrication methods of optical layers.
6. Classification and short characterization of optical switches and modulators.
7. Classification of optical fibers.
8. Classification of vacuum gauges.
9. Classification of vacuum pumps.
10. Comparison of filesystems: FAT, NTFS and EXT3.

11. Examples and applications of coupled field modeling in MEMS.
12. Examples of realization and application of thermoelectric structures and modules.
13. Explain principle of working of Single Electron Transistor SET and list three conditions which have to be fulfilled for proper operation.
14. Gas discharge characteristics – useful part for the sputtering phenomenon.
15. IC package types - technology, main features, advantages and disadvantages.
16. Interpolation, approximation and extrapolation of data sets.
17. List the methods of nanostructures fabrication and assign them into: „bottom-up" and „top-down" techniques.
18. LTCC and thick film sensors.
19. LTCC heating and cooling systems.
20. MEMS-based methods of energy harvesting and storage.
21. Methods for failure detection.
22. Methods of actuation and detection in microscale.
23. Pakcaging hierarchy - short description of technology used for each level.
24. Parameters of optical fibers.
25. Reliability - definitions of basic terms, basic characteristics of reliability.
26. Similarities and differences between reflow soldering and wave soldering.
27. Temperature-dependent failure models, Arrhenius model, temperature acceleration factor.
28. The role of statistics in engineering.
29. True reading vacuum gauges.
30. Types of superconductors and their properties.

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

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

13. Plan of studies (attachment no. 1)

Opinion of the Student Council of the Faculty

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

.....	.....
Date	Dean's signature

Attachment no. 1 to Programme of Studies

PLAN OF STUDIES

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

MAIN FIELD OF STUDY: ***Electronics and Telecommunications***

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

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

PROFILE: ***general academic***

SPECIALIZATION: ***Electronics, Photonics, Microsystems***

LANGUAGE OF STUDY: ***English***

Microsystem Electronics and Photonics Faculty Council resolution no. ***122/1/2016-2020 of May 17, 2017***

In effect since ***01.10.2017***

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

POINT AND HOUR LAYOUT OF THE PLAN OF STUDIES

	26 h	**I**	**30 p**	**27 h**	**II**	**30 p**	**9 h**	**III**	**30 p**
28									
27				ZMZ000134 **3W** 20000 Management course					
26	ETD8566 **2W** 20000 Autonomous Power Supplying Systems								
25				Foreign Language **A1/A2** 2C					
24	ETD8568 **1W** 20000**E** Vacuum and Plasma Techniques								
23									
22	ETD8564 **2W + 2L** 20200**E**								
21	Optical Fibers			ETD9582 **2W + 1P** 20010**E**			FLD129580 **2W** 10000 Philosophy of Science and Technology		
20				Ceramic Microsystems					
19	ETD8567 **2W + 2L** 10100			ETD9576 **1W + 2L** 10100					
18	MOEMS			Analytical Microsystems			**ETD9581**		
17	ETD8085 **1W + 2S** 10002								
16	Nanotechnology			ETD9575 **1W + 2L** 10200			**20D**		
15				Microsystem Modeling					
14	ETD8084 **2W** 20000						**12 godz.**		
13	Solid State Electronics			ETD9574 **2W + 2L** 20200					
12	ETD8083 **1W + 2C** 11000			Photovoltaics			**MSc Thesis Work**		
11	Optimization Methods								
10	ETD8082 **1W + 2L** 10100			ETD9583 **1W +2P** 10010					
9	Numerical Methods			Design and Construction of Optoelectronics Circuits					
8	ETD8081 **1W + 2C** 11000			ETD9572 **1W + 2L** 10100			ETD9586 **2S** 00002		
7	Statistics for EPM			Operating Systems			Diploma Seminar		
6				ETD9571 **1W + 1P** 10010			ETD9079 **1W + 2P** 10010		
5	MAT1449 **2W + 2C** 22000**E**			Optical-Fiber Networks			Diagnostics and Reliability		
4	Mathematics						ETD9585 **1W + 1L** 10200		
3				ETD9584 **1W + 1L + 2P** 10120**E**			Packaging of EPM		
2	Foreign Language 2B+ 1C			Advanced Optoelectronics					
1							ETD9078 **1W** 10000 Sensors and Actuators		
	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	ETD

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.	MAT001449W	Mathematics	2					K2eit_W06	30	60	2	1.2	T	E	O		PD	Ob.
2.	MAT001449C	Mathematics		2				K2eit_U06 K2eit_K02	30	60	2	1.4	T	Z	O	P	PD	Ob.
3.	ETD008081W	Statistics for EPM	1					K2eit_W05	15	30	1	0.6	T	Z			K	Ob.
4.	ETD008081C	Statistics for EPM		1				K2eit_U05 K2eit_K02	15	60	2	1.4	T	Z		P	K	Ob.
5.	ETD008082C	Numerical Methods	1					K2eit_W04 InzA_W02 K2eit_K07 InzA_K01	15	30	1	0.6	T	Z			K	Ob.
6.	ETD008082L	Numerical Methods			1			K2eit_U04 InzA_U01 K2eit_K07 InzA_K01	15	60	2	1.4	T	Z		P	K	Ob.
7.	ETD008083W	Optimization Methods	1					K2eit_W03	15	30	1	0.6	T	Z			K	Ob.
8.	ETD008083C	Optimization Methods		1				K2eit_U03 K2eit_K03	15	60	2	1.4	T	Z		P	K	Ob.
9.	ETD008084W	Solid State Electronics	2					K2eit_W02	30	60	2	1.2	T	Z			PD	Ob.
10.	ETD008085W	Nanotechnology	1					K2eit_W01	15	30	1	0.6	T	Z			K	Ob.
11.	ETD008085S	Nanotechnology					2	K2eit_U01 K2eit_K01	30	60	2	1.4	T	Z		P	K	Ob.
12.	ETD008567W	MOEMS	1					S2epm_W06	15	60	2	1.2	T	Z			S	Ob.
13.	ETD008567L	MOEMS			1			S2epm_U11 S2epm_K01	15	60	2	1.4	T	Z		P	S	Ob.
14.	ETD008564W	Optical Fibers	2					S2epm_W02	30	60	2	1.2	T	E			S	Ob.
15.	ETD008564L	Optical Fibers			2			S2epm_U02 S2epm_K01	30	60	2	1.4	T	Z		P	S	Ob.
16.	ETD008568W	Vacuum and Plasma Techniques	2					S2epm_W01	30	30	1	0.6	T	Z			S	Ob.
17.	ETD008566W	Autonomous Power Supplying Systems	2					K2eit_W11	15	60	2	1.2	T	Z			S	Ob.
		Total	15	4	4	0	2		375	870	29	18.8						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1.	JZL100709BK	Foreign Language 2B+		1					15	30	1	0.7	T	Z	O	P	KO	W
		Total	0	1	0	0	0		15	30	1	0.7						

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				
15	5	4	0	2	390	900	30	19.5

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.	ETD009584W	Advanced Optoelectronics	1					S2epm_W12	15	30	1	0.6	T	E	O		S	Ob.
2.	ETD009584L	Advanced Optoelectronics			1			S2epm_U15 S2epm_K04	15	30	1	0.7	T				S	Ob.
3.	ETD009584P	Advanced Optoelectronics				2		S2epm_U15 S2epm_K04	30	60	2	1.4	T			P	S	Ob.
4.	ETD009571W	Optical-Fiber Networks	1					S2epm_W02	15	30	1	0.6	T				S	Ob.
5.	ETD009571P	Optical-Fiber Networks				1		S2epm_U02 S2epm_K09	15	30	1	0.7	T			P	S	Ob.
6.	ETD009572W	Operating Systems	1					S2epm_W10	15	30	1	0.6	T				S	Ob.
7.	ETD009572L	Operating Systems			1			S2epm_U13 S2epm_K01	15	60	2	1.4	T			P	S	Ob.
8.	ETD009583W	Design and Construction of Optoelectronics Circuits	1					S2epm_W09	15	30	1	0.6	T				S	Ob.
9.	ETD009583P	Design and Construction of Optoelectronics Circuits				1		S2epm_U02 S2epm_U12 S2epm_K09	15	60	2	1.4	T			P	S	Ob.
10.	ETD009574W	Photovoltaics	2					S2epm_W16	30	60	2	1.2	T				S	Ob.
11.	ETD009574L	Photovoltaics			2			S2epm_U11 S2epm_K01	30	60	2	1.4	T			P	S	Ob.
12.	ETD009575W	Microsystem Modeling	1					S2epm_W07	15	30	1	0.6	T				S	Ob.
13.	ETD009575L	Microsystem Modeling			2			S2epm_U10 S2epm_K09	30	60	2	1.4	T			P	S	Ob.
14.	ETD009576W	Analytical Microsystems	1					S2epm_W06	15	30	1	0.6	T				S	Ob.
15.	ETD009576L	Analytical Microsystems			1			S2epm_U07 S2epm_K01	15	60	2	1.4	T				S	Ob.
16.	ETD009582W	Ceramic Microsystems	2					S2epm_W05 S2epm_U06	30	60	2	1.2	T	E			S	Ob.
17.	ETD009582P	Ceramic Microsystems				1		S2epm_U06 S2epm_K02	15	30	1	0.7	T			P	S	Ob.
18.	ZMZ000134W	Contemporary Management	2						30	90	3	1.8	T	Z	O		K	Ob.
		Total	12	0	7	5	0		360	840	28	18.3						

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.	JZL100710BK	Foreign Language A1/A2		3					45	60	2	1.4	T	Z	O	P	KO	W
		Total		3					45	60	2	1.4						

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
12	3	7	5	0	405	900	30	19.7

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.	ETD009078W	Sensors and Actuators	1					K2eit_W14	15	30	1	0.6	T	Z			K	Ob.
2.	ETD009079W	Diagnostics and Reliability	1					K2eit_W07	15	30	1	0.6	T	Z			K	Ob.
3.	ETD009079P	Diagnostics and Reliability				1		K2eit_U07 K2eit_K06	15	60	2	1.4	T	Z		P	K	Ob.
4.	ETD009585W	Packaging of EPM	1					S2epm_W14	15	30	1	0.6	T	Z			S	Ob.
5.	ETD009585L	Packaging of EPM			2			S2epm_U17 S2epm_K07	30	30	1	0.7	T	Z		P	S	Ob.
6.	ETD009586S	Diploma Seminar					2	K2eit_W01-K2eit_W12, S2epm_W01-S2epm_W14 K2eit_U01-K2eit_U16, S2epm_U01-S2epm_U19 S2epm_K01, S2epm_K03	30	60	2	1.4	T	Z		P	S	W
7.	ETD009581D	MSc Thesis Work						K2eit_W01-K2eit_W12, S2epm_W01-S2epm_W14 K2eit_U01-K2eit_U16, S2epm_U01-S2epm_U19 K2eit_K01-K2eit_K12, S2epm_K01-S2epm_K09	180	600	20	14	T	Z		P	S	W
8.	FLD129580W	Philosophy of Science and Technology	1						15	60	2	1.2	T	Z	O		KO	Ob.
		Total	4	0	2	1	2		315	900	30	20.5						

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
4	0	2	1	2	315	900	30	20.5

2. Set of exams in semestral arrangement

Course code	Name of course credited by examination	Semester
MAT001449W ETD008564W ETD008565W	1. Mathematics 2. Optical Fibers 3. Vacuum and Plasma Techniques	1
ETD009584W ETD009582W	1. Advanced Optoelectronics 2. Ceramic Microsystems	2

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

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

Opinion of the Student Council of the Faculty

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

.....	.....
Date	Dean's signature

Faculty:	**Microsystem Electronics and Photonics**	**Faculty Council resolution from:**	**17.05.2017**
Field of study:	**Electronics and Telecommunications – studies in English**	**In effect from:**	**01.10.2017**
Studies:	**2nd level, full-time**		

COURSE CATALOG

Subject cards for humanities, management, sport and language courses are posted on the Wrocław University of Science and Technology ECTS information catalog (http://www.portal.pwr.wroc.pl/syllabus,241.dhtml).

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Statistics for EPM**	
Name in English:	**Statistics for EPM**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008081**	
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. Basis knowledge of probability and mathematical analysis

SUBJECT OBJECTIVES

C01 Gaining the knowledge about the role of statistical methods in engineering and data collection methods
C02 Gaining the knowledge about such statistical methods like: descriptive statistics, point estimation, confidence intervals, hypothesis testing, analysis of variance, linear regression and correlation
C03 Coming the knowledge of the basis of statistical quality control
C04 Gaining the skill in practical problem solution with the aid of statistical methods
C05 Gaining students conscious of the necessity of application statistical methods in engineering

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Holding the knowledge in the field of collection, analysis and presentation of statistical data

Relating to skills

PEK_U01 Holding the ability to select and use suitable statistical tools for problem solving in engineering

Relating to social competences

PEK_K01 Perceiving and understanding aspects connected with collection and presentation of data in different domains of engineering and necessity of application of statistics

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction. Rules. Course contents. The role of statistics in engineering	2
Le_02	Probability and types of probability distributions. Point Estimation	2
Le_03	Descriptive statistics	2
Le_04	Statistical intervals. Linear regression and correlation	2
Le_05	Hypothesis testing. Analysis of variance	2
Le_06	Statistical quality control	2
Le_07	Computer software for statistical analysis	2
Le_08	Writing test	1
	TOTAL	15

Form of classes - Classes		Quantity
Cl_01	Introduction. Rules. Course contents	2
Cl_02	Solving examples of basis statistical calculations	2
Cl_03	Solving examples of application of selected probability distributions	2
Cl_04	Application of descriptive statistics in engineering – solving examples	2
Cl_05	Point estimation and statistical intervals – solving examples	2
Cl_06	Linear regression and correlation – solving examples	2
Cl_07	Analysis of variance – solving examples	2
Cl_08	Application of computer software for engineering problems solving with the use of statistical methods and statistical reasoning	1
	Total	15

TEACHING TOOLS USED

ND_01 Lecture with multimedia presentation and discussion
ND_02 Consultations
ND_03 Students' own work: get ready for the lecture
ND_04 Students' own work: get ready for classes
ND_05 Students' own work: independent solution of work tasks during classes
ND_06 Classes: short 15 minutes tests at the beginning of the lessons

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Writing test
P2 = F2 (classes)	PEK_U01	Positive mark from short test and ability to solving problems during classes

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Roman Nowak, Statystyka dla fizyków, PWN, 2002
2. R. Lyman Ott, Michael Longnecker, An introduction to statistical methods and data analysis, Brooks/Cole Cemgage Learning, 6th, Ed., 2010

Secondary literature

1. Dr. Graham Currell, Dr. Antony Dowman, Essential Mathematics and Statistics for Science, 2nd Edition, Wiley, 2009
2. S. J. Morrison, Statistics for Engineers: An Introduction, Wiley, 2009

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Statistics for EPM

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W05	C01-C03	Le_01-Le_07	ND_01-ND_03
PEK_U01 (skills)	K2eit_U05	C04	Cl_01-Cl_06	ND_04-ND_06
PEK_K01 (competences)	K2eit_K02	C05	Cl_01-Cl_06	ND_01-ND_06

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Numerical Methods**	
Name in English:	**Numerical Methods**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008082**	
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 on basics of mathematics and physics
2. Knowledge on basics of computer programming
3. Basic computer skills

SUBJECT OBJECTIVES

C01 To familiarize students with the basic numerical algorithms and methods used in engineering including restrictions, disadvantages and advantages of numerical techniques. In addition, gaining skills in using the Python scripting language
C02 Consolidation ability to work independently and in collaboration with the available educational materials
C03 The course is connected with the research activities in the area of numerical prototyping
C04 Application of numerical methods for solving simple engineering problems
C05 Participation of the students in the carried out research in numerical prototyping

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

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

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

Relating to skills

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

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

Relating to social competences

PEK_K01 Can appropriately define the priorities for implementation of specified tasks

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

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction to numerical methods and Python scripting language	2
Le_02	Numerical computing	2
Le_03	Differentiation and integration	2
Le_04	Linear and nonlinear equations and set of equations	2
Le_05	Interpolation, approximation and extrapolation	2
Le_06	Optimization, design of experiments and data interpretation	2
Le_07	Numerical methods for solving partial differential equations	2
Le_08	Final test	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introduction to numerical methods and engineering computing with Python programming language	2
La_02	Numerical computing errors - sources and types	2
La_03	Numerical differentiation and integration	2
La_04	Linear and nonliner equations and set of equations	2
La_05	Interpolation, approximation and extrapolation	2
La_06	Optimization and design of experiments	2
La_07	Partial differential equations	2
La_08	Individual project / Assessment	1
	Total	15

TEACHING TOOLS USED	
ND_01	Traditional lecture with multimedia presentations and discussion
ND_02	Laboratory: 5-minutes introduction and 5-minutes introductory tests
ND_03	Consultation
ND_04	Individual work: preparation for lecture
ND_05	Individual work: preparation for laboratories
ND_06	Individual work: literature study and preparation for the final test
ND_07	Individual work: laboratory reports

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01, PEK_W02	Discussions and final test
P2 = F2 (lab)	PEK_U01, PEK_U02, PEK_K01, PEK_K02	Laboratory tests and quizzes, lab reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

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

Secondary literature

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

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Numerical Methods

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W04	C01, C02	Le_01-Le_07	ND_01, ND_03, ND_04
PEK_W02	InzA_W02	C01, C02	Le_01-Le_07	ND_01, ND_03, ND_04

PEK_U01 (skills)	K2eit_U04	C03-C05	La_01-La_07	ND_02, ND_03, ND_05
PEK_U02	InzA_U01	C03-C05	La_01-La_07	ND_02, ND_03, ND_05
PEK_K01 (competences)	K2eit_K07	C03, C04	Le_08, La_08	ND_06, ND_07
PEK_K02	InzA_K01	C03, C04	Le_08, La_08	ND_06, ND_07

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Optimization Methods**	
Name in English:	**Optimization Methods**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008083**	
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 mathematics in the range of mathematical analysis and linear algebra
2. Credit of course: Mathematical analysis I
3. Credit of course: Algebra with analytical geometry

SUBJECT OBJECTIVES

C01 To acquaint students with the basic of optimization methods
C02 To gain skills of solution of simple problems dealing with optimization by means of different methods
C03 To understand need of application of optimization methods in practical engineering

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 He has theoretical knowledge and he understands different methods solution of linear and non-linear optimization problems

Relating to skills

PEK_U01 He is able to solve simple problems in the range of optimization by means of different methods

Relating to social competences

PEK_K01 He understands utilization of optimization methods in technical activity

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	General problems of linear programming	2
Le_02	Simplex method	2
Le_03	Method of artificial base.	2
Le_04	Dual problem	2
Le_05	Non-linear programming, non-gradient methods	2
Le_06	Gradient methods	2
Le_07	Constrained non-linear optimization	2
Le_08	Test	1
	TOTAL	15

Form of classes - Classes		Quantity
Cl_01	Solving of problems in the range of matrix algebra, solving of linear equations sets	2
Cl_02	Graphical method for solution of linear optimization problems	2
Cl_03	Simplex method for solution of linear optimization problems	2
Cl_04	Artificial base method for solution of linear optimization problems	2
Cl_05	Non-gradient methods for solution of non-linear optimization problems	2
Cl_06	Gradient methods for solution of non-linear optimization problems	2
Cl_07	Solving of constrained non-linear optimization problems	2
Cl_08	Test	1
	Total	15

TEACHING TOOLS USED

ND_01 Traditional lecture
ND_02 Classes- solving of problems connected with optimization methods
ND_03 Tutorials
ND_04 Individual work - studies for the lecture
ND_05 Individual work - studies of examples and exercises for classes
ND_06 Individual work - individual studies for test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Credit test
P2 = F2 (classes)	PEK_U01, PEK_K01	Discussion, solving of problems, credit test

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. K. Amborski, Podstawy metod optymalizacji, Ofic. Wyd. Pol. Warszawa, 2009
2. S.I. Gass, Programowanie liniowe, PWN, 1973

Secondary literature

1. B. Martos, Programowanie nieliniowe, PWN, 1983

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Optimization Methods

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W03	C01-C03	Le_01-Le_07	ND_01, ND_03, ND_04, ND_06
PEK_U01 (skills)	K2eit_U03	C01-C03	Cl_01-Cl_07	ND_02, ND_03, ND_05
PEK_K01 (competences)	K2eit_K03	C03	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:	**Solid state electronics**	
Name in English:	**Solid state electronics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008084**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of higher mathematics for understanding the issues in physics and quantum electronics
2. Completing the course Physics I

SUBJECT OBJECTIVES

C01 The acquisition of knowledge in the theoretical description of free and bound states of the electron in the solid and the band theory
C02 Learning the theoretically founded issues relating to physical phenomena occurring in the solid and their applicability
C03 Familiarizing with the existing models of the structure of matter

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has knowledge of the theoretical description of the electron in the solid
PEK_W02 Has structured and theoretically founded knowledge on the phenomena occurring in the solid
PEK_W03 Knows and understands the principle of operation of various types of quantum computers
PEK_W04 Has knowledge on the structure of the matter according to the current models

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Electrons inside crystal. Brillouin zones	2
Le_02	Kronig – Penney model - part I	2
Le_03	Kronig – Penney model - part II	2
Le_04	Photoelectron effect	2
Le_05	Acoustical-electronic phenomena	2
Le_06	Piezoelectric effect	2
Le_07	Superconductivity effect	2
Le_08	High-temperature superconductivity	2
Le_09	Spintronics	2
Le_10	Electronics of single electron	2
Le_11	Quantum computation - part I	2
Le_12	Quantum computation - part II	2
Le_13	Material constitution according to Standard Model	2
Le_14	Higgs theory	2
Le_15	Test	2
	TOTAL	30

TEACHING TOOLS USED
ND_01 Traditional lecture with presentations and discussion ND_02 Student's own work ND_03 Consultations

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01-PEK_W04	Writing test

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Chih-Tang Sah, Fundamentals of solid-state electronics, World Scientific, London, 1991
2. Tinkham M., Introduction to superconductivity, Dover Publications, Inc. Mineola, New York, 1996
3. Levine S.N., Fizyka kwantowa w elektronice, PWN, W-wa 1968
4. Ashcroft M., Mermin W., Fizyka ciała stałego, PWN, W-wa, 1986

Secondary literature

1. Boncz-Brujewicz W., Kałasznikow S., Fizyka półprzewodników, PWN, W-wa, 1985
2. Kittel C., Wstęp do fizyki ciała stałego, PWN, W-wa 1976
3. Van der Ziel A., Podstawy fizyczne elektroniki ciała stałego, WTN, W-wa, 1980

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Solid state electronics

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W02	C01	Le_01-Le_03	ND_01-ND_03
PEK_W02	K2eit_W02	C02	Le_04-Le_09	ND_01-ND_03
PEK_W03	K2eit_W02	C02	Le_10-Le_12	ND_01-ND_03
PEK_W04	K2eit_W02	C03	Le_13,Le_14	ND_01-ND_03

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Nanotechnology**	
Name in English:	**Nanotechnology**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008085**	
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 of fundamentals of physics and chemistry
2. Knowledge of fundamentals of solid state physics
3. Passed an examination of "Semiconductor devices II" course
4. Passed an examination of "Electronics devices and circuits" course
5. Passed an examination of "Optoelectronics" course

SUBJECT OBJECTIVES

C01 Presentation of Nanotechnology as an technical science which couples many fields of activities like: material science, chemistry, physics computer science and biology, which connected together allows fabrication of advanced structures useful in a common life

C02 Presentation of profits coming from taking advantages of new phenomena or unique properties of matter which are the results of size reduction

C03 Make Students familiar with fundamentals of processes and physico-chemical phenomena used for fabrication of nanostructures and nanoobjects

C04 Presentation of constructions of molecular electronic devices and discussion of influence of atomic structure of the material on their properties

C05 Improvement of the skills of expression and discussion in the range of scientific fields

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 It has an expanded and enhanced knowledge of the physics, including quantum physics, solid state physics and necessary knowledge for understanding physical phenomena which influence the properties of new materials and principles of working of optoelectronic devices

Relating to skills

PEK_U01 Can evaluate and use phenomena proceed in solid state materials for quantum electronics applications purposes

Relating to social competences

PEK_K01 It will be openness to new innovative solutions, structures and manufacturing processes

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction to Nanotechnology - definition, development direction and application fields	2
Le_02	Molecular electronic devices. Drexler's and Feynman's worlds	2
Le_03	Nanoelectronics - Two- and one- dimensional electron gas (2DEG and 1DEG) - properties. Carrier transport, ballistic carrier transport in low dimensional structures. Hall effect and quantum Hall effect. Quantum wire transistor and single electron transistor - construction, operation rules	4
Le_04	Principle of operation and construction of semiconductor devices containing low dimensional structures. Quantum size effects and their influence on properties of objects/devices. Self assembled structures - properties and technology. Properties of semiconductor devices with QD/Qdash/MQW (Quantum Dot/Quantum Dash/Multi Quantum Well) active regions. Modification of properties of semiconductor heterostructures during selective oxidation and rapid thermal annealing	3
Le_05	Influence of intermolecular interaction on properties of semiconductor heterostructures. Modification of band diagram of semiconductors by presence of defects, stresses and interstitial positions of atoms in crystal lattice. Consequences of rapid thermal annealing - short range order. Techniques of epitaxy of self-organizing structures	3
Le_06	Final test	1
	TOTAL	15

Form of classes - Seminar		Quantity
Se_01	Introducing; discussion of the subjects chosen by the students for individual elaboration	2
Se_02	Oral presentations performed by students which deal with a subject presented during lectures or new subjects proposed by teacher or students referring to semiconductor Nanotechnology or Nanotechnology of opto- and microelectronics devices, opened discussions to each presented topics in order to precise explanation of the discussed issues. Small tests during semester	26
Se_03	Visit in the Laboratory for Optical Spectroscopy of Nanostructures - depending on the seminar schedule	2
	Total	30

TEACHING TOOLS USED	
ND_01	Traditional lecture supported by the multimedial presentation, discussion and exhibition of chosen semiconductor devices
ND_02	Seminar: Oral presentations of selected subjects performed by students with discussion and comments of teacher, Two 10 min long tests in semester, Visit in the Laboratory for Optical Spectroscopy of Nanostructures
ND_03	Consultation hours
ND_04	Individual work - preparation of the oral presentation and chosen subjects for discussion
ND_05	Individual work - education including preparation for final test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Final test during the last lecture
P2 = F2 (sem)	PEK_U01, PEK_K01	Average grade dependent on the oral presentation, small tests and participation in discussion.

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Springer Handbook of Nanotechnology, Bharat Bhushan Editor, Springer-Verlang Berlin Heidelberg 2004
2. J. C. Ellenbogen, J. Christopher Love, Architectures for Molecular Electronic Computers: 1. Logic Structures and an Adder Designed from Molecular Electronic Diodes, lipiec 1999
3. J. H. Davies, A. R. Long, Physics of Nanostructures, Proceedings of the Thirty-Eighth Scottish Universitates Summer School in Physics St Andrews, 1991
4. R. Eisberg, R. Resnick, Fizyka Kwantowa atomów, cząsteczek, ciał stałych, jąder i cząsteczek elementarnych, PWN, Warszawa 1983
5. C. Joachim, J. K. Gimzewski, A. Aviram, Electronics using hybrid-molecular and mono-molecular devices, Nature, vol 408, 30 November 2000
6. D. Goldhaber-Gordon, Michael S. Montemerlo, J. Christopher Love, Gregory J. Opiteck, James C. Ellenbogen, Overview of nanoelectronic devices, The Procedings of the IEEE, April 1997
7. Kenneth J. Klabunde, Nanoscale Materials in Chemistry, Wiley, 2001
8. Bernard Ziętek, Optoelektronika, Wydawnictwo Uniwersytetu Mikołaja Kopernika, Toruń 2004
9. Pallab Bhattacharya, Semicondudtor Optoelectronic Devices, Second Edition, Prentice Hall New Jersey 1997

Secondary literature

1. D. Pucicki, Badanie kinetyki wzrostu heterostruktur InyGa1-yAs1-xNx/GaAs przeznaczonych do konstrukcji przyrządów optoelektronicznych, PhD thesis, PWr. 2006

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Nanotechnology

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W01	C01-C04	Le_01-Le_06	ND_01,ND_03, ND_05
PEK_U01 (skills)	K2eit_U01	C05	Se_02-Se_15	ND_02, ND_04
PEK_K01 (competences)	K2eit_K01	C05	Se_01-Se_15	ND_02, ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Optical Fibers**	
Name in English:	**Optical Fibers**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008564**	
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	E		Z		
Number of ECTS points	2		2		
Including number of ECTS points for practical (P) classes	0		2		
Including number of ECTS points for direct teacher-student contact (BK) classes	1.2		1.4		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of physics and optics
2. Fundamental knowledge of optical fibers

SUBJECT OBJECTIVES

C01 A reminder of fundamental knowledge of fiber optics
C02 Acquiring knowledge and skills allowing for correct selection of optical-waveguide components necessary to build optical-fiber systems
C03 Acquiring knowledge and skills necessary for measurements of fiber-optic components
C04 Acquiring knowledge on the most important optoelectronic components interacting with optical fibers
C05 Acquiring advanced expertise knowledge about different elements of fiber-optic communication path
C06 Mastering the skills of work with photonic elements and measurement instruments of optical-fiber technique
C07 Participation of the students in the carried out research in optical fibers technique

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has well-organized and theoretically founded knowledge in the field of photonics, including knowledge necessary to understand physical fundamentals of operation of optical telecommunication systems and optical recording and information processing

Relating to skills

PEK_U01 Knows and applies the principles of occupational health and safety when working with lasers and optical fibers. Can operate measurement instruments and assemble measurement systems in the field of photonics

Relating to social competences

PEK_K01 Works independently and in a team

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction - summary of basic knowledge about optical fibers	2
Le_02	Analysis of optical-fibers with methods of wave optics	2
Le_03	Fundamental properties of optical-fibers in the light of international standards	2
Le_04	Measurements of basic properties of optical fibers	2
Le_05	Dispersion of optical fibers	2
Le_06	Methods of optical-fiber dispersion measurements and compensation	2
Le_07	Connections of optical fibers and cables (spliced connectors)	2
Le_08	Connections of optical fibers and cables (dismountable connectors)	2
Le_09	Optical Time Domain Reflectometer	2
Le_10	Specialty fiber optic components (fiber-optic Bragg gratings, multiplexers, optical amplifiers)	2
Le_11	Multimode optical fibers	2
Le_12	Introduction to fiber-optic WDM systems	2
Le_13	Classification and characterization of fiber-optic telecommunication lines	2
Le_14	Elements of nonlinear optics and soliton transmission	2
Le_15	Colloquium, repertory and sample test	2
	TOTAL	30

Form of classes - Laboratory		Quantity
La_01	Fiber splicing by fusion in an electric arc	4
La_02	Preparation of ST fiber-optic connectors	4
La_03	Measurements of spectral characteristics of optical fibers	4
La_04	Passive elements of fiber-optic track (fiber-optic coupler and circulator	4
La_05	Measurements of optical-fiber lines by the direct method and with optical reflectometer	4
La_06	Measurement of refractive index distribution in optical fiber	4
La_07	Study of the impact of fiber attenuation on fiber-optic line distance	2
La_08	Study of the impact of dispersion on fiber-optic line distance	4
	Total	30

TEACHING TOOLS USED
ND_01 Classical lecture with presentations and discussion
ND_02 Lecture supported with e-learning tools
ND_03 Laboratory: short tests and the beginning of classes, exercises to be performed in a group
ND_04 Own work - preparation of selected issues for the lecture
ND_05 Own work - preparation for the lab exercises.
ND_06 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 = F1 (lecture)	PEK_W01	The average of tests, colloquium and final examination
P2 = F2 (lab)	PEK_U01, PEK_U02	Discussions, consultations, quizzes

PRIMARY AND SECONDARY LITERATURE
Primary literature
1. Marciniak M., Łączność światłowodowa, WKŁ, 1998
Secondary literature
1. Siuzdak J., Wstęp do współczesnej telekomunikacji światłowodowej, WKŁ, 1997

SUBJECT SUPERVISOR
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Optical Fibers

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W02	C01-C05, C07	Le_01-Le_15	ND_01, ND_02, ND_04, ND_06, ND_07
PEK_U01 (skills)	S2epm_U02	C06, C07	La_01-La_08	ND_03, ND_05
PEK_K01 (competences)	S2epm_K01	C06, C07	La_01-La_08	ND_03, ND_05

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Autonomous Power Supplying Systems**	
Name in English:	**Autonomous Power Supplying Systems**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008566**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

SUBJECT OBJECTIVES

C01 Presentation of rules of power supplying of autonomous electronic devices and microsystems
C02 Review of technical realisations and properties of energy harvesting methods and devices

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has detailed knowledge connected with physics and basics of chemistry necessary to understand operation of power supplying systems co-working with microsystems (principle of operation, technological and technical realisations, main parameters)

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Energy balance in microsystems	2
Le_02	Rules of microsystem power supplying	2
Le_03	Photovoltaic effect, solar cells	2
Le_04	Technical realisations and operation parameters of solar microcells and micromodules	2
Le_05	Thermoelectric phenomena	2
Le_06	Thermoelectric microgenerators - technical realisations and main operation parameters	2
Le_07	Direct and inversed piezoelectric effect	2
Le_08	Piezoelectric microgenerators - technical realisations and main operation parameters	2
Le_09	Fuell cels - pricniples of operation	2
Le_10	Microfuel cells - technological and construction realisations	2
Le_11	Mechanical energy microgenerators	2
Le_12	Rules of energy storage	2
Le_13	Batteries and accumulators for microsystems- technical realisations and main parameters	2
Le_14	Sources of energy - global issues	2
Le_15	Colloquium	2
	TOTAL	30

TEACHING TOOLS USED
ND_01 Lectures with presentations and discussions ND_02 Own work - preparation to the colloquium

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Test

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. D.M. Rove, Handbook of Thermoelectrics, CRC Press, 1996
2. W. Ehrefeld, Microreactors - new technology for modern chemistry, Wiley-Vch Verlag, 2000

Secondary literature

1. Articles in scientific journals – choosen by the lecturer

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Autonomous Power Supplying Systems

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W11	C01, C02	Le_01-Le_014	ND_01, ND_02

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:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008567**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamentals of the microsystem and microingineering technology, a base knowledge of optoelectronics and optics

SUBJECT OBJECTIVES

C01 Mastering knowledge on the mechanically passive and active optical microsystems
C02 Conducting own experiments with selected MEOMS-s on a laboratory scale
C03 Participation of the students in the research in topics related to MEOMS

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 He has in-depth knowledge of the manufacturing processes of optical microsystems, their design parameters and performance

Relating to skills

PEK_U01 He is able to develop a detailed documentation of the results of the experiment and prepare a report

Relating to social competences
PEK_K01 He is able to interact and work in a group assuming different roles in it

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	MEMS and MEOMS technological compatibility, classification of MEOMS, application fields, market, manufacturers, history and future development	2
Le_02	Static microoptical components: couplers, microlenses, diffraction grids 1-D and 2-D, microoptical benches, other constructions	2
Le_03	Movable microoptical components: mirrors, switcher, adaptive optics, DMD projectors, confocal and SNOM microscopes on-chip, opto-mechanical memory	2
Le_04	Light-beam modulators, optical filters, LIGA microspectrometers	2
Le_05	Physical and chemical MOEMS microsensors, microsensors for analytical applications, VIS/NIR spetrophotometric sensors in chemistry, bio and med science	2
Le_06	Spectrofluorometric sensors: scale factor, chromophores, excitation light sources, detectors, application in ELISA/DNA-chip and portable instruments	2
Le_07	CPT effect and its application in integrated cesium clocks, magnetometers and interferometric devices	2
Le_08	Summary and final test	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Computer aided simulation of the silicon membrane	3
La_02	Optical fiber sensor	3
La_03	VIS spectrometric detector	3
La_04	NIR spectrometric detector	3
La_05	Optical microswitch	3
	Total	15

TEACHING TOOLS USED
ND_01 Lecture with presentations and discussion ND_02 Short tests at the beginning of exercise ND_03 Consultations ND_04 Reports of the laboratory exercises

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

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

PRIMARY AND SECONDARY LITERATURE
Primary literature 1. P. Rai-Choudhury, MEMS and MOEMS Technology and Applications, SPIE Press

SUBJECT SUPERVISOR
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

MOEMS

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W06	C01	Wy_01-Wy_07	ND_01, ND_03
PEK_U01 (skills)	S2epm_U11	C02	La_01-La_05	ND_02-ND_04
PEK_K01 (competences)	S2epm_K01	C02, C03	La_01-La_05	ND_02-ND_04

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Vacuum and Plasma Techniques**	
Name in English:	**Vacuum and Plasma Techniques**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008568**	
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	E				
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. Credit for physics course

SUBJECT OBJECTIVES

C01 Understanding the phenomena under reduced pressure (vacuum)
C02 Possession of knowledge about the application of modern vacuum techniques (methods of generation and measuring vacuum)
C03 Gain knowledge about the role of vacuum in microelectronic technologies

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 He has knowledge of the phenomena occurring at low gas pressure and of the action of vacuum (vacuum production and measurement) in the context of the technological processes used in microelectronics

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Introduction. Basic definitions. Elements of the kinetic theory of gases	3
Le_02	Gas flow (gas throughput, pumping speed).	1
Le_03	Backing (pre-vacuum) pumps – oil sealed vacuum pumps (wet pumps).	2
Le_04	Backing (pre-vacuum) pumps – dry pumps.	2
Le_05	High vacuum transfer pumps (diffusion, turbomolecular pumps).	3
Le_06	High vacuum sorption pumps (ion, sublimation, cryo, getter pumps).	3
Le_07	Vacuum measurement using direct and indirect vacuum gauges	4
Le_08	Partial pressure vacuum gauges – mass spectrometers	1
Le_09	Modern vacuum – MEMS in vacuum systems	1
Le_10	Thin film vacuum deposition processes (evaporation, sputtering)	1
Le_11	Plasma – abnormal discharge. Classification of discharges.	1
Le_12	Basic processes in discharge. Movement of electrons and ions in rarefied gas during deposition process	1
Le_13	Ion sputtering. Ion plating. Ion implantation. Ion cleaning.	1
Le_14	Principles of the vacuum systems design. The role of vacuum parameters during thin film deposition. Scheme of the vacuum process. Visit at the vacuum lab – demonstration of thin film deposition process using magnetron sputtering	4
Le_15	Summary, course completion.	2
	TOTAL	30

TEACHING TOOLS USED

ND_01 Traditional lectures and interactive presentations supported elements of the assessment
ND_02 Own work
ND_03 Consultation
ND_04 Presentation of the vacuum the laboratory - a standard technological process of vacuum deposition of thin films (team work)

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Interactivity during a lecture, colloquium, oral exam

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. J.O'Hanlon, A user's Guide to Vacuum Technology, Wiley-Interscience, (third edition), 2003
2. M. Wutz, H. Adam, W. Walcher Theory and Practice of Vacuum Technology, Friedr.Vieweg & Sohn, Braunschweig 1989
3. N. Harris, Modern Vacuum Practice , self-published, (third edition), 2005
4. W.Posadowski, lecture notes

Secondary literature

1. Andrzej Hałas Technologia Wysokiej Próżni, PWN W-wa 1980
2. Andrzej Hałas, Piotr Szwemin, Podstawy Techniki Próżni, Uczelniane Wydawnictwo Naukowo-

Dydaktyczne, Kraków, 2008
3. Janusz Groszkowski, Technika Wysokiej Próżni, WNT W-wa 1978

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Vacuum and Plasma Techniques

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W01	C01-C03	Le_01-Le_15	ND_01-ND_04

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Sensors and actuators**	
Name in English:	**Sensors and actuators**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009078**	
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

No requirements

SUBJECT OBJECTIVES

C01 Organization of knowledge in the fields of micromechanical sensors and actuators
C02 To familiarize oneself with basic properties of micromechanical sensors
C03 To familiarize oneself with methods and algorithms of analog and digital conditioning of signals from micromechanical sensors
C04 Participation of the students in the carried out research on micromechanical sensors and actuators

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

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

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

TEACHING TOOLS USED
ND_01 Lecture with multimedia presentation and discussion ND_02 Self-work - preparation to final colloquium

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Final colloquium

PRIMARY AND SECONDARY LITERATURE
Primary literature
1. M. Bao, Analysis and Design Principles of MEMS Devices, Elsevier, 2005

SUBJECT SUPERVISOR
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Sensors and actuators

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W14	C01-C04	Le_01-Le_06	ND_01, ND_02

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Diagnostics and Reliability**	
Name in English:	**Diagnostics and Reliability**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009079**	
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 mathematics fundamentals in the range of mathematical analysis, probabilistics and statistics
2. Credit of course: Mathematics analysis I
3. Credit of course: Probability and statistics

SUBJECT OBJECTIVES

C01 To acquaint students with the problems dealing with diagnostics and reliability of components and electronic devices

C02 To gain skills necessary for analysis of problems connected with failure and reliability of components and electronic devices

C03 To understand the purpose of knowledge application in reliability analysis of components and devices

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 He has knowledge dealing with reliability theory, testing and diagnostics as well as failure models

Relating to skills

PEK_U01 He is able to solve independently the problems connected with reliability, failure diagnostics and measurement data analysis

Relating to social competences

PEK_K01 He understands the need of mathematics application in order to analyse technical problems

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Reliability of binary systems	2
Le_02	Systems structures- functions describing reliability	2
Le_03	Simulation models of reliability	2
Le_04	Selective tests	2
Le_05	Failure mechanisms of electronic components	2
Le_06	Reliability models	2
Le_07	Influence of operating conditions on reliability	2
Le_08	Final test	1
	TOTAL	15

Form of classes - Project		Quantity
Pr_01	Distribution of individual project exercises, description of subject-matter and conditions of project realization	2
Pr_02	Discussion of problems connected with graphical presentation of measurement results concerning reliability	2
Pr_03	Discussion of problems connected with application of numerical methods in projects	2
Pr_04	Discussion of Monte Carlo method used in realization of projects	2
Pr_05	Discussion of problems connected with prognosis of devices reliability depending on operating conditions	2
Pr_06	Presentation of individual project realization, discussion	2
Pr_07	Presentation of individual project realization, discussion	2
Pr_08	Collecting of students project, presentation of results	1
	Total	15

TEACHING TOOLS USED

ND_01 Traditional lecture
ND_02 Project - individual solving of project in the range of reliability, discussion of problems dealing with project realization
ND_03 Tutorials
ND_04 Individual work - studies for lectures
ND_05 Individual work - individual studies and tasks connected with project realization
ND_06 Individual work - individual studies for tests

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Final test
P2 = F2 (project)	PEK_U01, PEK_K01	Discussion, independent solution of project

PRIMARY AND SECONDARY LITERATURE

Primary literature

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

Secondary literature

1. Grabski, J. Jaźwiński, Metody bayesowskie w niezawodności i diagnostyce, WKŁ, 2001
2. S. Firkowicz, Statystyczne badanie wyrobów, WNT, 1970

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Diagnostics and Reliability

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W07	C01	Wy_01-Wy_07	ND_01, ND_03, ND_04, ND_06
PEK_U01 (skills)	K2eit_U07	C02, C03	Pr_01-Pr_07	ND_02, ND_03, ND_05
PEK_K01 (competences)	K2eit_K06	C02, C03	Pr_01-Pr_07	ND_02, ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Optical-Fiber Networks**	
Name in English:	**Optical-Fiber Networks**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009571**	
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			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 optical networks
2. Basic knowledge of optical fibers

SUBJECT OBJECTIVES

C01 Clearing and organizing fundamental knowledge on optical fibers and computer networks
C02 Familiarizing students with basics of optical networks operation
C03 Providing students with knowledge suitable for design of optical-fiber networks.
C04 Familiarizing students with the current state of knowledge in the field of operation of optical networks
C05 Providing students with the knowledge about network design and acquiring by students skills for useful for working in the organized groups
C06 Acquiring knowledge and research skills to design and build optical fiber networks

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has in-depth knowledge in the field of photonics, including the knowledge necessary to understand operation of telecommunications systems and optical recording and processing of information

Relating to skills

PEK_U01 Can choose and evaluate optical-fiber and optoelectronic elements used for construction of photonic and optical network systems

Relating to social competences

PEK_K01 Can develop a plan to implement a project, can interact and work in a group, accepting different roles in the group

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction to optical networks	2
Le_02	Optical Ethernet - 10M and 100M	2
Le_03	Optical Ethernet - 1G	2
Le_04	10G Optical Ethernet, and beyond	2
Le_05	Design and measurements procedures of optical networks	2
Le_06	WDM networks and all-optical network of the future	2
Le_07	RAINBOW - an example of all optical network	2
Le_08	Final test	1
	TOTAL	15

Form of classes - Project		Quantity
Pr_01	Optical Fiber Network design methodology	2
Pr_02	Determination of design requirements for a small LAN network	2
Pr_03	Preparation of maps and plans of the network localization	2
Pr_04	Selection and analysis of fiber-optic network equipment	4
Pr_05	Calculation of the balance of power for the designed network	2
Pr_06	Preparation of the final version of the project	3
	Total	15

TEACHING TOOLS USED

ND_01 Traditional lecture with presentations and discussion
ND_02 Lecture supported with e-learning tools
ND_03 Project: independent development by students of reports describing results of their work
ND_04 Project: independent search and analysis of data about components and devices.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Consultations, on-line tests, final test
P2 = F2 (project)	PEK_U01, PEK_K01	Evaluation of the entire project based on the evaluation of partial stages

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Vademecum Teleinformatyka cz. I, IDG, 2004

Secondary literature

1. Vademecum Teleinformatyka cz. III, IDG, 2004
2. Vademecum Teleinformatyka cz. II, IDG, 2002

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Optical-Fiber Networks

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W02	C01, C02, C04, C06	Wy_01-Wy_07	ND_01, ND_02
PEK_U01 (skills)	S2epm_U02	C03, C05, C06	Pr_01-Pr_06	ND_03, ND_04
PEK_K01 (competences)	S2epm_K09	C03, C05, C06	Pr_01-Pr_06	ND_03, ND_04

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Operating Systems**	
Name in English:	**Operating Systems**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009572**	
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. Completed the course material: Introduction to computer science OR Computer science

SUBJECT OBJECTIVES

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

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has ordered knowledge of the principles of operation and programming of operating systems, including embedded systems

Relating to skills

PEK_U01 He can use, configure and program applications for different operating systems, including embedded

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

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Real Time Operating System (RTOS) architecture and implementations	2
Le_02	Filesystems. FAT, NTFS, ext2 overview. Hard link and soft links, rights, data encryption, mounting and unmounting	2
Le_03	Programming mobile applications for Android	2
Le_04	Overview of Linux and Windows based operating systems. OS kernel functions. Mobile operating systems	2
Le_05	Memory management: virtual memory; paging and segmentation; protected mode; page descriptors	2
Le_06	Kernel-level process synchronization. Scheduler. Process states and transitions.	2
Le_07	Inter-process data exchange in Windows and Linux. Shared memory, signals, messages, pipes	2
Le_08	Final test	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introduction. Configuring VirtualPC / VBOX. Portability of ANSI C source code: a console application on Linux and Windows, the standard input / output in these systems	2
La_02	InterNICHE or MQX RTOS for ColdFire: Implementation of multi-tasking	2
La_03	Using threads and event-driven application in Windows. Selected elements of the subsystem WinAPI	2
La_04	Basics of Linux. Manage permissions, using shell scripting, mounting file systems	2
La_05	Process management in Linux system and interprocess data exchange	2
La_06	Preparation and launch of Android image for a development board	2
La_07	Design application for Android to control your device or model of intelligent building	2
La_08	Additional (spare) classes	1
	Total	15

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

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

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

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Friesen, Geoff, Java: przygotowanie do programowania na platformę Android , Helion, 2012
2. Silberschatz, Abraham, Operating system concepts, John Wiley & Sons, 2010
3. Tanenbaum, Andrew S., Modern operating systems, Pearson Prentice Hall, 2009
4. Tanenbaum, Andrew S., Systemy operacyjne, Helion, 2010

Secondary literature

1. Barry, Richard, Using the FreeRTOS real time kernel : ARM Cortex-M3 edition, Real Time Engineers, 2010

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Operating Systems

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W10	C01	Le_01-Le_07	ND_01-ND_03, ND_05
PEK_U01 (skills)	S2epm_U13	C02	La_01-La_07	ND_02, ND_04, ND_06
PEK_K01 (competences)	S2epm_K01	C02	La_01-La_07	ND_02, ND_04, ND_06

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Photovoltaics**	
Name in English:	**Photovoltaics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009574**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge on physics of semiconductor, in particular interaction between light and solid semiconductor (optoelectronics)
2. Basic knowledge on electronics, construction and manufacturing technology of semiconductor devices
3. Completed course on Semiconductor devices or similar

SUBJECT OBJECTIVES

C01 Getting knowledge on operation principles, construction and manufacturing of photovoltaic devices cells and modules
C02 Getting knowledge on basic characterization principles and techniques of photovltaic devices and systems
C03 Getting knowledge on basic characterization principles and techniques of photovltaic devices and systems
C04 Getting information on basic technical standards and best practice guidelines in photovoltaics
C05 Participation of the students in the carried out research in photovoltaics

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Acquiring basic, theoretically supported, knowledge about photovoltaic solar energy conversion, including understanding of physical basics of operation principles of photovoltaic devices, photovoltaic technologies, design and performance evaluation of photovoltaic systems

Relating to skills

PEK_U01 Ability to perform measurements, correctly evaluate basic parameters of photovoltaic devices, prepare assumptions and make simple design of photovolatic system, predict expected electrical energy yield

Relating to social competences

PEK_K01 Ability of working and collaborating in laboratory group, taking various roles, performing both measurement as well as more advanced project tasks

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Solar radiation - spectrum, irradiance, energy, measurements and standards	2
Le_02	Photovoltaic effect. Absorption, refraction and reflection of light. Mechanisms of carrier generation and recombination in semiconductors, p-n junction	2
Le_03	Solar cell: current-voltage characteristics, spectral response curve, basic parameters, efficiency and its limitations	2
Le_04	Silicon solar cells: construction and technology, solutions for terrestrial and special applications (high efficiency cells), special constructions	2
Le_05	Thin-film solar cells: amorphous and polycrystalline Si, hybrid (polymorphic), CdS/CdTe, CIS, CIGS, dye-sensitized, organic, polymer	3
Le_06	Multijunction high efficiency solar cells based on III-V compounds (GaAs) construction, technology and applications	2
Le_07	Concentrated Photovoltaics (CPV) optical systems, solar cells working in CPV	1
Le_08	Photovoltaic modules- assembly, lamination, materiały, requirements; standard characterization techniques of solar cells and modules; methods applied for lifetime estimation	2
Le_09	Autonomous photovoltaic systems: design and installation principles;	3
Le_10	Methods of energy storing, electrochemical batteries electronics in PV systems (charge controllers, inverters)	3
Le_11	Grid connected PV systems; Building Integrated Photovoltaics BIPV; design principles; examples	3
Le_12	Future and perspective solutions in PV technology; third generation photovoltaics	3
Le_13	Technical standards and best practice guidelines in photovoltaics	1
Le_14	Final exam	1
	TOTAL	30

Form of classes - Laboratory		Quantity
La_01	Practical introduction to exercises, training on laboratory setups, geting familiar with numerical software used in the lab	2
La_02	Measurement of I-V curve of illuminated solar cell at different irradiance levels, determination of basic cell parameters using I-V-Irr as well as ISC-VOC dependences	4
La_03	Measurement of I-V curves of illuminated solar cell at different temperatures extraction of cells internal parameters, like saturation current components, with use of computer aided fitting of measured I-V curves	4

La_04	Measurement o PV modules in various, matched and mismatched, configurations, investigation of partial shading effects	4
La_05	Dark measurements of commercial PV cells and modules, determination of parameters in equivalent electrical circuit both using graphical methods as well as with use of computer aided fitting of measured I-V curves	4
La_06	Computer aided design of a grid connected (GC) PV system	6
La_07	Computer aided design of a stand alone (SAS) PV system	6
	Total	30

TEACHING TOOLS USED	
ND_01	Standard lectures supported with visual presentations and interactive evaluation methods
ND_02	Midterm evaluation test
ND_03	Laboratory - short 10 min. written tests at the beginning of exercise
ND_04	Own work - preparation to practical exercises
ND_05	Own work - preparation to midterm and final written test
ND_06	Consultations
ND_07	Final exam

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Final written exam
P2 = F2 (lab)	PEK_U01, PEK_K01	Evaluation of particular exercises, including evaluation of exercise performing (completing), evaluation of final report

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. J. I. Pankove, Zjawiska optyczne w półprzewodnikach, WNT, 1984
2. Jarzębski, Przetwarzanie energii słonecznej. Konwersja Fotowoltaiczna, WNT, 1981
3. M. Wacławek, T. Rodziewicz, Ogniwa słoneczne, wpływ środowiska na ich pracę, WNT, 2011
4. T. Żdanowicz, lecture notes, PWr, 2011

Secondary literature

1. A. Luque, S.Hegedus, Handbook of Photovoltaic Science and Engineering , John Wiley & Sons Ltd., Chichester, England, 2003
2. J. Poortmans, V. Arkhipov, Thin Film Solar Cells, Fabrication, Characterization and Applications, Wiley Series in Materials for Electronic & Optoelectronic Applications, John Wiley & Sons, 2006
3. Lasnier, T.G. Ang, Photovoltaic Engineering Handbook, Adam Hilger, 1990
4. M.A. Green, Third Generation Photovoltaics. Advanced Solar Energy Conversion, in: Springer Series in Photonics , Springer-Verlag, Berlin Heidelberg New York, 2003
5. M.A.Green , SOLAR CELLS - Operating principles, Technology and System Applications, Univ. of New South Wales, Australia, 1992
6. P. Wuerfel, Physics of Solar Cells From Priniciples to New Concepts, Wiley-VCH Verkag GmbH &Co. KGaA, 2005
7. S.R. Wenham, M.A. Green, M.E. Watt, R. Corkish, APPLIED PHOTOVOLTAICS, ARC Centre for Advanced Silicon Photovoltaics and Photonics, Earthscan in the UK and USA, 2007
8. T. Markvart, Solar Electricity, UNESCO ENERGY ENGINEERING SERIES, John Wiley & Sons, 2000
9. Zbiory Polskich Norm, PKN

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Photovoltaics

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W16	C01, C02	Le_01-Le_13	ND_01, ND_02, ND_05, ND_07
PEK_U01 (skills)	S2epm_U11	C03-C05	La_01-La_07	ND_03, ND_04
PEK_K01 (competences)	S2epm_K01	C03, C04	La_01-La_07	ND_03, ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Microsystem modeling**	
Name in English:	**Microsystem modeling**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009575**	
Group of courses:	**NO**	

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	30		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. Knowledge on basics of mathematics and physics
2. Knowledge on basics of computer programming
3. Basic computer skills

SUBJECT OBJECTIVES

C01 Acquainting students with the basics of numerical design of the microelectronic structures
C02 Gaining the knowledge on how to use the numerical modeling software tools based on FEA method, for example ANSYS
C03 Acquainting students with the typical problems of numerical prototyping as optimization, design of experiments, etc.
C04 Strengthening skills of individual and group work with the available teaching materials
C05 Participation of the students in the carried out research in microsystems modelling

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Student has basic, structured and theoretically founded knowledge on techniques, methods and engineer numerical tools for MEMS prototyping

Relating to skills

PEK_U01 Student is able to find right tools for computer aided engineering design, such as: ANSYS, SolidWorks, which could be used in practical applications in the field of numerical prototyping using CAD and FEM software

Relating to social competences

PEK_K01 Student is able to prioritize appropriately tasks required for implementation of specified problems defined by himself or others

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Modeling of microsystems - Introduction	2
Le_02	Numerical modelling and simulations	2
Le_03	Modeling of mechanical and thermodynamical problems	2
Le_04	Modeling of electromagnetism and fluid dynamics	2
Le_05	Modelling of the coupled fields	2
Le_06	Methods and algorithms for numerical prototyping	2
Le_07	Numerical design and analysis of microsystems reliability	2
Le_08	Exam	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introduction to modeling using FEM method and Ansys software program	2
La_02	Numerical prototyping using parametric models	2
La_03	Analysis capabilities of electronic circuits and systems using FEM software, such as Ansys	2
La_04	Analysis of stress and strain fields	2
La_05	Analysis of heat dissipation and temperature distribution	2
La_06	Analysis of the electrostatic field distribution	2
La_07	Determination of basic electrical parameters such as resistance	2
La_08	Analysis of laminar and turbulent flows	2
La_09	Analysis of stress distribution for bi-material structures	2
La_10	Analysis electro-thermo-mechanical coupled fields	2
La_11	Methods of thermo-mechanical modelling	2
La_12	Optimization of a micromechanical pressure sensor	2
La_13	Individual project - problem selection and its analysis	2
La_14	Individual project - discussion, presentation and analysis	2
La_15	Individual project - assessment	2
	Total	30

TEACHING TOOLS USED	
ND_01	Traditional lecture with multimedia presentations and discussion
ND_02	Laboratory: 5-minutes introduction and 5-minutes introductory tests
ND_03	Consultation
ND_04	Individual work: preparation for lecture
ND_05	Individual work: preparation for laboratories
ND_06	Individual work: literature study and preparation for the final test
ND_07	Individual work: laboratory reports

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Discussions and exam
P2 = F2 (lab)	PEK_U01, PEK_K01	Laboratory tests and quizzes, lab reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

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

Secondary literature

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

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Microsystem modeling

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W07	C01, C03	Le_01-Le_07	ND_01, ND_03, ND_04, ND_06
PEK_U01 (skills)	S2epm_U10	C02, C04, C05	La_01-La_13	ND_02, ND_05
PEK_K01 (competences)	S2epm_K09	C04	La_14, La_15	ND_07

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Analytical Microsystems**	
Name in English:	**Analytical Microsystems**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009576**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

SUBJECT OBJECTIVES

C01 Gaining knowledge of the operation, production and application of microsystems for chemical and microchemistry
C02 Gaining knowledge of the design and measurement of analytical bio-chips
C03 Participation of the students in the carried out research on analytical microsystems

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Student has supported by theoretical knowledge of the physico-chemical basis, technology, design, manufacturing, operation and application of analytical microsystems, bio-chips, lab-on-chip and microreactors

Relating to skills

PEK_U01 Student can describe, evaluate and compare the performance of gas and liquid analytical microsystems; he knows the rules of design, manufacture, operation and the use of microsystems for chemistry and microchemistry

Relating to social competences

PEK_K01 He works independently and in a team

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Introduction. Definition of micro-total-analysis-system (microtas). Systematization, kinds. Position of microtass. Why miniaturization Physic of microtass: flow in microscale: laminar flow vs. vortex flow. Mixing and dozing in micro- and nano-volumes. EHF flow, electroosmotic flow, electro-flow-steerying.	2
Le_02	Technological review: Compatibility of microtass and MEMS. Basic processes. Microtass made of: silicon, silicon and glass, glass, ceramic, plastic, metal. Examples of flow-process-charts. Technological limits.	2
Le_03	Parts of microtass: microvalves - types, realization, parameters, steerying. Capillary channels, nets of channels. Capillary columns for eluation procedures. Vortex and diffusive mixers. Micropums.	2
Le_04	Microdetectors for liquids; conductometric, ion-selective (IGFETs), spectrofluorometric and spectrophotometric with fiber-optics.	2
Le_05	Liquid microtas; CE, FFFE, TFFF, bio-chips, PCR reactors, DNA-chips, immunoassay chips.	2
Le_06	Flow and mass flow gas detectors. Catharometers. Microdosing units. Back-flushed and repetitive real-time dosers.	2
Le_07	Integrated gas chromatographs: construction and steerying. On-line system applications. Microreactors, new chemical apparatus. Market relations, development programmes.	2
Le_08	Final test	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Microvalve and repetitive microinjector: parameters of injection in the computer controlled steerying system with the real-time signals processing	3
La_02	Gas flow and gas mass flow sensors: flow-trough and injection configurations, co-operation to microdosers. Relay time, detection limits, stability, real-time work	3
La_03	Fluorimetric DNA detection in micro scale	3
La_04	Micro-fluidic-chip with the open architecture of a fluid maintance, with five microvalves and on-the-chip integrated conductometric sensor. Injection, dozing, mixing in the T, Y configurations. Visualization of data	3
La_05	Flow and mixing of liquids in micro scale	3
	Total	15

TEACHING TOOLS USED
ND_01 Lecture with presentations and discussion
ND_02 Consultations
ND_03 Short tests at the beginning of exercises, discussions
ND_04 Preparation of the report

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

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

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Nam-Trung Nguyen, Steven T. Wereley, Fundamentals and applications of Microfluidics, Artech House, 2002

Secondary literature

1. Jan A. Dziuban, Technologia i zastosowanie mikromechanicznych struktur krzemowych i krzemowo-szklanych w technice mikrosystemów, Oficyna Wyd. Politechniki Wrocławskiej, 2004

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Analytical Microsystems

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W06	C01	Le_01-Le_08	ND_01, ND_02
PEK_U01 (skills)	S2epm_U07	C02, C03	La_01-La_05	ND_03, ND_04
PEK_K01 (competences)	S2epm_K01	C02	La_01-La_05	ND_03, ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**MSc Diploma thesis**
Name in English:	**MSc Diploma thesis**
Main field of studies:	**Electronics and Telecommunications**
Level and form of studies:	**II level / Full time**
Kind of subject:	**Optional / Faculty**
Subject code:	**ETD009581**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					
Number of hours of total student workload (CNPS)					
Form of crediting				Z	
Number of ECTS points				20	
Including number of ECTS points for practical (P) classes				20	
Including number of ECTS points for direct teacher-student contact (BK) classes				14	

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 technical studies

C02 Writing by a student "thesis" (as work) and to present an oral presentation concerning the issues of the scope of the study Electronics and Telecommunications, 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 Electronics and Telecommunications and specialization in Electronics, Photonics, Microsystems

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 The student executed thesis, based on a knowledge obtained during studying in the field of the Electronics and Telecommunications and specialization in Electronics, Photonics, Microsystems

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 Electronics and Telecommunications and specialization in Electronics, Photonics, Microsystems

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
F1	PEK_W01	Checking up the thesis realization degree
F2	PEK_U01	Thesis review
F3	PEK_K01	Checking up the successive research aims achievement realized personally and in co-operation with research groups
P = 0,4*F1 + 0,4*F2 + 0,2*F3		

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Specialist subject literature agreed with the promoter

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

MSc Diploma thesis

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W01-K2eit_W12, S2epm_W01-S2epm_W14	C01, C04	Pr_01	ND_01, ND_02, ND_04
PEK_U01 (skills)	K2eit_U01-K2eit_U16, S2epm_U01-S2epm_U19	C02, C04	Pr_02, Pr_03	ND_01, ND_02, ND_04
PEK_K01 (competences)	K2eit_K01-K2eit_K12, S2epm_K01-S2epm_K09	C03	Pr_01- Pr_03	ND_01-ND_03

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Ceramic Microsystems**	
Name in English:	**Ceramic Microsystems**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009582**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Successful completion of the micro-nano technologies
2. Knowledge of basic physics

SUBJECT OBJECTIVES

C01 To familiarize students with the basic phenomena occurring in sensors, transducers and microsystems
C02 Familiarizing yourself with the thick film technology and LTCC (Low Temperature Cofired Ceramics) in the performance of ceramic microsystems
C03 Gaining skills in designing ceramic sensors
C04 Development of ability to work in group
C05 Participation of the students in the carried out research in the field of ceramic microsystems technology

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has a structured, theoretically founded knowledge related to the construction, principles of operation, characteristics and application of physical and chemical sensors and microsystems made of thick-film technology and LTCC (Low Temperature Ceramic Cofired); knows the directions of development of LTCC microsystems

Relating to skills

PEK_U01 Is able to estimate the applicability of the physical and chemical sensors and microsystems manufactured in thick-film and LTCC technology

PEK_U02 Can design selected sensors, actuators and microsystems ceramic. Is able to develop assumptions regarding the structure of selected instruments and to develop the structure of the algorithm technology

Relating to social competences

PEK_K01 He understands the need for lifelong learning, understand the principle of the sensor elements, which uses and understands the need for sensors to improve human safety, rapid medical diagnostics and environmental control

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	General information. Sensors, actuators and microsystems fundamentals and classification. Physical and chemical sensors	2
Le_02	Fundamentals of thick film and LTCC. Microsystem materials and processes	2
Le_03	Physical sensors. Temperature, radiation and flow sensors - principle of work, construction, properties and application	2
Le_04	Mechanical sensors and actuators. Piezoresistive, magnetoresistive and piezoelectric effects. Pressure, force, displacement sensors	2
Le_05	Chemical and physical processes in sensors. Chemical sensors. Gas sensors	2
Le_06	Humidity sensors. Mechanisms of water adsorption. Methods of humidity measurements. Others chemical sensors	2
Le_07	Ceramic actuators	2
Le_08	LTCC microsystems	2
Le_09	LTCC microsystems for analytical chemistry	2
Le_10	LTCC microsystems for medicine	2
Le_11	LTCC microsystems for automotive industry	2
Le_12	Chemical microreactor	2
Le_13	Advanced packaging technology	2
Le_14	Design and fabrication of ceramic microsystems and devices	2
Le_15	Future trends in development and application of ceramic	2
	TOTAL	30

Form of classes - Project		Quantity
Pr_01	Introduction	1
Pr_02	Project of the piezoresistive pressure sensor	2
Pr_03	Project of the capacitive pressure sensor	2
Pr_04	Project of the ceramic accelerometer	2

Pr_05	Project of the microfluidic system with optical detection	2
Pr_06	Project of the microfluidic system with electrochemical detection	2
Pr_07	Project of the flow sensor	2
Pr_08	Project of the ceramic microsystem for biological application	2
	Total	15

TEACHING TOOLS USED
ND_01 Lecture traditional presentations and discussion ND_02 Consultation ND_03 Self-study and exam preparation ND_04 Own work - preparation for the lecture ND_05 Own work - preparation for project

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01, PEK_U01	Discussion, exam
P2 = F2 (project)	PEK_U02, PEK_K01	Discussion, lab reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. J.W. Gardner, Microsensors, Wiley, 1994
2. M. Prudenziati, Thick film sensors, Elsevier, 1994
3. L. Golonka, Zastosowanie ceramiki LTCC w mikroelektronice, Oficyna Wydawnicza Politechniki Wrocławskiej 2001
4. Proceedings of IMAPS/ACerS International Conference and Exhibition on Ceramic Interconnect and Ceramic Microsystems Technologies (CICMT)

Secondary literature

1. Scientific journals: Sensors and Actuators, Microelectronic Engineering, J. Micromech. Microeng.
2. Conference Proceeding: Conf. Eurosensors, Conf. COE, Conf. IMAPS USA, IMAPS Poland Chapter

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Ceramic Microsystems

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W05	C01-C03	Le_01-Le_15	ND_01-ND_04
PEK_U01 (skills)	S2epm_U06	C01-C03, C05	Le_01-Le_15	ND_01-ND_04
PEK_U02	S2epm_U06	C03-C05	Pr_01-Pr_08	ND_02-ND_05
PEK_K01 (competences)	S2epm_K02	C03, C04	Pr_01-Pr_08	ND_02-ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Design and Construction of Optoelectronic Circuits**	
Name in English:	**Design and Construction of Optoelectronic Circuits**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009583**	
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 Preliminary preparation and participation of the students in conducted scientific research in the field of optoelectronics, particularly on the issue of laser detection systems of silicon microcantilever deflection in near-field 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	3
	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
P1 = F1 (lecture)	PEK_W01	Final test
P2 = F2 (project)	PEK_U01, PEK_K01	Rating substantive participation in open discussions in class and rating of the project task design and its presentation

PRIMARY AND SECONDARY LITERATURE

Primary literature

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

Secondary literature

1. Journals: Elektronika praktyczna, Elektronizacja, Przegląd Telekomunikacyjny itp. and catalogues, 2012
2. A.Bjarklev, S.Benedetto, A.Willner, Optical Fiber Communication Systems, Artech House, London, 1996
3. G.C.Righini, A.Tajani, A.Cutolo, An Introduction to Optoelectronic Sensors, World Scientific Pub (London, Singapore, Taipei), 2009
4. J. Siuzdak, Systemy i Sieci Fotoniczne, WKŁ , 2009
5. M.Karpierz, E.Weinert-Rączka, Nieliniowa optyka światłowodowa, WNT, 2009
6. Noe Reinhold, Essentials of Modern Optical Fiber Communication, Springer-Verlag, 2010
7. Paek Un-Chul, Oh Kyunghwan, Silica Optical Fiber Technology for Device and Components, John Wiley, 2012

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Design and Construction of Optoelectronic Circuits

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W09	C01, C05	Le_01-Le_08	ND_01, ND_04, ND_06. ND_07
PEK_U01 (skills)	S2epm_U02, S2epm_U12	C02-C05	Pr_01-Pr_07	ND_02, ND_03, ND_05-ND_08
PEK_K01 (competences)	S2epm_K09	C02, C05	Pr_01-Pr_07	ND_02, ND_03, ND_05-ND_08

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Advanced optoelectronics**	
Name in English:	**Advanced optoelectronics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009584**	
Group of courses:	**NO**	

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15	30	
Number of hours of total student workload (CNPS)	30		30	60	
Form of crediting	Z		Z	Z	
Number of ECTS points	1		1	2	
Including number of ECTS points for practical (P) classes	0		1	2	
Including number of ECTS points for direct teacher-student contact (BK) classes	0.6		0,7	1,4	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of the solid state physics
2. Completed a course of Semiconductor Devices
3. Completed a course of Wave Optics ETD3076
4. Completed a course of Basic of the Solid State Electronics
5. Completed a course of Optoelectronics
6. Completed a course of Semiconductors, Dielectrics and Magnetics
7. Completed a course of Micro- and Nano - Technologies ETD4062

SUBJECT OBJECTIVES

C01 Recollection of the knowledge from the field of optical phenomena existing in semiconductor materials e.g light generation, transmission and absorbance

C02 Presentation of advanced construction of optoelectronic devices including infrared and organic optoelectronic devices. Review of application fields of the discussed optoelectronic devices especially in automotive industry, power industry, microsystems and mechatrionic constructions

C03 Recollection of the knowledge from the field of waveguide constructions including planar optical-fibre. Presentation of the constructions, principle of operation of photonic crystals and applications in the optical devices. Presentation of constructions and principle of operation of advanced optical modulators and

switches.

C04 Acquiring of the knowledge from the range of the methods of characterization of semiconductor structures dedicated for constructions of optoelectronics devices. Measurements of optical and electrical parameters of chosen semiconductor structures by using photovoltaic spectroscopy, electrochemical C-V profiling, photoluminescence, photoreflectance and transmission spectroscopy methods.

C05 Practice of the team work skills

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Expanded and well established knowledge of physics, especially quantum physics and Solid State Physics necessary for understanding physical phenomena affecting the properties of the new materials and advanced photonic devices work

Relating to skills

PEK_U01 Can develop a detailed documentation of the results of experimental work, the research task or design; can prepare an elaboration containing an overview of these results

Relating to social competences

PEK_K01 Can plan and develop a scheme of the realized project, can cooperate and work in a group taking in different roles

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction to optoelectronics: definitions, classifications, applications	1
Le_02	Basic optical phenomena in semiconductors - generation and absorption	1
Le_03	Fundamentals of optoelectronic structure constructions	2
Le_04	Advanced semiconductor light sources.	1
Le_05	Advanced semiconductor photodetectors.	1
Le_06	Optoelectronic systems in automotive industry and mechatronics	1
Le_07	Measurements and analysis of the planar waveguides.	1
Le_08	Fabrication methods of optical layers and planar waveguides.	2
Le_09	Integrated optics devices.	1
Le_10	Basis of nonlinear optics.	1
Le_11	Optical measurement methods.	1
Le_12	Photonic crystals - properties and technology.	1
Le_13	Final test	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introduction to the laboratory course - referring of the subjects of the exercises, organization of the semester and rules of evaluation, recollection and discussion of the content of the following exercises, safety instruction.	3
La_02	Measurements of photoluminescence spectra of low dimensional epitaxial structures.	3
La_03	Colorimetric characterization of light sources – RGBW LEDs.	3
La_04	Spatial distribution of light flux and radiometric measurements of light sources.	3
La_05	Design of the quantum structure with required (assumed) electronic structure.	3
	TOTAL	15

Form of classes - Project		Quantity
Cl_01	Introduction to the project - safety instruction, organization of the semester and rules of evaluation	2
Cl_02	Introduction to the software employed during realized classes (Linux, putty, WinSPC, APView)	2
Cl_03	Introduction to the simulation APSYS software	2
Cl_04	Computer simulation of the MSM photodiode	2
Cl_05	Computer simulation of the PIN photodiode	2
Cl_06	Computer simulation of the LED diode	2
Cl_07	Computer simulation and elaboration of reports containing achieved results	18
	Total	30

TEACHING TOOLS USED	
ND_01	Traditional lecture with presentations and discussion
ND_02	Consultations
ND_03	Individual work - preparation for a lecture the selected issues
ND_04	Individual work - self-study and preparation for a final test
ND_05	Laboratory: short tests at the beginning of the classes, exercises realized by group
ND_06	Project: Elaboration of the reports with achieved simulation results
ND_07	Individual work - preparation for realized laboratory exercises
ND_08	Individual work - preparation for realized project classes

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Final test
P2 = F2 (lab)	PEK_U01, PEK_K01	Tests and reports
P3 = F3 (project)	PEK_U01, PEK_K01	Reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. B. Mroziewicz, M. Bugajski, Wł. Nakwaski, Lasery półprzewodnikowe, WNT 1985
2. J. E. Midwinder, Y. L. Guo, Optoelektronika i technika światłowodowa, WKŁ 1995
3. J. I. Pankove, Zjawiska optyczne w półprzewodnikach, WNT 1984

4. J. Piotrowski, A. Rogalski, Półprzewodnikowe detektory podczerwieni, WNT 1985
5. B. Ziętek Optoelektronika, Wyd. UMK, 2004
6. Z. Bielecki, A. Rogalski, Detekcja sygnałów optycznych, WNT 2001

Secondary literature

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

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Advanced optoelectronics

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W12	C01, C02	Le_01-Le_13	ND_01-ND_04
PEK_U01 (skills)	S2epm_U15	C03-C05	La_01-La_05, Pr_01-Pr_07	ND_05-ND_08
PEK_K01 (competences)	S2epm_K04	C04, C05	La_01-La_05, Pr_01-Pr_07	ND_05-ND_08

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Packaging of EPM**	
Name in English:	**Packaging of EPM**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009585**	
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

No requirements

SUBJECT OBJECTIVES

C01 Mastery of theoretical knowledge of electronic assembly and packaging
C02 Gaining practical skills through laboratory tasks
C03 Consolidation of skills of group work

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has a structured and theoretically founded knowledge in the field of electronic assembly allows independent performance of electronic systems based on the available electronic components and assembly techniques

Relating to skills

PEK_U01 Is able to properly select and apply the techniques of electronic assembly, depending on design requirements and reliability of devices

Relating to social competences

PEK_K01 Is able to set priorities in the use of adequate techniques for electronic assembly

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Packaging hierarchy and technologies	1
Le_02	Wire bonding	1
Le_03	Flip Chip technology	2
Le_04	Printed circuit boards	2
Le_05	Passive and active components for packaging	2
Le_06	Fundamentals of soldering process	2
Le_07	Overview of soldering technologies	2
Le_08	Defects of solder joints	2
Le_09	Colloquium	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introduction to laboratories	2
La_02	Measurement of surface ionic contaminants on printed circuit boards	4
La_03	Assembly of SMT devices on printed circuit boards	4
La_04	Assessment of solder joints by measuring the shear strength of solder joints	4
La_05	Rework station and manual soldering	4
La_06	Measurement of resistance of electrically conductive adhesives	4
La_07	Combined loading tests of soldered joints reliability	4
La_08	Supplementary term and visiting other lab facilities	4
	Total	30

TEACHING TOOLS USED	
ND_01	Traditional lecture with multimedia presentations and discussion
ND_02	Consultations
ND_03	Self-study and preparation for test
ND_04	A short, 10-minute introduction and assessment of student preparation (at the beginning of the laboratory)
ND_05	A brief summary of the results of the work carried out (at the end of the laboratory)
ND_06	Self-study and preparation for laboratory classes

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

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

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Fałat T., Felba J., Matkowski P., Packaging of Electronics, Photonics and Microsystems, PRINTPAP Łódź, 2011
2. Tummala R.R., Fundamentals of Microsystem Packaging, McGraw-Hill, 2001

Secondary literature

1. Felba J., Montaż w elektronice, Oficyna Wydawnicza Politechniki Wrocławskiej, 2010
2. Ganesan S., Pecht M., Led-free Electronics, John Willey & Sons Inc., 2006
3. Harper Ch.A., Electronic Packaging and Interconnection Handbook, McGraw-Hill, 1991
4. Suhir E., Lee Y.C., Wong C.P., Micro- and Opto- Electronic Materials and Structures, Springer S+B Media Inc., 2007

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Packaging of EPM

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	S2epm_W14	C01	Le_01-Le_08	ND_01-ND_03
PEK_U01 (skills)	S2epm_U17	C02, C03	La_02-La_08	ND_04-ND_06
PEK_K01 (competences)	S2epm_K07	C02, C03	La_02-La_08	ND_04-ND_06

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Diploma Seminar**	
Name in English:	**Diploma Seminar**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009586**	
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. Shortage of ECTS points not greater than resulting from resolution of the Faculty Council

SUBJECT OBJECTIVES

C01 Student acquires presentation skills of personal qualifications in the field of knowledge, learning and social competences

C02 Fixing of skills to work collectively

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 The student has well-ordered and theoretically established knowledge in the field that is demanded in Electronics and Telecommunication field of study and Electronics, Photonics and Microsystems specialization

Relating to skills

PEK_U01 The student is able to present personal qualifications in the range of knowledge, learning and social competences proper to Electronics and Telecommunication field of study and Electronics, Photonics and Microsystems specialization

Relating to competences

PEK_K01 The student is able to think and act in a creative and enterprising way and to co-operate and work in a group (collectively) accepting various roles in it

PROGRAMME CONTENT

Form of classes - Seminar		Quantity
Se_01	Introduction to the seminar	1
Se_02	Thesis, final examination - general information, regular requirements obligatory in Wrocław University of Science and Technology, the rules of technical and scientific texts creation	2
Se_03	Thesis - students discuss the subject matter and scope of expected research	3
Se_04	Multimedia presentation of CV done by every seminar participant	4
Se_05	Discussion of the exam questions	8
Se_06	Thesis - multimedia presentations of received results	6
Se_07	Thesis - short presentation prepared for the final examination	4
Se_08	Summary of the seminar and credition	2
	TOTAL	30

TEACHING TOOLS USED

ND_01 Presentation of selected issues concerning the thesis and discussion
ND_02 Personal work - preparation to multimedia presentation of assigned problems
ND_03 Personal work - individual studies and preparation to the final examination
ND_04 Consultations

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01, PEK_K01, PEK_K02	Control of the activity during classes and participation in the discussion
F2	PEK_U01	Assessment of the presentations about the examination topics
F3	PEK_U01	Assessment of the presentations about the progresses in the diploma thesis
P = 0,4*F1 + 0,4*F2 + 0,2*F3	PEK_W01, PEK_U01, PEK_K01, PEK_K02	Average grade

PRIMARY AND SECONDARY LITERATURE
Primary literature 1. Regulations governing higher education studies at Wrocław University of Science and Technology 2. Notes from lectures 3. Scientific publications from the field of the realised diploma thesis

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Diploma Seminar

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W01-K2eit_W12, S2epm_W01-S2epm_W14	C01	Se_02-Se_07	ND_01, ND_02, ND_04
PEK_U01 (skills)	K2eit_U01-K2eit_U16, S2epm_U01-S2epm_U19	C01, C02	Se_02-Se_07	ND_01, ND_02, ND_04
PEK_K01 (competences)	S2epm_K01, S2epm_K03	C02	Se_02-Se_07	ND_01-ND_03

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Mathematics**	
Name in English:	**Mathematics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ University-wide**
Subject code:	**MAT001449**	
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	E	Z			
Number of ECTS points	2	2			
Including number of ECTS points for practical (P) classes	0	2			
Including number of ECTS points for direct teacher-student contact (BK) classes	1.2	1.4			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of differential and integral calculus of functions of one and several variables
2. Knowledge of the properties and applications of complex numbers and matrices
3. Knowledge of the theory and application of numerical series and power series

SUBJECT OBJECTIVES

C01 Understanding of the basic concepts of linear spaces
C02 Understanding of the basic properties of Fourier series and Fourier transforms
C03 Understanding of the basic concepts, theorems, methods and applications relating to ordinary differential equations using the equations of the first and second order and linear systems of ordinary differential equations of the first order
C04 Understanding of the basic concepts, theorems and methods for simple partial differential equations and integral equations of type Volterra and Fredholm

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has a basic knowledge of linear space
PEK_W02 Has a basic knowledge of Fourier series and Fourier transforms
PEK_W03 Has a basic knowledge of ordinary differential equations with a particular focus on equations of first and second order and linear systems of ordinary differential equations of the first order
PEK_W04 Has a basic knowledge of partial differential equations of first and second order and integral equations of type Volterra and Fredholm

Relating to skills

PEK_U01 Can calculate Fourier series and Fourier transform of basic functions
PEK_U02 Is able to solve the equations of the first order with separated variables, linear, homogenous and Bernoulli, second-order equations reducible to first order, and the equation with constant coefficients, systems of linear ordinary differential equations of the first order by matrix methods
PEK_U03 Can solve simple partial differential equations and apply iterative methods for solving integral equations of type Volterra and Fredholm

Relating to social competences

PEK_K01 Is able to find and use the recommended literature course and independently acquire knowledge
PEK_K02 Understands the need for systematic and independent work on mastery of course material

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	The finite-dimensional and infinite-dimensional linear spaces. Examples	2
Le_02	Trigonometric Fourier series	3
Le_03	Fourier transform and its basic properties. Convolution	3
Le_04	Ordinary differential equations of the first order. The initial value problem for the first order differential equation. A direction field. Picard's theorem on the existence and uniqueness of solutions of Cauchy initial value problem for the equation of the first order	2
Le_05	Linear differential equations of the first order. The method of integrating factor. Bernoulli equation. Orthogonal curves	3
Le_06	Ordinary differential equations of the second order. Initial value problems for ordinary differential equations of second-order. Ordinary differential equations of second order differential equations reducible to first order	3
Le_07	Ordinary differential equations of second order linear homogeneous and heterogeneous. The method of variation of parameters	2
Le_08	Homogeneous systems of linear differential equations. The Euler method	2
Le_09	Partial differential equations of the first order. The integral of linear homogeneous equation. Clairaut equation. Transport equation	3
Le_10	Partial differential equations of the second order. Wave equation. The heat equation. Laplace equation	3
Le_11	Integral equations of the first and second kind, Fredholm and Volterra equations. Examples. Abel integral equation. Fredholm equation with degenerate kernel	4
	TOTAL	30

Form of classes - Classes		Quantity
Cl_01	Analyzing the issues related to the concepts of linear space	3
Cl_02	Determination and study of Fourier series	3
Cl_03	Determination of the Fourier transform and convolution	2
Cl_04	Solving of linear differential equations of the first order of separated variables, homogenous and Bernoulli equations. Application of the above equations	4
Cl_05	Solving differential equations of the second order and their applications	3
Cl_06	Solving systems of linear differential equations	3
Cl_07	Solving partial differential equations of the first order	3

Cl_08	Solving partial differential equations of the second order	3
Cl_09	Solving integral equations of the Volterra and Fredholm kind	4
Cl_10	Tests	2
	Total	30

TEACHING TOOLS USED
ND_01 Lecture – traditional method ND_02 Classes – traditional method (exercises solving and discussion) 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
P1 = F1 (lecture)	PEK_W01-PEK_W03 PEK_K02	Exam
P2 = F2 (classes)	PEK_U01-PEK_U04, PEK_K01, PEK_K02	Oral presentations, quizzes, tests

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. J. D. Logan, A first course in differential equations, SpringerVerlag, NY 2006
2. M. Gewert i Z. Skoczylas, Równania różniczkowe zwyczajne. Teoria, przykłady, zadania, Oficyna Wydawnicza GiS, Wrocław, 2006
3. F. Bierski, Funkcje zespolone – Szeregi Fouriera i przekształcenie Fouriera, przekształcenie całkowe Laplace'a, przekształcenie Laurenta, Uczelniane Wydawnictwa Naukowo-Dydaktyczne, Kraków, 1999
4. A. Piskorek, Równania całkowe. Elementy teorii i zastosowania, WNT, Warszawa, 1997

Secondary literature

1. P. Blanchard, R. L. Devany, and G. R. Hall, Differential Equations, 3rd ed., Thompson, Brook/Cole, Belmont, CA, 2006
2. A. Palczewski, Równania różniczkowe zwyczajne, WNT, Warszawa 2004
3. A. N. Tichonow, A. A. Samarski, Równania fizyki matematycznej, PWN, Warszawa 1963
4. K. T. Tang, Mathematical Methods for Engineerd and Scientis 2, Springer-Verlag, Berlin Heidelberg, 2007
5. K. T. Tang, Mathematical Methods for Engineerd and Scientis 3, Springer-Verlag, Berlin Heidelberg, 2007

SUBJECT SUPERVISOR

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Faculty's Committee for university-wide courses

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Mathematics

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronics and Telecommunications

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)	K2eit_W06	C01	Le_01	ND_01, ND_03, ND_04
PEK_W02	K2eit_W06	C02	Le_02, Le_03	ND_01, ND_03, ND_04
PEK_W03	K2eit_W06	C03	Le_04-Le_08	ND_01, ND_03, ND_04
PEK_W04	K2eit_W06	C04	Le_09-Le_11	ND_01, ND_03, ND_04
PEK_U01 (skills)	K2eit_U06	C02	Cl_02, Cl_03	ND_02-ND_04
PEK_U02	K2eit_U06	C03	Cl_04-Cl_06	ND_02-ND_04
PEK_U03	K2eit_U06	C04	Cl_07-Cl_09	ND_02-ND_04
PEK_K01 (competences)	K2eit_K02	C01-C04	Le_02-Le_11 Cl_02-Cl_09	ND_01-ND_04
PEK_K02	K2eit_K02	C01-C04	Le_01-Le_11 Cl_01-Cl_09	ND_01-ND_04