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: ***Microsystems***

LANGUAGE OF STUDY: ***Polish***

Content:

Microsystem Electronics and Photonics Faculty Council resolution of **29.09.2015**

In effect since ***01.10.2015***

FIELD OF STUDY EDUCATIONAL EFFECTS

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

Location of the field of study in the area of education

The field of study *Electronics and Telecommunication* (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 Technology at the specialization of EiT should posses 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
W – category of knowledge
U – category skills
K (after line/dash) – category of social competences
T2A – educational effects in the area of technical sciences for the second level study
01, 02, 03 and further– number of educational effects

Field-of-study educational effects at the 2-nd level study	DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS Upon completion of the second level study in the field of Electronics and Telecommunication, within specialization, the graduate:	Correlation with educational effects for 2-nd level study in area of technical sciences
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	T2A_W01
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)	T2A_W01
K2eit_W03	has basic knowledge concerning theory and methods of linear and nonlinear programming used in optimization procedures	T2A_W07
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	T2A_W04
K2eit_W05	knows and understands the elements of mathematical statistics in terms of possibilities of its application in engineering practice and scientific research	T2A_W07
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	T2A_W01
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	T2A_W06 T2A_W07
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	T2A_W03
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	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10

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	T2A_W11
K2eit_W11	has knowledge necessary to understand economic, legal, social and beyond technical factors of engineering activities and their using in engineering practice	T2A_W08
K2eit_W12	has basic knowledge concerning management, quality management and running a business	T2A_W09
K2eit_W13	achieves results in KNOWLEDGE category in one of the following specializations: ▪ Microsystems – EMS (attachmenet 1) ▪ Optoelectronics and Waveguide Technology – EOT (attachement 2) ▪ Electronics, Photonics, Microsystems – EPM (attachement 3)	
K2eit_W14	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	T2A_W07
SKILLS		
K2eit_U01	is able to assess and use devices/objects with nanometric dimensions (especially semiconductor devices and other ones, made using different technologies)	T2A_U10
K2eit_U02	is able to assess and use the phenomena occurring in solid state materials in quantum electronics applications	T2A_U10
K2eit_U03	using the methods of linear and nonlinear programming, is able to solve problems and tasks, optimizing the goal	T2A_U09
K2eit_U04	is able to use the learned numerical methods for solving typical engineering tasks	T2A_U09
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	T2A_U08
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	T2A_U09
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	T2A_U18
K2eit_U08	is able to explain the operating principle and basic characteristics and designs of deflection actuators using piezoelectric and electrostatic actuation	T2A_U10

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	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06
K2eit_U10	is able to use the acquired knowledge on modern production systems, processes of production management, market analysis, logistics and people management	T2A_U13 T2A_U14
K2eit_U11	is able to formulate and test the hypotheses connected with engineering problems and simple research work	T2A_U11
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	T2A_U12
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	T2A_U15
K2eit_U14	is able to suggest rationalization proposal/improvements to existing technical solutions	T2A_U16
K2eit_U15	is able to assess and use semiconductor devices and other devices fabricated using various techniques/technologies	T2A_U10
K2eit_U16	is able to define the fields of further education and follow the process of self learning	T2A_U05
K2eit_U17	achieves results in SKILLS category in one of the following specializations: ▪ Microsystems – EMS (attachment 1) ▪ Optoelectronics and Waveguide Technology – EOT (attachment 2) ▪ Electronics, Photonics, Microsystems – EPM (attachment 3)	
COMPETENCES		
K2eit_K01	shows curiosity about new innovative design solutions and production processes	T2A_K07
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	T2A_K06
K2eit_K03	perceives the necessity of undertaking and putting into practice optimization measures in various areas of life	T2A_K06
K2eit_K04	takes into account the need of using numerical methods in design process	T2A_K06
K2eit_K05	can think and act in a creative and entrepreneurial way	T2A_K06
K2eit_K06	properly recognizes, solves, and acting in a team, puts into practice the knowledge concerning analysis of mathematical problems	T2A_K01 T2A_K03
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	T2A_K06
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	T2A_K06

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	T2A_K06 T2A_K07
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	T2A_K02
K2eit_K11	is able to define priorities for realization of a particular task	T2A_K04
K2eit_K12	properly recognizes and settles dilemmas connected with professional activity	T2A_K05
K2eit_K13	achieves results in COMPETENCES category in one of the following specializations: ▪ Microsystems – EMS (attachment 1) ▪ Optoelectronics and Waveguide Technology – EOT (attachment 2) ▪ Electronics, Photonics, Microsystems – EPM (attachment 3)	
K2eit_K14	thinks that the conscious and systematic physical activity during studies and after graduation, helps in improvement of life quality	T2A_K01 T2A_K03
K2eit_K15	can working in a team, according to the specified rules and fair play rules, during participation in different forms of physical activity	T2A_K03

Where:
K1yyy – symbol for the field of study at the first level
K2yyy – symbol for the field of study at the second level
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE
_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES

T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

Attachement 1

EDUCATIONAL EFFECTS FOR EMS SPECIALIZATION

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

Specialization educational effects at the 2-nd level study	**DESCRIPTION OF EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of Electronics and Telecommunication, within the specialization, the graduate:**	**Correlation with educational effects for 2-nd level study in area of technical sciences**
	KNOWLEDGE	
S2ems_W01	has extended and deepened knowledge concerning technological processes applied in widely understood thin-film microelectronics, with the use of the knowledge on phenomena occurring in plasma processes carried out at reduced pressure	T2A_W03
S2ems_W02	has extended and deepened knowledge concerning theoretical and practical aspects of application of numerical methods for modeling and design in the field of microsystems	T2A_W01
S2ems_W03	has ordered basic knowledge concerning structure and operation of analog integrated circuits	T2A_W02
S2ems_W04	understands methodology of programming and implementation of *FPGA* systems	T2A_W07
S2ems_W05	has extended and deepened knowledge in the range of sciences (physics, chemistry, biology, informatics, material engineering) necessary to understand the essence of phenomena/ properties being the result of size reduction, which are used in nanotechnology	T2A_W01
S2ems_W06	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics and theoretical and experimental basis of specific phenomena in the field of electronics and photonics, necessary to understand phenomena (photoelectronic, electro-acoustic and superconductivity)	T2A_W01
S2ems_W07	has basic knowledge concerning theory and methods of linear and nonlinear programming used in optimization procedures	T2A_W07
S2ems_W08	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	T2A_W04

S2ems_W09	knows and understands the elements of mathematical statistics in terms of possibilities of its application in engineering practice and scientific research	T2A_W07
S2ems_W10	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	T2A_W01
S2ems_W11	has extended, deepened and ordered knowledge in the range 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)	T2A_W01
S2ems_W12	has theoretically grounded knowledge on current achievements in commercial and industrial electronics: microelectronics, high power and high temperature electronics, microsystems, including MEMS and MOEMS; has knowledge about the newest achievements in electronics application	T2A_W05
S2ems_W13	has ordered and theoretically grounded knowledge related to 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	T2A_W01
S2ems_W14	has theoretically grounded knowledge concerning physico-chemical, and technological basis, design, fabrication, operation and applications of analytical microsystems, microreactors, bio-chips and lab-on-chips	T2A_W01
S2ems_W15	has ordered knowledge concerning application of the methods of investigation and analysis of results for comprehensive diagnostics of the properties of materials for electronics and photonics	T2A_W03
S2ems_W16	has knowledge on the basis of sensor technology relevant to the studied discipline, including the knowledge necessary to understand physical and chemical mechanisms of sensor operation, taking into account the relations between their functional parameters and the structure; moreover has knowledge on classification and technologies of sensor fabrication	T2A_W01 T2A_W05
S2ems_W17	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 for microcontrollers	T2A_W02 T2A_W05
S2ems_W18	has ordered knowledge concerning structure, operation and designing of specific electronic circuits responsible for measurement and processing of sensor signals	T2A_W03
S2ems_W19	has knowledge concerning reliability theory, methods of testing of elements and devices and diagnostic methods; has knowledge on basic characteristics in the theory of reliability, typical distributions, reliability of systems, estimation of reliability parameters, experiment design, testing and diagnostics as well as failure models	T2A_W07
S2ems_W20	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 and piezoelectric sensors and structures of MEMS systems	T2A_W03

S2ems_W21	has ordered , theoretically grounded general and detailed knowledge in the field of exact and technical sciences relevant to the studied discipline; knows basic principles of editing of research projects and diploma thesis	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10
S2ems_W22	has ordered knowledge on basic technological processes, characteristic of polymer and molecular electronics and basic materials, passive elements and active devices of organic electronics	T2A_W01
S2ems_W23	has ordered, theoretically grounded general and detailed knowledge in the range of exact and technical sciences relevant to the field of study	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10
S2ems_W24	has knowledge on the basis of production management and management systems useful for the managers of a small or middle enterprises; knows modern production systems and production management systems as well as financial information, market analysis, logistics, people management, which are necessary in strategic enterprise management	T2A_W11
SKILLS		
S2ems_U01	is able to design a technological process of thin-film deposition, including the processes occurring in gas discharge	T2A_U09
S2ems_U02	is able - while formulating and solving the tasks associated with modeling and design of microsystems - to integrate knowledge coming from different sources	T2A_U10
S2ems_U03	is able to asses and compare, in terms of the parameters describing an integrated circuit, system solutions and perform analysis of operation of analog and digital integrated circuits in typical applications	T2A_U18
S2ems_U04	is able to program and implement *FPGA* systems	T2A_U07
S2ems_U05	is able to assess and use devices/objects with nanometric dimensions (especially semiconductor devices and other ones, made using different technologies)	T2A_U10
S2ems_U06	is able to assess and use the phenomena occurring in a solid state material in quantum electronics applications	T2A_U10
S2ems_U07	is able, using the methods of linear and nonlinear programming, to solve the tasks optimizing the goal	T2A_U09
S2ems_U08	is able to use the learned numerical methods for solving typical engineering tasks	T2A_U09
S2ems_U09	has basic practical skills concerning presentation, analysis and interpreting data as well as application of statistical methods in the analysis of various physical phenomena	T2A_U08
S2ems_U10	is able, properly and effectively to apply the knowledge on differential and integral equations, and stochastic processes relevant to the studied engineering discipline	T2A_U09
S2ems_U11	depending on requirements and available solutions, is able to choose and apply exploitation parameters suitable source for supplying a microsystem	T2A_U01

S2ems_U12	is able to assess the usefulness of application of novel solutions (circuits, systems of functional and industrial electronics) with innovative character	T2A_U10
S2ems_U13	is able to asses the usefulness and possibility of using physical and chemical sensors, and microsystems made in LTCC technology	T2A_U10
S2ems_U14	is able to design chosen sensors, actuators and ceramic microsystems; is able to develop prerequisites concerning the structure of selected devices and develop an algorithm of technological process for their fabrication	T2A_U10
S2ems_U15	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	T2A_U10
S2ems_U16	is able to use the acquired knowledge for carrying out the studies of the components of analytical microsystems (valves, metering units, mixers and detectors); knows the operation principles of advanced analytical microsystems (e.g. integrated gas chromatograph)	T2A_U08
S2ems_U17	is able to plan and safely carry out measurements and work out the measurement results	T2A_U08
S2ems_U18	is able to make distinctions between methods used in investigation of semiconductor surface structures applied in microsystem electronics and in structural characterization of modern materials for opto- and microelectronics	T2A_U18
S2ems_U19	is able to assess the usefulness and apply the learned methods, used in microelectronics for characterization of a solid material surface, structure, material composition and optical properties	T2A_U18
S2ems_U20	is able to design, make and carry out investigation of the produced and commercially available sensors, and to determine their functional parameters	T2A_U03 T2A_U05
S2ems_U21	has a skill of using low-level system functions and is able to program and configure embedded systems intended for microcontrollers	T2A_U19
S2ems_U22	is able to design electronic circuits responsible for the measurement and processing of sensor signals – and depending on complexity level – make, run and measure functional properties of designed, precise analog and digital (microcontroller) systems, including the automatic control systems	T2A_U18
S2ems_U23	is able to explain the principle of operation and basic characteristics of the deflection actuators functioning on piezoelectric and electrostatic actuation principle	T2A_U10
S2ems_U24	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 related to the studied discipline	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06

S2ems_U25	is able to assess and use the knowledge about passive elements and sub-systems (sensors based on the composites: powder filler-organic resin), active devices of organic electronics (emitters of optical radiation, displays, detectors of radiation, organic transistors, integrated circuits and mass memories) as well as chemical sensors based on organic semiconductors	T2A_U15
S2ems_U26	is able, using the literature information and basing on own work results, while integrating and interpreting and making critical evaluation, to prepare and give an oral presentation concerning the subjects relevant to the field of study	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06
S2ems_U27	is able to use the acquired knowledge about modern production systems and production management processes, market analysis, logistics and people management	T2A_U13 T2A_U14
COMPETENCES		
S2ems_K01	can work individually and in a team	T2A_K06
S2ems_K02	takes into account the necessity of using numerical methods in design process	T2A_K06
S2ems_K03	can think and act in creative and entrepreneurial way	T2A_K06
S2ems_K04	shows curiosity about new innovative design solutions and production processes	T2A_K07
S2ems_K05	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	T2A_K06
S2ems_K06	perceives the necessity of undertaking and putting into practice optimization measures in different areas of life	T2A_K06
S2ems_K07	properly, recognizes solves, and acting in a team, puts into practice the knowledge concerning analysis of mathematical problems	T2A_K01 T2A_K03
S2ems_K08	understands the need of permanent education; understands the operation principle of the used sensor devices; understands the necessity of sensor applications to improve people's safety, accelerate medical diagnostics and monitor the environment condition	T2A_K07
S2ems_K09	is able to set clear priorities for realization of a task defined by himself/herself or other person; can safely perform and work out results of measurements	T2A_K06
S2ems_K10	is conscious of importance of the issues connected with implementation and functioning in engineering activity, modern production systems, production management systems, logistics and people management	T2A_K06
S2ems_K11	understands the need of formulating and sharing in society, e.g. 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, taking into account various points of view	T2A_K06, T2A_K07

Where:
S1yyy – symbol for specialization at the first level study
S2emsyyy – symbol for specialization at the second level study
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE

_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES
T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

Attachement 2

EDUCATIONAL EFFECTS FOR EOT SPECIALIZATION

Faculty: Microsystem Electronics and Photonics
Field of study: Electronics and Telecommunication
Level of studies: second level full time study
Specialization: Optoelectronics and Waveguide Technology (EOT)

Specialization educational effects at the 2-nd level study	**DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of Electronics and Telecommunication, within the specialization, the graduate:**	**Correlation with educational effects for 2-nd level study in area of technical sciences**
	KNOWLEDGE	
S2eot_W01	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics necessary to understand the phenomena having an important impact on the properties of novel materials and operation of advanced photonic devices	T2A_W01
S2eot_W02	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary to understand the operation of optical telecommunication systems and optical recording and processing of information	T2A_W01 T2A_W03 T2A_W04
S2eot_W03	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics, necessary to understand physical phenomena having an important impact on the properties of novel materials and operation of advanced electronic devices	T2A_W01
S2eot_W04	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary to understand the operation of optical telecommunication systems and optical recording and processing of information	T2A_W01 T2A_W03 T2A_W04
S2eot_W05	has deepened and theoretically grounded knowledge concerning basic mechanisms of amplification and generation of electromagnetic radiation, lasers and applications of laser technique	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05
S2eot_W06	has deepened and ordered knowledge about the processes of fabrication of electronic elements, integrated circuits and microsystems as well as on the influence of process parameters on the design and functional parameters of produced objects; has basic knowledge from the field of nanotechnology	T2A_W03 T2A_W07

S2eot_W07	has deepened and ordered knowledge concerning applications and design of optical fiber measurement systems used in contemporary technology	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05 T2A_W07
S2eot_W08	has deepened and ordered knowledge on the basic optical phenomena in semiconductors, physical basis and structures of advanced optoelectronic devices and systems, and applications of optoelectronic systems	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05 T2A_W07
S2eot_W09	understands the design methodology of advanced analog, digital and mixed electronic circuits (also in integrated version) and electronic systems; knows the languages for equipment description and computer tools for design and simulation of circuits and systems	T2A_W03 T2A_W07
S2eot_W10	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary for understanding the operation of optical telecommunication systems and optical recording and processing of information; has basic knowledge concerning algorithms used in the applications employed for modeling of optoelectronic devices and systems; knows and understands advanced numerical methods applied in designing of electronic and photonic devices and systems	T2A_W01 T2A_W03 T2A_W04 T2A_W07
S2eot_W11	has deepened and theoretically grounded knowledge in 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	T2A_W01 T2A_W02 T2A_W03 T2A_W04
S2eot_W12	has ordered and theoretically grounded knowledge in the field of photovoltaics, including the knowledge necessary to understand the physical basis of operation of photovoltaic elements and designs and to assess the quality of photovoltaic systems	T2A_W01
SKILLS		
S2eot_U01	is able to acquire information from literature, databases and other sources, is able to integrate acquired information, perform its interpretation, and critical assessment, draw conclusions, and formulate and profoundly justify opinions	T2A_U01
S2eot_U02	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	T2A_U02 T2A_U03
S2eot_U03	is able to develop detailed documentation of the results of experiment, design task or research project; is able to prepare a report containing discussion of the results	T2A_U04
S2eot_U04	is able to prepare and give a presentation on realization of a task or research project and conduct a discussion concerning the presentation	T2A_U04
S2eot_U05	can use English at the level sufficient for communication, also in professional issues, reads with understanding the professional literature and is able to prepare and give a short oral presentation on realization of a task or research project	T2A_U04

S2eot_U06	can use the learned methods and mathematical models (and should the need arise, modify them) for the analysis and design of electronic and photonic components, circuits and systems	T2A_U08 T2A_U15 T2A_U17
S2eot_U07	is able to assess and compare design solutions and fabrication methods of electronic devices and circuits in terms of presumed functional and economical criteria (power consumption, thermal budget, rate of operation, reliability, time consumption, costs etc.)	T2A_U14
S2eot_U08	is able to plan and carry out simulations and measurements of electrical and optical characteristics and extract the parameters characterizing materials, devices and analog and digital electronic circuits	T2A_U08
S2eot_U09	is able to plan a process of testing of a complex electronic circuit and electronic or photonic system	T2A_U09 T2A_U18
S2eot_U10	is able to design analog, digital and mixed electronic devices, electronic (photonic) circuits and electronic systems taking into account the functional and economical criteria, and should the need arise, adapt the existing or develop new design methods or tools for computer aided design (CAD)	T2A_U18
S2eot_U11	is able to design electronic circuits and systems intended for different applications, including monolithic and hybrid electronic and photonic circuits	T2A_U18
S2eot_U12	is able to apply communication devices in local and wide area teleinformatic networks, including optical fibers networks	T2A_U18
S2eot_U13	is able, with the use of suitable analytic, simulation and experimental tools, to formulate and test the hypotheses connected with modeling and design of electronic components, circuits and systems and design the process of their manufacturing	T2A_U09
S2eot_U14	in formulating and solving the tasks connected with modeling and design of electronic components, circuits and systems and designing their manufacturing process, is able to integrate the knowledge from the field of electronics, photonics, informatics, automatics, telecommunications and other disciplines, using a system approach with taking into account beyond technical aspects	T2A_U11
S2eot_U15	in formulating and solving the tasks connected with modeling and design of electronic elements, circuits and systems and designing their manufacturing process, is able to integrate the knowledge from different sources	T2A_U01 T2A_U18
S2eot_U16	is able to asses the cost of design and realization of an electronic or photonic circuit or system	T2A_U14
S2eot_U17	is able to propose improvements of existing design solutions and models of electronic devices, circuits and systems	T2A_U15 T2A_U16
S2eot_U18	is able to assess the usefulness and possibility of application of modern achievements in materials, elements, design and fabrication methods (including microelectronic technologies) for the design and fabrication of electronic circuits and systems, containing solutions of innovative character	T2A_U12 T2A_U17
S2eot_U19	is able to design a complex device, object, system or process and develop this project (even in part), relevant to the studied discipline, with the use of suitable methods and tools, both the existing ones and newly developed	T2A_U19

S2eot_U20	is able to choose and assess optical fiber and optoelectronic elements used in designing of photonic systems and optical fiber networks; knows the techniques of measurements of waveguides, waveguide couplers and possibilities of their application in waveguide systems	T2A_U02 T2A_U08 T2A_U15
COMPETENCES		
S2eot_K01	is able to think and act in creative and entrepreneurial way	T2A_K06
S2eot_K02	understands the need of permanent updating the lifetime learning process, is able to prepare educational aids and popular science presentations	T2A_K01 T2A_K07
S2eot_K03	is able to think in an ecology-friendly way, is conscious of the importance and understands the beyond technical aspects and results of engineering activity, including its impact on environment; is able to design systems using alternative energy sources	T2A_K02
S2eot_K04	is able to design and develop a plan of a project realization, is able to co-operate and work in a team, undertaking different tasks	T2A_K03 T2A_K04

Where:
S1yyy – symbol for specialization at the first level study
S2eotyyy – symbol for specialization at the second level study
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE
_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES

T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

Attachment 3

EDUCATIONAL EFFECTS FOR EPM SPECIALIZATION

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

Specialization educational effects at the 2-nd level study	**DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS** **Upon completion of the 2-nd level study in the field of Electronics and Telecommunication, within the specialization, the graduate:**	**Correlation with educational effects for 2-nd level study in area of technical sciences**
	KNOWLDGE	
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	T2A_W03
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	T2A_W01 T2A_W03 T2A_W04
S2epm_W03	has deepened and ordered knowledge concerning applications and design of optical fiber measurement systems used in contemporary technique	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05 T2A_W07
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)	T2A_W01
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	T2A_W01
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	T2A_W01
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	T2A_W01

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	T2A_W01
S2epm_W09	has knowledge concerning the principles of designing electronic devices with the use of optoelectronic and optical fiber subsystems, satisfying presumed input parameters	T2A_W02 T2A_W06 T2A_W07
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	T2A_W02 T2A_W05
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	T2A_W01 T2A_W02 T2A_W03 T2A_W04
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	T2A_W01 T2A_W02 T2A_W05
S2epm_W13	has ordered , theoretically grounded general and detailed knowledge in the field of exact and technical sciences relevant to the academic discipline of study; knows basic principles of editing of research projects and diploma thesis	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10
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	T2A_W02 T2A_W04 T2A_W06
S2epm_W15	has theoretically grounded knowledge concerning physico-mechanical, technological, design, fabrication, operation and application bases of microsystems of MEMS and MOEMS type	T2A_W01
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	T2A_W01
SKILLS		
S2epm_U01	is able to design a technological process of thin-film deposition, including the processes occurring in gas discharge	T2A_U09

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	T2A_U02 T2A_U08 T2A_U15
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	T2A_U09 T2A_U18
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 engineering discipline	T2A_U09
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	T2A_U01
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	T2A_U10
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	T2A_U10
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)	T2A_U08
S2epm_U09	is able to plan and safely carry out measurements and work out the measurement results	T2A_U08
S2epm_U10	is able - while formulating and solving tasks associated with modeling and design of microsystems - to integrate knowledge coming from different sources	T2A_U10
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	T2A_U03
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	T2A_U01 T2A_U02 T2A_U11 T2A_U16
S2epm_U13	has a skill of using low-level system functions as well as program and configure embedded systems intended for microcontrollers	T2A_U19

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	T2A_U02 T2A_U03 T2A_U04
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	T2A_U02 T2A_U07 T2A_U10 T2A_U12
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	T2A_U02
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	T2A_U02 T2A_U07, T2A_U08
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	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06
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	T2A_U17
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	T2A_U18
SOCIAL COMPETENCES		
S2epm_K01	is able to work individually and in a team	T2A_K06
S2epm_K02	is open to novel innovative design solutions and production processes	T2A_K07
S2epm_K03	is able to think and act in creative and entrepreneurial way	T2A_K06
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	T2A_K07
S2epm_K05	properly identifies, solves and puts into practice, co-operating in a team, the knowledge connected with the analysis of mathematical problems	T2A_K01 T2A_K03
S2epm_K06	takes into account the necessity to use numerical methods in the design process	T2A_K06
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	T2A_K06
S2epm_K08	is conscious of the importance and understands the necessity of putting into practice renewable energy sources	T2A_K02

S2epm_K09	is able to design and develop a plan of a project realization, can co-operate and work in a team, undertaking different tasks	T2A_K03 T2A_K04

Where:
S1yyy – symbol for specialization at the first level study
S2epmyyy – symbol for specialization at the second level study
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE
_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES

T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

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*** ***D – grade in diploma*** ***RK – interview*** *The faculty reserves the right to interview the candidates if the*	*Upon completion of studies graduate obtains* *professional degree of:* ***M. Sc. engineer*** *2-nd level qualifications*

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 specializations (EOT, EMS) 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:

Wroclaw University of 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 Wroclaw University of 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, Wroclaw University of 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 Wroclaw University of 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 Wroclaw University of 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	FLH121521W	Philosophy of Science and Technology	1						15	60	2	1,2	T	Z	O		KO	Ob.
		Total	1	0	0	0	0		15	60	2	1,2						

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				
1	0	0	0	0	15	60	2	1,2

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	MAP001206W	Mathematics	2					K2eit_W06	30	60	2	1,2	T	E	O		PD	Ob.
2	MAP001206C	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	ETD008078W	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	ETD008075W	Statistics for EFM	1					K2eit_W05	15	30	1	0,6	T	Z			K	Ob.
2	ETD008075C	Statistics for EFM		1				K2eit_U05 K2eit_K02	15	60	2	1,4	T	Z		P	K	Ob.
3	ETD008076W	Numerical Methods	1					K2eit_W04 InzA_W02 K2eit_K07 InzA_K01	15	30	1	0,6	T	Z			K	Ob.
4	ETD008076L	Numerical Methods			1			K2eit_U04 InzA_U01 K2eit_K07 InzA_K01	15	60	2	1,4	T	Z		P	K	Ob.
5	ETD008077W	Optimization Methods	1					K2eit_W03	15	30	1	0,6	T	Z			K	Ob.
6	ETD008077C	Optimization Methods		1				K2eit_U03 K2eit_K03	15	60	2	1,4	T	Z		P	K	Ob.
7	ETD008079W	Nanotechnology	1					K2eit_W01	15	30	1	0,6	T	Z			K	Ob.
8	ETD008079S	Nanotechnology					2	K2eit_U01 K2eit_K01	30	60	2	1,4	T	Z		P	K	Ob.
9	ETD008080W	Sensors and Actuators	1					K2eit_W14	15	30	1	0,6	T	Z			K	Ob.
10	ETD009077W	Diagnostics and Reliability	1					K2eit_W07	15	30	1	0,6	T	Z			K	Ob.
11	ETD009077P	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	ETD008270W	Programmable logic devices	1					S2ems_W04	15	30	1	0,6	T	Z			S	Ob.
2	ETD008270P	Programmable logic devices				1		S2ems_U04	15	60	2	1,4	T	Z		P	S	Ob.
3	ETD008271W	Modelling of microsystems	1					S2ems_W02	15	30	1	0,6	T	E			S	Ob.
4	ETD008271L	Modelling of microsystems			2			S2ems_U02 S2ems_K03	30	60	2	1,4	T	Z		P	S	Ob.
5	ETD008274W	Autonomous Power Supplying Systems	2					K2eit_W11	30	60	2	1,2	T	Z			S	Ob.
6	ETD008275W	Vacuum and Plasma Techniques	1					S2ems_W01	15	30	1	0,6	T	E			S	Ob.
7	ETD009280W	Diagnostic methods	3					K2eit_W13 S2ems_W15	45	90	3	1,8	T	Z			S	Ob.
8	ETD009280C	Diagnostic methods		2				S2ems_U19 S2ems_K09	30	90	3	2,1	T	Z		P	S	Ob.
9	ETD009281W	Analytical Microsystems	1					S2ems_W14	15	30	1	0,6	T	Z			S	Ob.
10	ETD9009281L	Analytical Microsystems			1			S2ems_U15 S2ems_K01	15	60	2	1,4	T	Z		P	S	Ob.
11	ETD009282W	Ceramic Microsystems	2					S2ems_W13 S2ems_U13	30	60	2	1,2	T	E			S	Ob.
12	ETD009282P	Ceramic Microsystems				1		S2ems_U14 S2ems_K08	15	60	2	1,4	T	Z		P	S	Ob.
13	ETD009290W	Sensors	3					S2ems_W16	45	60	2	1,2	T	E			S	Ob.
14	ETD009290L	Sensors			2			S2 ems_U20 S2ems_K08	30	60	2	1,4	T	Z		P	S	Ob.
15	ETD009291W	Operating Systems	1					S2ems_W17	15	30	1	0,6	T	Z			S	Ob.
16	ETD009291L	Operating Systems			1			S2ems_U21 S2ems_K01	15	60	2	1,4	T	Z		P	S	Ob.
17	ETD009292W	Application of analogue and digital integrated circuits	1					S2ems_W03	15	30	1	0,6	T	Z			S	Ob.
18	ETD009292P	Application of analogue and digital integrated circuits				2		S2ems_U22 S2ems_K01	30	60	2	1,4	T	Z		P	S	Ob.

19	ETD009283S	Achievements in electronics and microsystems					2	K2eit_W01-K2eit_W13, S2ems_W12 K2eit_U01-K2eit_U17, S2ems_U01 S2ems_U26 S2ems_K11	30	60	2	1,4	T	Z		P	S	Ob.
20	ETD009293W	Polymer and Molecular Electronics	2					S2ems_W22	30	60	2	1,2	T	Z			S	Ob.
		Total	18	2	6	4	2		480	1080	36	23,5						

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				
18	2	6	4	2	480	1080	36	23,5

4.2 List of optional modules

4.2.1 List of general education modules

4.2.1.1 *Liberal-managerial subjects* modules

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	MCM023001BK	Management	2						30	90	3	1,8	T	Z	O		KO	W
	MCM023002W	Enterprise Management																
	MCM023001W	Small Enterprise Management																
		Total	2	0	0	0	0		30	90	3	1,8						

4.2.1.2 *Foreign languages* module

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	JZL100400BK	Foreign language B2+		1					15	30	1	0,7	T	Z	O	P	KO	W
2	JZL100400BK	Foreign language A1/A2		3					45	60	2	1,4	T	Z	O	P	KO	W
		Total	0	4	0	0	0		60	90	3	2,1						

4.2.1.3 *Sporting classes* module

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

Altogether for general education modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
2	5	0	0	0	105	210	7	4,9

4.2.2 List of basic sciences modules

4.2.3 List of main-field of science modules

4.2.3.4 *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	ETD009286S	Diploma Seminar					2	K2eit_W01-K2eit_W13, S2ems_W01-S2ems_W24 K2eit_U01-K2eit_U17, S2ems_U01-S2ems_U27S 2ems_K01, S2ems_K03	30	60	2	1,4	T	Z		P	S	W
2	ETD009287D	MSc Thesis Work		12				S2ems_W21 S2ems_U24 S2ems_K01	180	600	20	14	T	Z		P	S	W
		Total	0	12	0	0	2		210	690	23	16,1						

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	12	0	0	2	210	690	23	16,1

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

Name of training		Training	
Number of ECTS points	**Number of ECTS points for BK classes1**	**Training crediting mode**	**Code**

Training duration	Training objective

4.3 Diploma dissertation module

Type of diploma dissertation	engineering	
Number of semesters of diploma dissertation	**Number of ECTS points**	**Code**
1	**20**	**ETD009390D**

Character of diploma dissertation

The Faculty students may, in the collection of topics of diploma dissertations, choose a diploma dissertation of different characters:
- analytical, (analysis, e.g. numerical, properties)
- technological (Technology of epitaxial growth)
- project (Project of a sensor)
- design (Laboratory stand for annealing by RTS method)
- application (Assessment of applicability)
- usage (Application of a heterostructure in construction)
- research (Testing, characterization)
- survey (Current state of knowledge concerning the growth mechanisms)

Number of BK1 ECTS points	14

5. Ways of verifying assumed educational effects

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

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

56,3 ECTS

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

Number of ECTS points for obligatory subjects	3,8
Number of ECTS points for optional subjects	0
Total number of ECTS points	3,8

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	31
Number of ECTS points for optional subjects	27
Total number of ECTS points	58

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)
   13 ECTS

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

1. RISC and CISC processors – comparison.
2. Temperature sensors – classification and parameters.
3. Smart sensors – integration levels.
4. Definition of optoelectronic sensor – schematic, basic elements of optical fiber measurement system.
5. Motion detection in alarm systems.
6. Material diagnostic by light transmission.
7. DNA chips – constructions, principle of operation, applications.
8. LTCC gas delivery systems (microvalves, micropumps and flow detectors) – constructions and principle of operation.
9. Electronic auditory perception – from on-the-ear hearing aid to brainstem implant.
10. Smart building – idea, applied systems.
11. Series interfaces in single microcontroller circuits.
12. Construction and principle of operation of SnO_2 thick-film gas detectors – parameters, advantages and disadvantages.
13. Characterization of peripheral devices in a microcontroller.
14. Interrupt mechanism in a microprocessor – operation and programming.
15. Measurement methods of high and ultra-high vacuum.
16. Pumping methods for high and ultra-high vacuum applications.
17. Harmonic oscillator model of the micromechanical beam.
18. Effects and phenomena occurring during the interaction of light with solid state matter.
19. Piezoresistive force and deflection detection in MEMS.
20. Processor core connection with memory and peripheral devices.
21. Access control systems – types and security.
22. PVD and CVD techniques – advantages and disadvantages.
23. Timer and counter circuits - modes of operation, programming and external connections.
24. List and describe the physical effects applied for amplitude modulation of light wave in optical fiber sensor systems.
25. Liquid and gas flow induction and control in micro-channels.
26. Biosensors – principle of operation.
27. Potentiometer sensors – principle of operation.
28. Piezoelectric tuning fork – principle of operation.

29. Design principles of membrane micromechanical pressure sensors manufactured in silicon.
30. Define what is the plasma gas discharge, describe its nature and present the classification.

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

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

13. Plan of studies (attachment no. 3)

Opinion of the Student Council of the Faculty

....

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

....

Date Dean's signature

Attachment no. 3 do Programme of Education

PLAN OF STUDIES

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

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

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

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

PROFILE: ***general academic***

SPECIALIZATION: ***Microsystems***

LANGUAGE OF STUDY: ***Polish***

Microsystem Electronics and Photonics Faculty Council resolution from **29.09.2015**

In effect from **1.10.2015**

Faculty: **Microsystem Electronics and Photonics** Faculty Council resolution from: **29.09.2015**
Field of study: **Electronics and Telecommunication** In effect from: **01.10.2015**
Specialization: **Microsystems**
Studies: **2nd level, full-time**

POINT AND HOUR LAYOUT OF THE PLAN OF STUDIES

	26 h	I	30 p	26 h	II	30 p	8 h	III	30 p
28									
27									
26	**1C** 01000 Sport			**2W** 10000 Philosophy of Science and Technology					
25	ETD8274 **2W** 20000			Foreign Language A1/A2 **2C**					
24	Autonomous Power Supplying Systems								
23	ETD8275 **1W** 10000**E** Vacuum and Plasma Techniques								
22	ETD8271 **1W + 2L** 10200**E**			ETD9282 **2W + 2P** 20010**E**					
21	Modelling of microsystems			Ceramic Microsystems					
20							**ETD9287**		
19	ETD8270 **1W + 2P** 10010			ETD9281 **1W + 2L** 10100			**20D**		
18	Programmable logic devices			Analytical Microsystems					
17	ETD8080 **1W** 10000 Sensors and actuators						**12 h**		
16	ETD8079 **1W + 2S** 10002			ETD9280 **3W + 3C** 32000					
15	Nanotechnology								
14				Diagnostic methods					
13	ETD8078 **2W** 20000						**MSc Diploma thesis**		
12	Solid state electronics								
11	ETD8077 **1W + 2C** 11000			ETD9290 **2W + 2L** 30200**E**					
10	Optimization Methods								
9	ETD8076 **1W + 2L** 10100			Sensors					
8	Numerical Methods						ETD9286 **3S** 00002		
7	ETD8075 **1W + 2C** 11000			ETD9291 **1W + 2L** 10100			Diploma seminar		
6	Statistics for EPM			Operating Systems			ETD9283 **2S** 00002		
5				ETD9292 **1W + 2P** 10020			Achievements in electronics and microsystems		
4	MAP1206 **2W + 2C** 22000**E**			Application of analogue and digital integrated circuits			ETD9293 **2W** 20000		
3	Mathematics						Polymer and Molecular Electronics		
2				ETD9077 **1W + 2P** 10010			**3W** 20000		
1	Foreign Language 2B+ **1C**			Diagnostics and Reliability			Management		
	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	MAP001206W	Mathematics	2					K2eit_W06	30	60	2	1,2	T	E	O		PD	Ob.
2	MAP001206C	Mathematics		2				K2eit_U06 K2eit_K02	30	60	2	1,4	T	Z	O	P	PD	Ob.
3	ETD008075W	Statistics for EPM	1					K2eit_W05	15	30	1	0,6	T	Z			K	Ob.
4	ETD008075C	Statistics for EPM		1				K2eit_U05 K2eit_K02	15	60	2	1,4	T	Z		P	K	Ob.
5	ETD008076W	Numerical Methods	1					K2eit_W04 K2eit_K07	15	30	1	0,6	T	Z			K	Ob.
6	ETD008076L	Numerical Methods			1			K2eit_U04 K2eit_K07	15	60	2	1,4	T	Z		P	K	Ob.
7	ETD008077W	Optimization Methods	1					K2eit_W03	15	30	1	0,6	T	Z			K	Ob.
8	ETD008077C	Optimization Methods		1				K2eit_U03 K2eit_K03	15	60	2	1,4	T	Z		P	K	Ob.
9	ETD008078W	Solid state electronics	2					K2eit_W02	30	60	2	1,2	T	Z			PD	Ob.
10	ETD008079W	Nanotechnology	1					K2eit_W01	15	30	1	0,6	T	Z			K	Ob.
11	ETD008079S	Nanotechnology					2	K2eit_U01 K2eit_K01	30	60	2	1,4	T	Z		P	K	Ob.
12	ETD008080W	Sensors and actuators	1					K2eit_W14	15	30	1	0,6	T	Z			K	Ob.
13	ETD008270W	Programmable logic devices	1					S2ems_W04	15	30	1	0,6	T	Z			S	Ob.
14	ETD008270P	Programmable logic devices				1		S2ems_U04	15	60	2	1,4	T	Z		P	S	Ob.
15	ETD008271W	Modelling of microsystems	1					S2ems_W02	15	30	1	0,6	T	E			S	Ob.
16	ETD008271L	Modelling of microsystems			2			S2ems_U02 S2ems_K03	30	60	2	1,4	T	Z		P	S	Ob.
17	ETD008274W	Autonomous Power Supplying Systems	2					K2eit_W11	30	60	2	1,2	T	Z			S	Ob.
18	ETD008275W	Vacuum and Plasma Techniques	1					S2ems_W01	15	30	1	0,6	T	E			S	Ob.
		Total	14	4	3	1	2		360	840	28	18,2						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	JZL000000BK	Foreign Language 2B+		1					15	30	1	0,7	T	Z	O	P	KO	W
2	WFW000000BK	Sport		1					15	30	1	1	T	Z	O	P	KO	W
		Total	0	2	0	0	0		30	60	2	1,7						

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				
14	6	5	0	2	405	900	30	19,9

Semester 2

Obligatory courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	FLH121521W	Philosophy of Science and Technology	1						15	60	2	1,2	T	Z	O		KO	Ob.
2	ETD009077W	Diagnostics and Reliability	1					K2eit_W07	15	30	1	0,6	T	Z			K	Ob.
3	ETD009077P	Diagnostics and Reliability				1		K2eit_U07 K2eit_K06	15	60	2	1,4	T	Z		P	K	Ob.
4	ETD009280W	Diagnostic methods	3					K2eit_W13 S2ems_W15	45	90	3	1,8	T	Z			S	Ob.
5	ETD009280C	Diagnostic methods		2				S2ems_U19 S2ems_K09	30	90	3	2,1	T	Z		P	S	Ob.
6	ETD009281W	Analytical Microsystems	1					S2ems_W14	15	30	1	0,6	T	Z			S	Ob.
7	ETD9009281L	Analytical Microsystems			1			S2ems_U15 S2ems_K01	15	60	2	1,4	T	Z		P	S	Ob.
8	ETD009282W	Ceramic Microsystems	2					S2ems_W13 S2ems_U13	30	60	2	1,2	T	E			S	Ob.
9	ETD009282P	Ceramic Microsystems				1		S2ems_U14 S2ems_K08	15	60	2	1,4	T	Z		P	S	Ob.
10	ETD009290W	Sensors	3					S2ems_W16	45	60	2	1,2	T	E			S	Ob.
11	ETD009290L	Sensors			2			S2 ems_U20 S2ems_K08	30	60	2	1,4	T	Z		P	S	Ob.
12	ETD009291W	Operating Systems	1					S2ems_W17	15	30	1	0,6	T	Z			S	Ob.
13	ETD009291L	Operating Systems			1			S2ems_U21 S2ems_K01	15	60	2	1,4	T	Z		P	S	Ob.
14	ETD009292W	Application of analogue and digital integrated circuits	1					S2ems_W03	15	30	1	0,6	T	Z			S	Ob.
15	ETD009292P	Application of analogue and digital integrated circuits				2		S2ems_U22 S2ems_K01	30	60	2	1,4	T	Z		P	S	Ob.
		Total	13	2	4	4	0		345	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.	JZL000000BK	Foreign Language A1/A2		3					45	60	2	1,4	T	Z	O	P	KO	W
		Total	0	3	0	0	0		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				
13	5	4	4	0	390	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	ETD009283S	Achievements in electronics and microsystems					2	K2eit_W01-K2eit_W13, S2ems_W12 K2eit_U01-K2eit_U17, S2ems_U01 S2ems_U26 S2ems_K11	30	60	2	1,4	T	Z		P	S	Ob.
2	ETD009293W	Polymer and Molecular Electronics	2					S2ems_W22	30	60	2	1,2	T	Z			S	Ob.
3	ETD009286S	Diploma seminar					2	K2eit_W01-K2eit_W13, S2ems_W01-S2ems_W24 K2eit_U01-K2eit_U17, S2ems_U01-S2ems_U27S 2ems_K01, S2ems_K03	30	90	3	2,1	T	Z		P	S	W
4	ETD009287D	MSc Diploma thesis		12				S2ems_W21 S2ems_U24 S2ems_K01	180	600	20	14	T	Z		P	S	W
		Total	2	12	0	0	4		270	810	27	18,7						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	MCM023001BK	Management	2						30	90	3	1,8	T	Z	O		KO	W
	MCM023002W	Enterprise Management																
	MCM023001W	Small Enterprise Management																
		Total	2						30	90	3	1,8						

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
4	12	0	0	4	300	900	30	20,5

2. Set of exams in semestral arrangement

Course code	Name of course credited by examination	Semester
MAP001206W ETD008271W ETD008275W	1. Mathematics 2. Modelling of microsystems 3. Vacuum and Plasma Techniques	1
ETD009392W ETD009386W	1. Ceramic Microsystems 2. Sensors	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

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: ***Optoelectronics and Optical Waveguide Technology***

LANGUAGE OF STUDY: ***Polish***

Content:

Microsystem Electronics and Photonics Faculty Council resolution of **29.09.2015**

In effect since ***01.10.2015***

FIELD OF STUDY EDUCATIONAL EFFECTS

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

Location of the field of study in the area of education

The field of study *Electronics and Telecommunication* (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 Technology at the specialization of EiT should posses 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
W – category of knowledge
U – category skills
K (after line/dash) – category of social competences
T2A – educational effects in the area of technical sciences for the second level study
01, 02, 03 and further– number of educational effects

Field-of-study educational effects at the 2-nd level study	DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS Upon completion of the second level study in the field of Electronics and Telecommunication, within specialization, the graduate:	Correlation with educational effects for 2-nd level study in area of technical sciences
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	T2A_W01
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)	T2A_W01
K2eit_W03	has basic knowledge concerning theory and methods of linear and nonlinear programming used in optimization procedures	T2A_W07
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	T2A_W04
K2eit_W05	knows and understands the elements of mathematical statistics in terms of possibilities of its application in engineering practice and scientific research	T2A_W07
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	T2A_W01
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	T2A_W06 T2A_W07
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	T2A_W03
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	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10

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	T2A_W11
K2eit_W11	has knowledge necessary to understand economic, legal, social and beyond technical factors of engineering activities and their using in engineering practice	T2A_W08
K2eit_W12	has basic knowledge concerning management, quality management and running a business	T2A_W09
K2eit_W13	achieves results in KNOWLEDGE category in one of the following specializations: ▪ Microsystems – EMS (attachmenet 1) ▪ Optoelectronics and Waveguide Technology – EOT (attachement 2) ▪ Electronics, Photonics, Microsystems – EPM (attachement 3)	
K2eit_W14	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	T2A_W07
SKILLS		
K2eit_U01	is able to assess and use devices/objects with nanometric dimensions (especially semiconductor devices and other ones, made using different technologies)	T2A_U10
K2eit_U02	is able to assess and use the phenomena occurring in solid state materials in quantum electronics applications	T2A_U10
K2eit_U03	using the methods of linear and nonlinear programming, is able to solve problems and tasks, optimizing the goal	T2A_U09
K2eit_U04	is able to use the learned numerical methods for solving typical engineering tasks	T2A_U09
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	T2A_U08
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	T2A_U09
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	T2A_U18
K2eit_U08	is able to explain the operating principle and basic characteristics and designs of deflection actuators using piezoelectric and electrostatic actuation	T2A_U10

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	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06
K2eit_U10	is able to use the acquired knowledge on modern production systems, processes of production management, market analysis, logistics and people management	T2A_U13 T2A_U14
K2eit_U11	is able to formulate and test the hypotheses connected with engineering problems and simple research work	T2A_U11
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	T2A_U12
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	T2A_U15
K2eit_U14	is able to suggest rationalization proposal/improvements to existing technical solutions	T2A_U16
K2eit_U15	is able to assess and use semiconductor devices and other devices fabricated using various techniques/technologies	T2A_U10
K2eit_U16	is able to define the fields of further education and follow the process of self learning	T2A_U05
K2eit_U17	achieves results in SKILLS category in one of the following specializations: ▪ Microsystems – EMS (attachment 1) ▪ Optoelectronics and Waveguide Technology – EOT (attachment 2) ▪ Electronics, Photonics, Microsystems – EPM (attachment 3)	
COMPETENCES		
K2eit_K01	shows curiosity about new innovative design solutions and production processes	T2A_K07
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	T2A_K06
K2eit_K03	perceives the necessity of undertaking and putting into practice optimization measures in various areas of life	T2A_K06
K2eit_K04	takes into account the need of using numerical methods in design process	T2A_K06
K2eit_K05	can think and act in a creative and entrepreneurial way	T2A_K06
K2eit_K06	properly recognizes, solves, and acting in a team, puts into practice the knowledge concerning analysis of mathematical problems	T2A_K01 T2A_K03
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	T2A_K06
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	T2A_K06

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	T2A_K06 T2A_K07
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	T2A_K02
K2eit_K11	is able to define priorities for realization of a particular task	T2A_K04
K2eit_K12	properly recognizes and settles dilemmas connected with professional activity	T2A_K05
K2eit_K13	achieves results in COMPETENCES category in one of the following specializations: ▪ Microsystems – EMS (attachment 1) ▪ Optoelectronics and Waveguide Technology – EOT (attachment 2) ▪ Electronics, Photonics, Microsystems – EPM (attachment 3)	
K2eit_K14	thinks that the conscious and systematic physical activity during studies and after graduation, helps in improvement of life quality	T2A_K01 T2A_K03
K2eit_K15	can working in a team, according to the specified rules and fair play rules, during participation in different forms of physical activity	T2A_K03

Where:
K1yyy – symbol for the field of study at the first level
K2yyy – symbol for the field of study at the second level
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE
_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES

T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

Attachement 1

EDUCATIONAL EFFECTS FOR EMS SPECIALIZATION

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

Specialization educational effects at the 2-nd level study	**DESCRIPTION OF EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of Electronics and Telecommunication, within the specialization, the graduate:**	**Correlation with educational effects for 2-nd level study in area of technical sciences**
	KNOWLEDGE	
S2ems_W01	has extended and deepened knowledge concerning technological processes applied in widely understood thin-film microelectronics, with the use of the knowledge on phenomena occurring in plasma processes carried out at reduced pressure	T2A_W03
S2ems_W02	has extended and deepened knowledge concerning theoretical and practical aspects of application of numerical methods for modeling and design in the field of microsystems	T2A_W01
S2ems_W03	has ordered basic knowledge concerning structure and operation of analog integrated circuits	T2A_W02
S2ems_W04	understands methodology of programming and implementation of *FPGA* systems	T2A_W07
S2ems_W05	has extended and deepened knowledge in the range of sciences (physics, chemistry, biology, informatics, material engineering) necessary to understand the essence of phenomena/ properties being the result of size reduction, which are used in nanotechnology	T2A_W01
S2ems_W06	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics and theoretical and experimental basis of specific phenomena in the field of electronics and photonics, necessary to understand phenomena (photoelectronic, electro-acoustic and superconductivity)	T2A_W01
S2ems_W07	has basic knowledge concerning theory and methods of linear and nonlinear programming used in optimization procedures	T2A_W07
S2ems_W08	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	T2A_W04

S2ems_W09	knows and understands the elements of mathematical statistics in terms of possibilities of its application in engineering practice and scientific research	T2A_W07
S2ems_W10	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	T2A_W01
S2ems_W11	has extended, deepened and ordered knowledge in the range 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)	T2A_W01
S2ems_W12	has theoretically grounded knowledge on current achievements in commercial and industrial electronics: microelectronics, high power and high temperature electronics, microsystems, including MEMS and MOEMS; has knowledge about the newest achievements in electronics application	T2A_W05
S2ems_W13	has ordered and theoretically grounded knowledge related to 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	T2A_W01
S2ems_W14	has theoretically grounded knowledge concerning physico-chemical, and technological basis, design, fabrication, operation and applications of analytical microsystems, microreactors, bio-chips and lab-on-chips	T2A_W01
S2ems_W15	has ordered knowledge concerning application of the methods of investigation and analysis of results for comprehensive diagnostics of the properties of materials for electronics and photonics	T2A_W03
S2ems_W16	has knowledge on the basis of sensor technology relevant to the studied discipline, including the knowledge necessary to understand physical and chemical mechanisms of sensor operation, taking into account the relations between their functional parameters and the structure; moreover has knowledge on classification and technologies of sensor fabrication	T2A_W01 T2A_W05
S2ems_W17	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 for microcontrollers	T2A_W02 T2A_W05
S2ems_W18	has ordered knowledge concerning structure, operation and designing of specific electronic circuits responsible for measurement and processing of sensor signals	T2A_W03
S2ems_W19	has knowledge concerning reliability theory, methods of testing of elements and devices and diagnostic methods; has knowledge on basic characteristics in the theory of reliability, typical distributions, reliability of systems, estimation of reliability parameters, experiment design, testing and diagnostics as well as failure models	T2A_W07
S2ems_W20	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 and piezoelectric sensors and structures of MEMS systems	T2A_W03

S2ems_W21	has ordered , theoretically grounded general and detailed knowledge in the field of exact and technical sciences relevant to the studied discipline; knows basic principles of editing of research projects and diploma thesis	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10
S2ems_W22	has ordered knowledge on basic technological processes, characteristic of polymer and molecular electronics and basic materials, passive elements and active devices of organic electronics	T2A_W01
S2ems_W23	has ordered, theoretically grounded general and detailed knowledge in the range of exact and technical sciences relevant to the field of study	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10
S2ems_W24	has knowledge on the basis of production management and management systems useful for the managers of a small or middle enterprises; knows modern production systems and production management systems as well as financial information, market analysis, logistics, people management, which are necessary in strategic enterprise management	T2A_W11
SKILLS		
S2ems_U01	is able to design a technological process of thin-film deposition, including the processes occurring in gas discharge	T2A_U09
S2ems_U02	is able - while formulating and solving the tasks associated with modeling and design of microsystems - to integrate knowledge coming from different sources	T2A_U10
S2ems_U03	is able to asses and compare, in terms of the parameters describing an integrated circuit, system solutions and perform analysis of operation of analog and digital integrated circuits in typical applications	T2A_U18
S2ems_U04	is able to program and implement *FPGA* systems	T2A_U07
S2ems_U05	is able to assess and use devices/objects with nanometric dimensions (especially semiconductor devices and other ones, made using different technologies)	T2A_U10
S2ems_U06	is able to assess and use the phenomena occurring in a solid state material in quantum electronics applications	T2A_U10
S2ems_U07	is able, using the methods of linear and nonlinear programming, to solve the tasks optimizing the goal	T2A_U09
S2ems_U08	is able to use the learned numerical methods for solving typical engineering tasks	T2A_U09
S2ems_U09	has basic practical skills concerning presentation, analysis and interpreting data as well as application of statistical methods in the analysis of various physical phenomena	T2A_U08
S2ems_U10	is able, properly and effectively to apply the knowledge on differential and integral equations, and stochastic processes relevant to the studied engineering discipline	T2A_U09
S2ems_U11	depending on requirements and available solutions, is able to choose and apply exploitation parameters suitable source for supplying a microsystem	T2A_U01

S2ems_U12	is able to assess the usefulness of application of novel solutions (circuits, systems of functional and industrial electronics) with innovative character	T2A_U10
S2ems_U13	is able to asses the usefulness and possibility of using physical and chemical sensors, and microsystems made in LTCC technology	T2A_U10
S2ems_U14	is able to design chosen sensors, actuators and ceramic microsystems; is able to develop prerequisites concerning the structure of selected devices and develop an algorithm of technological process for their fabrication	T2A_U10
S2ems_U15	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	T2A_U10
S2ems_U16	is able to use the acquired knowledge for carrying out the studies of the components of analytical microsystems (valves, metering units, mixers and detectors); knows the operation principles of advanced analytical microsystems (e.g. integrated gas chromatograph)	T2A_U08
S2ems_U17	is able to plan and safely carry out measurements and work out the measurement results	T2A_U08
S2ems_U18	is able to make distinctions between methods used in investigation of semiconductor surface structures applied in microsystem electronics and in structural characterization of modern materials for opto- and microelectronics	T2A_U18
S2ems_U19	is able to assess the usefulness and apply the learned methods, used in microelectronics for characterization of a solid material surface, structure, material composition and optical properties	T2A_U18
S2ems_U20	is able to design, make and carry out investigation of the produced and commercially available sensors, and to determine their functional parameters	T2A_U03 T2A_U05
S2ems_U21	has a skill of using low-level system functions and is able to program and configure embedded systems intended for microcontrollers	T2A_U19
S2ems_U22	is able to design electronic circuits responsible for the measurement and processing of sensor signals – and depending on complexity level – make, run and measure functional properties of designed, precise analog and digital (microcontroller) systems, including the automatic control systems	T2A_U18
S2ems_U23	is able to explain the principle of operation and basic characteristics of the deflection actuators functioning on piezoelectric and electrostatic actuation principle	T2A_U10
S2ems_U24	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 related to the studied discipline	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06

S2ems_U25	is able to assess and use the knowledge about passive elements and sub-systems (sensors based on the composites: powder filler-organic resin), active devices of organic electronics (emitters of optical radiation, displays, detectors of radiation, organic transistors, integrated circuits and mass memories) as well as chemical sensors based on organic semiconductors	T2A_U15
S2ems_U26	is able, using the literature information and basing on own work results, while integrating and interpreting and making critical evaluation, to prepare and give an oral presentation concerning the subjects relevant to the field of study	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06
S2ems_U27	is able to use the acquired knowledge about modern production systems and production management processes, market analysis, logistics and people management	T2A_U13 T2A_U14
COMPETENCES		
S2ems_K01	can work individually and in a team	T2A_K06
S2ems_K02	takes into account the necessity of using numerical methods in design process	T2A_K06
S2ems_K03	can think and act in creative and entrepreneurial way	T2A_K06
S2ems_K04	shows curiosity about new innovative design solutions and production processes	T2A_K07
S2ems_K05	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	T2A_K06
S2ems_K06	perceives the necessity of undertaking and putting into practice optimization measures in different areas of life	T2A_K06
S2ems_K07	properly, recognizes solves, and acting in a team, puts into practice the knowledge concerning analysis of mathematical problems	T2A_K01 T2A_K03
S2ems_K08	understands the need of permanent education; understands the operation principle of the used sensor devices; understands the necessity of sensor applications to improve people's safety, accelerate medical diagnostics and monitor the environment condition	T2A_K07
S2ems_K09	is able to set clear priorities for realization of a task defined by himself/herself or other person; can safely perform and work out results of measurements	T2A_K06
S2ems_K10	is conscious of importance of the issues connected with implementation and functioning in engineering activity, modern production systems, production management systems, logistics and people management	T2A_K06
S2ems_K11	understands the need of formulating and sharing in society, e.g. 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, taking into account various points of view	T2A_K06, T2A_K07

Where:
S1yyy – symbol for specialization at the first level study
S2emsyyy – symbol for specialization at the second level study
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE

_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES
T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

Attachement 2

EDUCATIONAL EFFECTS FOR EOT SPECIALIZATION

Faculty: Microsystem Electronics and Photonics
Field of study: Electronics and Telecommunication
Level of studies: second level full time study
Specialization: Optoelectronics and Waveguide Technology (EOT)

Specialization educational effects at the 2-nd level study	**DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS** **Upon completion of the second level study in the field of Electronics and Telecommunication, within the specialization, the graduate:**	**Correlation with educational effects for 2-nd level study in area of technical sciences**
	KNOWLEDGE	
S2eot_W01	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics necessary to understand the phenomena having an important impact on the properties of novel materials and operation of advanced photonic devices	T2A_W01
S2eot_W02	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary to understand the operation of optical telecommunication systems and optical recording and processing of information	T2A_W01 T2A_W03 T2A_W04
S2eot_W03	has extended and deepened knowledge in the field of physics, encompassing basis of quantum physics and solid state physics, necessary to understand physical phenomena having an important impact on the properties of novel materials and operation of advanced electronic devices	T2A_W01
S2eot_W04	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary to understand the operation of optical telecommunication systems and optical recording and processing of information	T2A_W01 T2A_W03 T2A_W04
S2eot_W05	has deepened and theoretically grounded knowledge concerning basic mechanisms of amplification and generation of electromagnetic radiation, lasers and applications of laser technique	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05
S2eot_W06	has deepened and ordered knowledge about the processes of fabrication of electronic elements, integrated circuits and microsystems as well as on the influence of process parameters on the design and functional parameters of produced objects; has basic knowledge from the field of nanotechnology	T2A_W03 T2A_W07

S2eot_W07	has deepened and ordered knowledge concerning applications and design of optical fiber measurement systems used in contemporary technology	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05 T2A_W07
S2eot_W08	has deepened and ordered knowledge on the basic optical phenomena in semiconductors, physical basis and structures of advanced optoelectronic devices and systems, and applications of optoelectronic systems	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05 T2A_W07
S2eot_W09	understands the design methodology of advanced analog, digital and mixed electronic circuits (also in integrated version) and electronic systems; knows the languages for equipment description and computer tools for design and simulation of circuits and systems	T2A_W03 T2A_W07
S2eot_W10	has deepened and theoretically grounded knowledge in the field of photonics, including the knowledge necessary for understanding the operation of optical telecommunication systems and optical recording and processing of information; has basic knowledge concerning algorithms used in the applications employed for modeling of optoelectronic devices and systems; knows and understands advanced numerical methods applied in designing of electronic and photonic devices and systems	T2A_W01 T2A_W03 T2A_W04 T2A_W07
S2eot_W11	has deepened and theoretically grounded knowledge in 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	T2A_W01 T2A_W02 T2A_W03 T2A_W04
S2eot_W12	has ordered and theoretically grounded knowledge in the field of photovoltaics, including the knowledge necessary to understand the physical basis of operation of photovoltaic elements and designs and to assess the quality of photovoltaic systems	T2A_W01
SKILLS		
S2eot_U01	is able to acquire information from literature, databases and other sources, is able to integrate acquired information, perform its interpretation, and critical assessment, draw conclusions, and formulate and profoundly justify opinions	T2A_U01
S2eot_U02	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	T2A_U02 T2A_U03
S2eot_U03	is able to develop detailed documentation of the results of experiment, design task or research project; is able to prepare a report containing discussion of the results	T2A_U04
S2eot_U04	is able to prepare and give a presentation on realization of a task or research project and conduct a discussion concerning the presentation	T2A_U04
S2eot_U05	can use English at the level sufficient for communication, also in professional issues, reads with understanding the professional literature and is able to prepare and give a short oral presentation on realization of a task or research project	T2A_U04

S2eot_U06	can use the learned methods and mathematical models (and should the need arise, modify them) for the analysis and design of electronic and photonic components, circuits and systems	T2A_U08 T2A_U15 T2A_U17
S2eot_U07	is able to assess and compare design solutions and fabrication methods of electronic devices and circuits in terms of presumed functional and economical criteria (power consumption, thermal budget, rate of operation, reliability, time consumption, costs etc.)	T2A_U14
S2eot_U08	is able to plan and carry out simulations and measurements of electrical and optical characteristics and extract the parameters characterizing materials, devices and analog and digital electronic circuits	T2A_U08
S2eot_U09	is able to plan a process of testing of a complex electronic circuit and electronic or photonic system	T2A_U09 T2A_U18
S2eot_U10	is able to design analog, digital and mixed electronic devices, electronic (photonic) circuits and electronic systems taking into account the functional and economical criteria, and should the need arise, adapt the existing or develop new design methods or tools for computer aided design (CAD)	T2A_U18
S2eot_U11	is able to design electronic circuits and systems intended for different applications, including monolithic and hybrid electronic and photonic circuits	T2A_U18
S2eot_U12	is able to apply communication devices in local and wide area teleinformatic networks, including optical fibers networks	T2A_U18
S2eot_U13	is able, with the use of suitable analytic, simulation and experimental tools, to formulate and test the hypotheses connected with modeling and design of electronic components, circuits and systems and design the process of their manufacturing	T2A_U09
S2eot_U14	in formulating and solving the tasks connected with modeling and design of electronic components, circuits and systems and designing their manufacturing process, is able to integrate the knowledge from the field of electronics, photonics, informatics, automatics, telecommunications and other disciplines, using a system approach with taking into account beyond technical aspects	T2A_U11
S2eot_U15	in formulating and solving the tasks connected with modeling and design of electronic elements, circuits and systems and designing their manufacturing process, is able to integrate the knowledge from different sources	T2A_U01 T2A_U18
S2eot_U16	is able to asses the cost of design and realization of an electronic or photonic circuit or system	T2A_U14
S2eot_U17	is able to propose improvements of existing design solutions and models of electronic devices, circuits and systems	T2A_U15 T2A_U16
S2eot_U18	is able to assess the usefulness and possibility of application of modern achievements in materials, elements, design and fabrication methods (including microelectronic technologies) for the design and fabrication of electronic circuits and systems, containing solutions of innovative character	T2A_U12 T2A_U17
S2eot_U19	is able to design a complex device, object, system or process and develop this project (even in part), relevant to the studied discipline, with the use of suitable methods and tools, both the existing ones and newly developed	T2A_U19

S2eot_U20	is able to choose and assess optical fiber and optoelectronic elements used in designing of photonic systems and optical fiber networks; knows the techniques of measurements of waveguides, waveguide couplers and possibilities of their application in waveguide systems	T2A_U02 T2A_U08 T2A_U15
COMPETENCES		
S2eot_K01	is able to think and act in creative and entrepreneurial way	T2A_K06
S2eot_K02	understands the need of permanent updating the lifetime learning process, is able to prepare educational aids and popular science presentations	T2A_K01 T2A_K07
S2eot_K03	is able to think in an ecology-friendly way, is conscious of the importance and understands the beyond technical aspects and results of engineering activity, including its impact on environment; is able to design systems using alternative energy sources	T2A_K02
S2eot_K04	is able to design and develop a plan of a project realization, is able to co-operate and work in a team, undertaking different tasks	T2A_K03 T2A_K04

Where:
S1yyy – symbol for specialization at the first level study
S2eotyyy – symbol for specialization at the second level study
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE
_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES

T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

Attachment 3

EDUCATIONAL EFFECTS FOR EPM SPECIALIZATION

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

Specialization educational effects at the 2-nd level study	**DESCRIPTION OF FIELD OF STUDY EDUCATIONAL EFFECTS** **Upon completion of the 2-nd level study in the field of Electronics and Telecommunication, within the specialization, the graduate:**	**Correlation with educational effects for 2-nd level study in area of technical sciences**
	KNOWLDGE	
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	T2A_W03
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	T2A_W01 T2A_W03 T2A_W04
S2epm_W03	has deepened and ordered knowledge concerning applications and design of optical fiber measurement systems used in contemporary technique	T2A_W01 T2A_W02 T2A_W03 T2A_W04 T2A_W05 T2A_W07
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)	T2A_W01
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	T2A_W01
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	T2A_W01
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	T2A_W01

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	T2A_W01
S2epm_W09	has knowledge concerning the principles of designing electronic devices with the use of optoelectronic and optical fiber subsystems, satisfying presumed input parameters	T2A_W02 T2A_W06 T2A_W07
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	T2A_W02 T2A_W05
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	T2A_W01 T2A_W02 T2A_W03 T2A_W04
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	T2A_W01 T2A_W02 T2A_W05
S2epm_W13	has ordered , theoretically grounded general and detailed knowledge in the field of exact and technical sciences relevant to the academic discipline of study; knows basic principles of editing of research projects and diploma thesis	T2A_W01 T2A_W04 T2A_W05 T2A_W07 T2A_W10
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	T2A_W02 T2A_W04 T2A_W06
S2epm_W15	has theoretically grounded knowledge concerning physico-mechanical, technological, design, fabrication, operation and application bases of microsystems of MEMS and MOEMS type	T2A_W01
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	T2A_W01
SKILLS		
S2epm_U01	is able to design a technological process of thin-film deposition, including the processes occurring in gas discharge	T2A_U09

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	T2A_U02 T2A_U08 T2A_U15
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	T2A_U09 T2A_U18
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 engineering discipline	T2A_U09
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	T2A_U01
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	T2A_U10
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	T2A_U10
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)	T2A_U08
S2epm_U09	is able to plan and safely carry out measurements and work out the measurement results	T2A_U08
S2epm_U10	is able - while formulating and solving tasks associated with modeling and design of microsystems - to integrate knowledge coming from different sources	T2A_U10
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	T2A_U03
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	T2A_U01 T2A_U02 T2A_U11 T2A_U16
S2epm_U13	has a skill of using low-level system functions as well as program and configure embedded systems intended for microcontrollers	T2A_U19

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	T2A_U02 T2A_U03 T2A_U04
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	T2A_U02 T2A_U07 T2A_U10 T2A_U12
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	T2A_U02
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	T2A_U02 T2A_U07, T2A_U08
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	T2A_U01 T2A_U02 T2A_U03 T2A_U04 T2A_U06
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	T2A_U17
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	T2A_U18
SOCIAL COMPETENCES		
S2epm_K01	is able to work individually and in a team	T2A_K06
S2epm_K02	is open to novel innovative design solutions and production processes	T2A_K07
S2epm_K03	is able to think and act in creative and entrepreneurial way	T2A_K06
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	T2A_K07
S2epm_K05	properly identifies, solves and puts into practice, co-operating in a team, the knowledge connected with the analysis of mathematical problems	T2A_K01 T2A_K03
S2epm_K06	takes into account the necessity to use numerical methods in the design process	T2A_K06
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	T2A_K06
S2epm_K08	is conscious of the importance and understands the necessity of putting into practice renewable energy sources	T2A_K02

S2epm_K09	is able to design and develop a plan of a project realization, can co-operate and work in a team, undertaking different tasks	T2A_K03 T2A_K04

Where:
S1yyy – symbol for specialization at the first level study
S2epmyyy – symbol for specialization at the second level study
_W01, _W02, … – symbols for educational effects concerning KNOWLEDGE
_U01, _U02, … – symbols for educational effects concerning SKILLS
_K01, _K02, … – symbols for educational effects concerning COMPETENCES

T – educational area in the field of technical sciences
1 – first level study,
2 – second level study
A – general academic profile, P – practical profile

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*** ***D – grade in diploma*** ***RK – interview*** *The faculty reserves the right to interview the candidates if the*	*Upon completion of studies graduate obtains* *professional degree of:* ***M. Sc. engineer*** *2-nd level qualifications*

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 specializations (EOT, EMS) 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:

Wroclaw University of 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 Wroclaw University of 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, Wroclaw University of 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 Wroclaw University of 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 Wroclaw University of 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	FLH121521W	Philosophy of Science and Technology	1						15	60	2	1,2	T	Z	O		KO	Ob.
		Total	1	0	0	0	0		15	60	2	1,2						

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				
1	0	0	0	0	15	60	2	1,2

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	MAP001206W	Mathematics	2					K2eit_W06	30	60	2	1,2	T	E	O		PD	Ob.
2	MAP001206C	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	ETD008078W	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	ETD008075W	Statistics for EFM	1					K2eit_W05	15	30	1	0,6	T	Z			K	Ob.
2	ETD008075C	Statistics for EFM		1				K2eit_U05 K2eit_K02	15	60	2	1,4	T	Z		P	K	Ob.
3	ETD008076W	Numerical Methods	1					K2eit_W04 InzA_W02 K2eit_K07 InzA_K01	15	30	1	0,6	T	Z			K	Ob.
4	ETD008076L	Numerical Methods			1			K2eit_U04 InzA_U01 K2eit_K07 InzA_K01	15	60	2	1,4	T	Z		P	K	Ob.
5	ETD008077W	Optimization Methods	1					K2eit_W03	15	30	1	0,6	T	Z			K	Ob.
6	ETD008077C	Optimization Methods		1				K2eit_U03 K2eit_K03	15	60	2	1,4	T	Z		P	K	Ob.
7	ETD008079W	Nanotechnology	1					K2eit_W01	15	30	1	0,6	T	Z			K	Ob.
8	ETD008079S	Nanotechnology					2	K2eit_U01 K2eit_K01	30	60	2	1,4	T	Z		P	K	Ob.
9	ETD008080W	Sensors and Actuators	1					K2eit_W14	15	30	1	0,6	T	Z			K	Ob.
10	ETD009077W	Diagnostics and Reliability	1					K2eit_W07	15	30	1	0,6	T	Z			K	Ob.
11	ETD009077P	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	ETD008366W	Optical Fibers	2					S2eot_W03	30	60	2	1,2	T	E			S	Ob.
2	ETD008366L	Optical Fibers			2			S2eot_U09 S2eot_K03	30	60	2	1,4	T	Z		P	S	Ob.
3	ETD008367W	Photovoltaics	2					S2eot_W12	30	60	2	1,2	T	E			S	Ob.
4	ETD008367L	Photovoltaics			2			S2eot_U03 S2eot_K01	30	60	2	1,4	T	Z		P	S	Ob.
5	ETD008369W	Optoelectronic elements and circuits I	1					S2eot_W01	15	30	1	0,6	T	Z			S	Ob.
6	ETD009387W	Computer Simulations in Photonics	1					S2eot_W10	15	30	1	0,6	T	Z			S	Ob.
7	ETD009387L	Computer Simulations in Photonics			1			S2eot_U06 S2eot_K01	15	60	2	1,4	T	Z		P	S	Ob.
8	ETD009393W	Design and Construction of Optoelectronic Circuits	1					S2eot_W07, S2eot_W11	15	30	1	0,6	T	Z			S	Ob.
9	ETD009393P	Design and Construction of Optoelectronic Circuits				1		S2eot_U11 S2eot_U19 S2eot_K04	15	60	2	1,4	T	Z		P	S	Ob.
10	ETD009381L	Optoelectronic Elements and circuits II			1			S2eot_U03 S2eot_K04	15	30	1	0,7	T	Z			S	Ob.
11	ETD009381P	Optoelectronic Elements and circuits II				2		S2eot_U03 S2eot_K04	30	60	2	1,4	T	Z		P	S	Ob.
12	ETD009392W	Fiber Optic Sensors	2					S2eot_W07	30	30	1	0,6	T	E			S	Ob.
13	ETD009392L	Fiber Optic Sensors			2			S2eot_U19 S2eot_K03	30	60	2	1,4	T	Z		P	S	Ob.
14	ETD009383W	MOEMS	1					S2eot_W06	15	30	1	0,6	T	Z			S	Ob.
15	ETD009383L	MOEMS			1			S2eot_U03 S2eot_K04	15	60	2	1,4	T	Z		P	S	Ob.
16	ETD009384W	Laser Techniques	1					S2eot_W05	15	30	1	0,6	T	Z			S	Ob.
17	ETD009384L	Laser Techniques			1			S2eot_U03	15	60	2	1,4	T	Z		P	S	Ob.
18	ETD009385W	Fiber Optics Telecommunication	1					S2eot_W11	15	30	1	0,6	T	Z			S	Ob.
19	ETD009385L	Fiber Optics Telecommunication			1			S2eot_U03 S2eot_U12	15	30	1	0,7	T	Z		P	S	Ob.
20	ETD009386W	Optoelectronic Metrology	1					S2eot_W07 S2eot_W08	15	30	1	0,6	T	E			S	Ob.
21	ETD009386L	Optoelectronic Metrology			1			S2eot_U09 S2eot_U15 S2eot_K04	15	60	2	1,4	T	Z		P	S	Ob.

22	ETD009391S	Achievements in electronics and photonics					2	K2eit_W01-K2eit_W13, S2eot_W01-S2eot_W11 K2eit_U01-K2eit_U17, S2eot_U18 S2eot_U01 S2eot_U04, S2eot_U05 S2eot_K01-S2eot_K04	30	60	2	1,4	T	Z		P	S	Ob.
23	ETD009394W	Optical-Fiber Networks	1					S2eot_W02	15	30	1	0,6	T	Z			S	Ob.
24	ETD009394P	Optical-Fiber Networks				1		S2eot_U20 S2eot_K04	15	30	1	0,7	T	Z		P	S	Ob.
		Total	14	0	12	4	2		480	1080	36	23,9						

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				
14	0	12	4	2	480	1080	36	23,9

4.2 List of optional modules

4.2.1 List of general education modules

4.2.1.1 *Liberal-managerial subjects* modules

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	MCM023001BK	Management	2						30	90	3	1,8	T	Z	O		KO	W
	MCM023002W	Enterprise Management																
	MCM023001W	Small Enterprise Management																
		Total	2	0	0	0	0		30	90	3	1,8						

4.2.1.2 *Foreign languages* module

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	JZL100400BK	Foreign language B2+		1					15	30	1	0,7	T	Z	O	P	KO	W
2	JZL100400BK	Foreign language A1/A2		3					45	60	2	1,4	T	Z	O	P	KO	W
		Total	0	4	0	0	0		60	90	3	2,1						

4.2.1.3 *Sporting classes* module

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

Altogether for general education modules:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
2	5	0	0	0	105	210	7	4,9

4.2.2 List of basic sciences modules

4.2.3 List of main-field of science modules

4.2.3.4 *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	ETD009389S	Diploma Seminar					2	K2eit_W01-K2eit_W13 S2eot_W01-S2eot_W11 K2eit_U01-K2eit_U17 S2eot_U01-S2eot_U19 S2eot_K01, S2eot_K04	30	60	2	1,4	T	Z		P	S	W
2	ETD009390D	MSc Thesis Work		12				K2eit_W01-K2eit_W13 S2eot_W01-S2eot_W11 K2eit_U01-K2eit_U17 S2eot_U01-S2eot_U19 K2eit_K01-K2eit_K12 S2eot_K01, S2eot_K04	180	600	20	14	T	Z		P	S	W
		Total	0	12	0	0	2		210	690	23	16,1						

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	12	0	0	2	210	690	23	16,1

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

Name of training		Training	
Number of ECTS points	**Number of ECTS points for BK classes1**	**Training crediting mode**	**Code**

Training duration	Training objective

4.3 Diploma dissertation module

Type of diploma dissertation	engineering	
Number of semesters of diploma dissertation	**Number of ECTS points**	**Code**
1	**20**	**ETD009390D**

Character of diploma dissertation

The Faculty students may, in the collection of topics of diploma dissertations, choose a diploma dissertation of different characters:
- analytical, (analysis, e.g. numerical, properties)
- technological (Technology of epitaxial growth)
- project (Project of a sensor)
- design (Laboratory stand for annealing by RTS method)
- application (Assessment of applicability)
- usage (Application of a heterostructure in construction)
- research (Testing, characterization)
- survey (Current state of knowledge concerning the growth mechanisms)

Number of BK1 ECTS points	14

5. Ways of verifying assumed educational effects

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

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

60,5 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	34
Number of ECTS points for optional subjects	27
Total number of ECTS points	61

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)
   13 ECTS

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

1. What is soliton, how it is created and what possibilities of application it introduces to optical fiber technique?
2. Filtration of frequencies – optical systems, examples, applications.
3. Light interference, conditions of stable interference.
4. Gas lasers – review.
5. Solid state lasers – review.
6. Photonic materials – classification, characterization and comparison.
7. Modulation of light in optical fiber systems – classification and comparison.
8. Describe the photovoltaic effect.
9. Classification of photovoltaic systems.
10. Describe optical networks other than telecommunication, TV and computer networks.
11. Optical MEMS switches – constructions, parameters, areas of application.
12. Definitions: transmission rate, modulation rate and bit error rate.
13. Channels and access points in ISDN network.
14. Model of a functional digital network with service integration.
15. Model of a telecommunication system.
16. Model of optical fiber FITL client loop.
17. Basic characteristic of plesiochronous PDH hierarchy.
18. Basic characteristic of synchronous SDH hierarchy.
19. Applications of lasers.
20. Laser resonators – parameters and principle of generation of laser radiation.
21. Characterize Ethernet networks with optical fibers.
22. Characterize the WDM technique applied in transmission via optical fiber. Describe the principles of transmission, possibilities and limits.
23. Measurement principles of parameters of telecommunication optical fibers. Describe phases of correctly conducted measurement.
24. Classification and description of non-linear optical effects occurring in optical fiber technique.
25. Spectral width of emission line. Broadening and saturation.
26. Wavelength spectrum of laser radiation. Coherence.
27. List the types of access networks.
28. List the parameters of the photovoltaic cells.
29. Manufacturing of optical layers and planar waveguides – classification and comparison.
30. Optical amplifiers – classification, constructions, parameters.

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

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

13. Plan of studies (attachment no. 3)

Opinion of the Student Council of the Faculty

....

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

....

Date Dean's signature

Attachment no. 3 do Programme of Education

PLAN OF STUDIES

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

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

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

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

PROFILE: ***general academic***

SPECIALIZATION: ***Optoelectronics and Optical Fiber Technique***

LANGUAGE OF STUDY: ***Polish***

Microsystem Electronics and Photonics Faculty Council resolution from **29.09.2015**

In effect from **1.10.2015**

Faculty: **Microsystem Electronics and Photonics** Faculty Council resolution from: **29.09.2015**
Field of study: **Electronics and Telecommunication** In effect from: **01.10.2015**
Specialization: **Optoelectronics and Optical Fiber Technique**
Studies: **2nd level, full-time**

POINT AND HOUR LAYOUT OF THE PLAN OF STUDIES

	27 h	**I**	**30 p**	**25 h**	**II**	**30 p**	**8 h**	**III**	**30 p**
28									
27	**1C** 01000 Sport								
26	ETD8369 **1W** 10000 Optoelectronic elements and circuits I								
25				**2W** 10000 Philosophy of Science and Technology					
24	ETD8367 **2W + 2L** 20200**E**								
23	Photovoltaics			Foreign Language A1/A2 **2C**					
22									
21				ETD9386 **1W + 2L** 10100**E**					
20	ETD8366 **2W + 2L** 20200**E**			Optoelectronic Metrology					
19				ETD9385 **1W + 1L** 10100			**ETD9390**		
18	Optical Fibers			Fiber Optics Telecommunication					
17	ETD8080 **1W** 10000 Sensors and actuators			ETD9384 **1W + 2L** 10100			**20D**		
16	ETD8079 **1W + 2S** 10002			Laser Techniques					
15	Nanotechnology			ETD9383 **1W + 2L** 10100			**12 h**		
14				MOEMS					
13	ETD8078 **2W** 20000								
12	Solid state electronics			ETD9392 **1W + 2L** 20200**E**			**MSc Diploma thesis**		
11	ETD8077 **1W + 2C** 11000			Fiber Optic Sensors					
10	Optimization Methods								
9	ETD8076 **1W + 2L** 10100			ETD9381 **1L + 2P** 00120					
8	Numerical Methods			Optoelectronic Elements and circuits II			ETD9389 **3S** 00002		
7	ETD8075 **1W + 2C** 11000						Diploma seminar		
6	Statistics for EPM			ETD9393 **1W + 2P** 10010			ETD9394 **1W + 1P** 10010		
5				Design and Construction of Optoelectronic Circuits			Optical-Fiber Networks		
4	MAP1206 **2W + 2C** 22000**E**			ETD9387 **1W + 2L** 10100			ETD9391 **2S** 00002		
3	Mathematics			Computer Simulations in Photonics			Achievements in electronics and photonics		
2				ETD9077 **1W + 2P** 10010			**3W** 20000		
1	Foreign Language 2B+ **1C**			Diagnostics and Reliability			Management		
	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	MAP001206W	Mathematics	2					K2eit_W06	30	60	2	1,2	T	E	O		PD	Ob.
2	MAP001206C	Mathematics		2				K2eit_U06 K2eit_K02	30	60	2	1,4	T	Z	O	P	PD	Ob.
3	ETD008075W	Statistics for EPM	1					K2eit_W05	15	30	1	0,6	T	Z			K	Ob.
4	ETD008075C	Statistics for EPM		1				K2eit_U05 K2eit_K02	15	60	2	1,4	T	Z		P	K	Ob.
5	ETD008076W	Numerical Methods	1					K2eit_W04 K2eit_K07	15	30	1	0,6	T	Z			K	Ob.
6	ETD008076L	Numerical Methods			1			K2eit_U04 K2eit_K07	15	60	2	1,4	T	Z		P	K	Ob.
7	ETD008077W	Optimization Methods	1					K2eit_W03	15	30	1	0,6	T	Z			K	Ob.
8	ETD008077C	Optimization Methods		1				K2eit_U03 K2eit_K03	15	60	2	1,4	T	Z		P	K	Ob.
9	ETD008078W	Solid state electronics	2					K2eit_W02	30	60	2	1,2	T	Z			PD	Ob.
10	ETD008079W	Nanotechnology	1					K2eit_W01	15	30	1	0,6	T	Z			K	Ob.
11	ETD008079S	Nanotechnology					2	K2eit_U01 K2eit_K01	30	60	2	1,4	T	Z		P	K	Ob.
12	ETD008080W	Sensors and actuators	1					K2eit_W14	15	30	1	0,6	T	Z			K	Ob.
13	ETD008366W	Optical Fibers	2					S2eot_W03	30	60	2	1,2	T	E			S	Ob.
14	ETD008366L	Optical Fibers			2			S2eot_U09 S2eot_K03	30	60	2	1,4	T	Z		P	S	Ob.
15	ETD008367W	Photovoltaics	2					S2eot_W12	30	60	2	1,2	T	E			S	Ob.
16	ETD008367L	Photovoltaics			2			S2eot_U03 S2eot_K01	30	60	2	1,4	T	Z		P	S	Ob.
17	ETD008369W	Optoelectronic elements and circuits I	1					S2eot_W01	15	30	1	0,6	T	Z			S	Ob.
		Total	14	4	5	0	2		375	840	28	18,2						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	JZL000000BK	Foreign Language 2B+		1					15	30	1	0,7	T	Z	O	P	KO	W
2	WFW000000BK	Sport		1					15	30	1	1	T	Z	O	P	KO	W
		Total	0	2	0	0	0		30	60	2	1,7						

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				
14	6	5	0	2	405	900	30	19,9

Semester 2

Obligatory courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1	FLH121521W	Philosophy of Science and Technology	1						15	60	2	1,2	T	Z	O		KO	Ob.
2	ETD009077W	Diagnostics and Reliability	1					K2eit_W07	15	30	1	0,6	T	Z			K	Ob.
3	ETD009077P	Diagnostics and Reliability				1		K2eit_U07 K2eit_K06	15	60	2	1,4	T	Z		P	K	Ob.
4	ETD009387W	Computer Simulations in Photonics	1					S2eot_W10	15	30	1	0,6	T	Z			S	Ob.
5	ETD009387L	Computer Simulations in Photonics			1			S2eot_U06 S2eot_K01	15	60	2	1,4	T	Z		P	S	Ob.
6	ETD009393W	Design and Construction of Optoelectronic Circuits	1					S2eot_W07, S2eot_W11	15	30	1	0,6	T	Z			S	Ob.
7	ETD009393P	Design and Construction of Optoelectronic Circuits				1		S2eot_U11 S2eot_U19 S2eot_K04	15	60	2	1,4	T	Z		P	S	Ob.
8	ETD009381L	Optoelectronic Elements and circuits II			1			S2eot_U03 S2eot_K04	15	30	1	0,7	T	Z			S	Ob.
9	ETD009381P	Optoelectronic Elements and circuits II				2		S2eot_U03 S2eot_K04	30	60	2	1,4	T	Z		P	S	Ob.
10	ETD009392W	Fiber Optic Sensors	2					S2eot_W07	30	30	1	0,6	T	E			S	Ob.
11	ETD009392L	Fiber Optic Sensors			2			S2eot_U19 S2eot_K03	30	60	2	1,4	T	Z		P	S	Ob.
12	ETD009383W	MOEMS	1					S2eot_W06	15	30	1	0,6	T	Z			S	Ob.
13	ETD009383L	MOEMS			1			S2eot_U03 S2eot_K04	15	60	2	1,4	T	Z		P	S	Ob.
14	ETD009384W	Laser Techniques	1					S2eot_W05	15	30	1	0,6	T	Z			S	Ob.
15	ETD009384L	Laser Techniques			1			S2eot_U03	15	60	2	1,4	T	Z		P	S	Ob.
16	ETD009385W	Fiber Optics Telecommunication	1					S2eot_W11	15	30	1	0,6	T	Z			S	Ob.
17	ETD009385L	Fiber Optics Telecommunication			1			S2eot_U03 S2eot_U12	15	30	1	0,7	T	Z		P	S	Ob.
18	ETD009386W	Optoelectronic Metrology	1					S2eot_W07 S2eot_W08	15	30	1	0,6	T	E			S	Ob.
19	ETD009386L	Optoelectronic Metrology			1			S2eot_U09 S2eot_U15 S2eot_K04	15	60	2	1,4	T	Z		P	S	Ob.
		Total	10	0	8	4	0		330	840	28	18,6						

Optional courses

No.	Course/group of courses code	Name of course/group of courses (denote the group of courses with **GK** symbol)	Weekly number of hours					Field of study educational effect symbol	Number of hours		Number of ECTS		Form[2] of course/ group of courses	Way[3] of crediting	Course/group of courses			
			lec	c	lab	p	s		ZZU	CNPS	total	BK[1] classes			university-wide[4]	practical[5]	kind[6]	type[7]
1.	JZL000000BK	Foreign Language A1/A2		3					45	60	2	1,4	T	Z	O	P	KO	W
		Total	0	3	0	0	0		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				
10	3	8	4	0	375	900	30	20

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	ETD009391S	Achievements in electronics and photonics					2	K2eit_W01-K2eit_W13, S2eot_W01-S2eot_W11 K2eit_U01-K2eit_U17, S2eot_U18 S2eot_U01 S2eot_U04, S2eot_U05 S2eot_K01-S2eot_K04	30	60	2	1,4	T	Z		P	S	Ob.
2	ETD009394W	Optical-Fiber Networks	1					S2eot_W02	15	30	1	0,6	T	Z			S	Ob.
3	ETD009394P	Optical-Fiber Networks				1		S2eot_U20 S2eot_K04	15	30	1	0,7	T	Z		P	S	Ob.
4	ETD009389S	Diploma seminar					2	K2eit_W01-K2eit_W13 S2eot_W01-S2eot_W11 K2eit_U01-K2eit_U17 S2eot_U01-S2eot_U19 S2eot_K01, S2eot_K04	30	90	3	2,1	T	Z		P	S	W
5	ETD009390D	MSc Diploma thesis		12				K2eit_W01-K2eit_W13 S2eot_W01-S2eot_W11 K2eit_U01-K2eit_U17 S2eot_U01-S2eot_U19 K2eit_K01-K2eit_K12 S2eot_K01, S2eot_K04	180	600	20	14	T	Z		P	S	W
		Total	1	12	0	1	4		270	810	27	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	MCM023001BK	Management	2						30	90	3	1,8	T	Z	O		KO	W
	MCM023002W	Enterprise Management																
	MCM023001W	Small Enterprise Management																
		Total	2						30	90	3	1,8						

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Number of ECTS points for BK[1] classes
lec	c	lab	p	s				
3	12	0	1	4	300	900	30	20,6

2. Set of exams in semestral arrangement

Course code	Name of course credited by examination	Semester
MAP001206W ETD008366W ETD008367W	1. Mathematics 2. Optical fibers 3. Photovoltaics	1
ETD009392W ETD009386W	1. Fiber Optic Sensors 2. Optoelectronic Metrology	2

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

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

Opinion of the Student Council of the Faculty

....

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

....

Date Dean's signature

Faculty:	**Microsystem Electronics and Photonics**	**Faculty Council resolution from:**	**29.09.2015**
Field of study:	**Electronics and Telecommunication**	**In effect from:**	**01.10.2015**
Studies:	**2nd level, full-time**		

COURSE CATALOG

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

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Metody statystyczne w EMF**	
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:	**ETD008075**	
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

Jaroslaw.Domaradzki@pwr.edu.pl

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:	**Metody numeryczne**	
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:	**ETD008076**	
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

Arutr.Wymyslowski@pwr.edu.pl

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

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Metody optymalizacji**	
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:	**ETD008077**	
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

Karol.Malecha@pwr.edu.pl, Damian.Nowak@pwr.edu.pl

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

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Elektronika ciała stałego**	
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:	**ETD008078**	
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

Danuta.Kaczmarek@pwr.edu.pl

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:	**Nanotechnologia**	
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:	**ETD008079**	
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

Damian.Pucicki@pwr.edu.pl

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

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Czujniki i aktuatory**	
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:	**ETD008080**	
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
Rafal.Walczak@pwr.edu.pl

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

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Programowalne układy logiczne**	
Name in English:	**Programmable logic devices**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008270**	
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. Fundamentals of digital technology

SUBJECT OBJECTIVES

C01 Enlargement the knowledge about FPGA programming techniques
C02 Mastering the Verilog language
C03 Participation of the students in the carried out research on programmable logic devices

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 He has knowledge of programming and commissioning of FPGA digital circuits

Relating to skills

PEK_U01 Ability of programming FPGA circuit, coding in Verilog language

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Introduction to VLSI circuits	2
Le_02	Verilog language basics	2
Le_03	Combinational circuits, blocking and non-blocking assignments	2
Le_04	Sequential circuits - always instruction	2
Le_05	SERDES circuits	2
Le_06	Coding state machines	2
Le_07	Speed, power, resources	2
Le_08	Final test	1
	TOTAL	15

Form of classes - Project		Quantity
Pr_01	Xilinx ISE tools	2
Pr_02	Sequential circuits simulation	2
Pr_03	Techniques for automatic verification	2
Pr_04	Individual project - concepts of the architecture	2
Pr_05	Individual project - coding	2
Pr_06	Individual project - verification	2
Pr_07	Individual project - physical implementation	2
Pr_08	Individual project - examination	1
	Total	15

TEACHING TOOLS USED
ND_01 Lecture with discussion ND_02 Computer laboratory ND_03 Individual work - literature and preparation for test ND_04 Individual work - project

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	Rating for individual project

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. T. Łuba, B. Zbierzchowski, Komputerowe projektowanie układów cyfrowych, WKŁ, 2000
2. Z. Hajduk, Wprowadzenie do języka Verilog, Wydawnictwo BTC, 2009
3. P. Minns, E. Ian, FSM-based digital design using Verilog HDL, John Wiley & Sons, 2008
4. P.P. Chu, FPGA prototyping by Verilog examples: Xilinx Spartan-3 version. John Wiley & Sons, 2011
5. D. Donald, P. Moorby, The Verilog® Hardware Description Language, Vol. 2. Springer Science & Business Media, 2002

Secondary literature

1. Standard nr 1364-2001 (Verilog), IEEE, 2001
2. Xilinx Design Suite – technical documentation, Xilinx, 2012

SUBJECT SUPERVISOR

Daniel.Kopiec@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Programmable logic devices

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)	S2ems_W04	C01	Le_01-Le_07	ND_01, ND_03
PEK_U01 (skills)	S2ems_U04	C02, C03	Pr_01-Pr_08	ND_02, ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Modelowanie mikrosystemów**	
Name in English:	**Modelling of microsystems**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008271**	
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

Arutr.Wymyslowski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Modelling of 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)	S2ems_W02	C01, C03	Le_01-Le_07	ND_01, ND_03, ND_04, ND_06
PEK_U01 (skills)	S2ems_U02	C02, C04, C05	La_01-La_13	ND_02, ND_05
PEK_K01 (competences)	S2ems_K03	C04	La_14, La_15	ND_07

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Autonomiczne systemy zasilające**	
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:	**ETD008274**	
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

Rafal.Walczak@pwr.edu.pl

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:	**Techniki Próżniowe i Plazmowe**	
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:	**ETD008275**	
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	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	Basic definitions. Elements of the kinetic theory of gases	1
Le_02	Gas flow, gas pumping speed	2
Le_03	Pressure measurement, ranges and measurement methods	1
Le_04	Mechanical and viscosity gauges	2
Le_05	Thermal conductivity and ion gauges	2
Le_06	Pre-vacuum pumps (rotary, diaphragm ....)	2
Le_07	High-vacuum flow pumps (the lab presentation of the standard vacuum process)	3
Le_08	The role of the conditions of pressure (vacuum) in the thin films deposition processes. Scheme of the vacuum process	2
	TOTAL	15

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, final test

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

Witold.Posadowski@pwr.edu.pl

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)	S2ems_W01	C01-C03	Le_01-Le_08	ND_01-ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Światłowody**	
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:	**ETD008366**	
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

Sergiusz.Patela@pwr.edu.pl

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)	S2eot_W03	C01-C05, C07	Le_01-Le_15	ND_01, ND_02, ND_04, ND_06, ND_07
PEK_U01 (skills)	S2eot_U09	C06, C07	La_01-La_08	ND_03, ND_05
PEK_K01 (competences)	S2eot_K03	C06, C07	La_01-La_08	ND_03, ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Fotowoltaika**	
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:	**ETD008367**	
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

Tadeusz.Zdanowicz@pwr.edu.pl

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)	S2eot_W12	C01, C02	Le_01-Le_13	ND_01, ND_02, ND_05, ND_07
PEK_U01 (skills)	S2eot_U03	C03-C05	La_01-La_07	ND_03, ND_04
PEK_K01 (competences)	S2eot_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:	**Elementy i układy optoelektroniczne I**	
Name in English:	**Optoelectronic elements and circuits I**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD008369**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. 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 Skill achievement to conduct researches related to technical sciences, in terms of disciplines such as electronics, materials engineering, telecommunications

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

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 - LED	1
Le_05	Fundamentals of laser light generation - DBR, DFB and QCL lasers	1
Le_06	Advanced semiconductor photodetectors: MSM, QWIP, MQW	1
Le_07	Solar cells	1
Le_08	Organic optoelectronics: fundamentals, base of operation, devices	2
Le_09	Infrared optoelectronics	1
Le_10	Optoelectronic systems in mechatronics	1
Le_11	Optoelectronic systems in automotive industry	1
Le_12	Optoelectronic logic circuits	1
Le_13	Final test	1
	TOTAL	15

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

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

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

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

Beata.Sciana@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Optoelectronic elements and circuits I

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)	S2eot_W01	C01-C03	Le_01-Le_13	ND_01-ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Diagnostyka i niezawodność**	
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:	**ETD009077**	
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

Karol.Malecha@pwr.edu.pl, Damian.Nowak@pwr.edu.pl

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

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Metody diagnostyczne**	
Name in English:	**Diagnostic methods**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009280**	
Group of courses:	**NO**	

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45	30			
Number of hours of total student workload (CNPS)	90	90			
Form of crediting	Z	Z			
Number of ECTS points	3	3			
Including number of ECTS points for practical (P) classes	0	3			
Including number of ECTS points for direct teacher-student contact (BK) classes	1.8	2.1			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of fundamentals in physics and solid body electronics
2. Completion of the Metrology course

SUBJECT OBJECTIVES

C01 Acquisition of theoretically founded knowledge in physical bases of specialist material diagnostic methods, e.g.: electron microscopy, X-Ray diffraction, optical and electronic methods

C02 Acquisition of knowledge in qualitative and quantitative analysis of structural, optical and electrical properties of solid bodies

C03 Recognition of advanced methods of measurement and analysis of material properties

C04 Acquiring the skills in organization of tests and diagnostics of materials by means of properly selected methods

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has the knowledge of optical methods of material testing
PEK_W02 Has the knowledge methods of materials surface testing
PEK_W03 Has the knowledge the structural properties of materials

Relating to skills

PEK_U01 Can independently determine parameters of selected materials and interpret the phenomena occurring
PEK_U01 Is able to analyse the measured data

Relating to social competences

PEK_K01 Can think and act in a creative way, depending on the task

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Classification of optical diagnostics methods	2
Le_02	Fast optical methods	2
Le_03	Spectroscopy of photoelectrons and its application	2
Le_04	Method of photoluminescence and its application	2
Le_05	Method of photoconductance and its application	2
Le_06	Comparison of the EBIC-OBIC and CL-PL methods	2
Le_07	Method of transmission and its application	2
Le_08	Surface of solid body, surface topography, atomic structure, plane defects	2
Le_09	Methods of obtaining the atomic clean surface	2
Le_10	Classification of solid body surface testing methods	2
Le_11	Methods of testing and determining the atomic structure of surface (LEED, RHEED)	2
Le_12	Qualitative-quantitative analysis of surface with the AES and SIMS methods	2
Le_13	Application of electron microscopy in diagnostics of semiconducting structures	2
Le_14	Electron structure and electron properties of semiconductor surfaces	2
Le_15	Credit colloquium (final test)	2
Le_16	Solid body structure, model of a crystal	2
Le_17	Reverse lattice of crystal and its practical significance	2
Le_18	Measurement principle and interpretation of reflection curves for epitaxial layers	2
Le_19	Measurement principle and interpretation of the reverse lattice nodes in epitaxial layers	2
Le_20	Measurement methodology for epitaxial layers of significant lattice misfit in relation to substrate	2
Le_21	Application of reflectometry to characterizing of epitaxial layers	2
Le_22	Description of polycrystalline sensor layer structure	2
Le_23	Credit colloquium	1
	TOTAL	45

Form of classes - Classes		Quantity
Cl_01	Introduction – overview of material properties and diagnostic methods	2
Cl_02	Analysis of material composition using the BSE signal in the COMPO mode in SEM	2
Cl_03	Analysis of artefacts appearing in SEM in the COMPO mode	2
Cl_04	Analysis of artefacts appearing in SEM in the TOPO mode	2
Cl_05	Analysis of material composition influence on crystalline microstructure formation	2
Cl_06	Analysis of heating temperature influence on material structure formation	2
Cl_07	Analysis of oxides using photoelectron spectroscopy	2
Cl_08	Determination of photoelectric properties of junction at the base of photoconductance method	2
Cl_09	Application of the envelope method for interpretation of the results obtained from light interference in thin films	2
Cl_10	Analysis of optical properties of materials at the base of light transmission measurement	2
Cl_11	Tests of deep levels in the AIIIBV structures using the DLTS method	2
Cl_12	Research of point and extended defects AIIIBV structures using SEM	2
Cl_13	Phase identification of polycrystalline sensor layers	2
Cl_14	Characterization of epitaxial layers and quantum wells at the base of reflection curves	2
Cl_15	Colloquium	2
	Total	30

TEACHING TOOLS USED
ND_01 Traditional lecture with presentations and discussion
ND_02 Own work of a student
ND_03 Consultations
ND_04 Short knowledge tests before the exercises
ND_05 Solving the problem and computational tasks

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01-PEK_W03	Writing test
P2 = F2 (classes)	PEK_U01, PEK_U02	Positive mark from short test and ability to solving problems during classes

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Szaynok A., Kuźmiński S., Podstawy fizyki powierzchni półprzewodników, WNT, Warszawa, 2000
2. Szuber J., Metody powierzchniowe w nanotechnologii półprzewodników, WNT Warszawa 2002
3. Bojarski Z., Cigła M., Stróż K., Surowiec M., Krystalografia – podręcznik wspomagany komputerowo, PWN, Warszawa, 1999
4. Misiewicz J., Podstawy optyki ciała stałego, Oficyna Wydawnicza Politech. Wrocł., 1996
5. Schröder D., Semiconductor material and device characterization, J. Wiley & Sons, INC., USA, 1998
6. Kozłowski J., Własności strukturalne związków (Ga,Al,In)N przeznaczonych do konstrukcji przyrządów elektroniki wysokotemperaturowej, Raport nr 19, Wrocław, 2001.

Secondary literature

1. Oleś A., Metody doświadczalne w fizyce ciała stałego, WNT Warszawa, 1998
2. Hummel R., Właściwości elektroniczne materiałów, Springer-Verlag, New York, 1985
3. PC-Materials Research Diffractometer, User Guide, Philips Analytical X-Ray, 1999

SUBJECT SUPERVISOR

Danuta.Kaczmarek@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Diagnostic 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_W13, S2ems_W15	C01, C02	Le_01-Le_07	ND_01-ND_03
PEK_W02	S2ems_W15	C01, C02	Le_08-Le_15	ND_01-ND_03
PEK_W03	S2ems_W15	C01, C02	Le_16-Le_23	ND_01-ND_03
PEK_U01 (skills)	S2ems_U19	C03, C04	Cl_01-Cl_15	ND_04-ND_05
PEK_U02	S2ems_U19	C03, C04	Cl_01-Cl_15	ND_04-ND_05
PEK_K01 (competences)	S2ems_K09	C03, C04	Cl_01-Cl_15	ND_04-ND_05

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Mikrosystemy analityczne**	
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:	**ETD009281**	
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

Anna.Gorecka-Drzazga @pwr.edu.pl

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)	S2ems_W14	C01	Le_01-Le_08	ND_01, ND_02
PEK_U01 (skills)	S2ems_U15	C02, C03	La_01-La_05	ND_03, ND_04
PEK_K01 (competences)	S2ems_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:	**Mikrosystemy ceramiczne**	
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:	**ETD009282**	
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

Leszek.Golonka@pwr.edu.pl

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)	S2ems_W13	C01-C03	Le_01-Le_15	ND_01-ND_04
PEK_U01 (skills)	S2ems_U13	C01-C03, C05	Le_01-Le_15	ND_01-ND_04
PEK_U02	S2ems_U14	C03-C05	Pr_01-Pr_08	ND_02-ND_05
PEK_K01 (competences)	S2ems_K08	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:	**Postępy elektroniki i mikrosystemów**	
Name in English:	**Achievements in electronics and microsystems**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009283**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of electronics and microsystems
2. The ability to search for information
3. The ability to create multimedia presentations

SUBJECT OBJECTIVES

C01 Capture and consolidate knowledge of the achievements of modern consumer and industrial electronics: microelectronics, hig-power electronics and high-temperature electronics, microsystems
C02 The student should after the course have knowledge about the latest electronics applications
C03 To acquire and consolidate skills by students search for information on a given topic
C04 To acquire and consolidate skills make presentations, preparation for public speaking skills and formulation of studies in writing
C05 The ability to take an active part in the discussion in a public forum

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 A student has ordered and supported in theory knowledge on current developments in consumer and industrial electronics: microelectronics, high-power electronics and high-temperature electronics, microsystems including: MEMS and MOEMS. has knowledge of the latest electronics applications

Relating to skills

PEK_U01 The student is able to evaluate the usefulness and the possibility of the use of new solutions (systems, consumer electronics and industrial systems) with an innovative
PEK_U02 The student can obtain information from literature, databases, and other sources
PEK_U03 The student can prepare a multimedia presentation

Relating to competences

PEK_K01 The student understands the need to formulate and communicate to the public, inter alia, through the mass media, information, and opinions on the achievements of the direction his study and other aspects for electronics engineer, in a widely understandable taking into account the various points of view

PROGRAMME CONTENT

Form of classes - Seminar		Quantity
Se_01	Introduction to the course, assign issues to develop	2
Se_02	Rules for correct writing technical texts and for the preparation of multimedia presentations	2
Se_03	Student presentations of issues mandatory	2
Se_04	Student presentations of issues mandatory	2
Se_05	Student presentations of issues mandatory	2
Se_06	Student presentations of issues mandatory	2
Se_07	Student presentations of issues mandatory	2
Se_08	Student presentations of issues mandatory	2
Se_09	Student presentations of issues mandatory	2
Se_10	Student presentations of their own topics	2
Se_11	Student presentations of their own topics	2
Se_12	Student presentations of their own topics	2
Se_13	Student presentations of their own topics	2
Se_14	Student presentations of their own topics	2
Se_15	Student presentations of their own topics	2
	TOTAL	30

TEACHING TOOLS USED

ND_01 Presentation of selected issues and discussion
ND_02 Own work-independent studies and searching materials
ND_03 Own work-preparation of multimedia presentation given issues
ND_04 Own work-preparation of elaborate written issues presented
ND_05 Consultation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01, PEK_U01, PEK_U02	Assessment of the substantive content of the multimedia presentation and text design
F2	PEK_U03	Evaluation of multimedia presentation and development of the technical text
F3	PEK_W01	Part in the discussion
P1 (seminar) = 0,5*F1 + 0,25*F2 + 0,25*F3		

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Actual literautre, datasheets, Internet, scientific journals

SUBJECT SUPERVISOR

Ryszard.Korbutowicz@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Achievements in electronics and 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)	K2eit_W01-K2eit_W13, S2ems_W12	C01, C02	Se_03-Se_15	ND_02-ND_05
PEK_U01 (skills)	K2eit_U01-K2eit_U17, S2ems_U01	C01-C04	Se_03-Se_15	ND_02-ND_05
PEK_U02	S2ems_U26	C03	Se_03-Se_15	ND_02-ND_05
PEK_U03	S2ems_U26	C04	Se_01-Se_15	ND_01-ND_05
PEK_K01 (competences)	S2ems_K11	C05	Se_03-Se_15	ND_01-ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Seminarium dyplomowe**	
Name in English:	**Diploma Seminar**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009286**	
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 Electonics and Telecommunication field of study 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 Electonics and Telecommunication field of study 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 informations, regular requirements obligatory in Politechnika Wrocławska, 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	Multimedial presentation of CV done by every seminar participant	4
Se_05	Discussion of the exam questions	8
Se_06	Thesis - multimedial 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 multimedial 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 Technology 2. Notes from lectures 3. Scientific publications from the field of the realised diploma thesis

SUBJECT SUPERVISOR
Zbigniew.W.Kowalski@pwr.edu.pl pl

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_W13, S2ems_W01-S2ems_W24	C01	Se_02-Se_07	ND_01, ND_02, ND_04
PEK_U01 (skills)	K2eit_U01-K2eit_U17, S2ems_U01-S2ems_U27	C01, C02	Se_02-Se_07	ND_01, ND_02, ND_04
PEK_K01 (competences)	S2ems_K01, S2ems_K03	C02	Se_02-Se_07	ND_01-ND_03

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Praca dyplomowa magisterska**
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:	**ETD009287**
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 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 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 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

Zbigniew.W.Kowalski@pwr.edu.pl

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)	S2ems_W21	C01, C04	Pr_01	ND_01, ND_02, ND_04
PEK_U01 (skills)	S2ems_U24	C02, C04	Pr_02, Pr_03	ND_01, ND_02, ND_04
PEK_K01 (competences)	S2ems_K01	C03	Pr_01- Pr_03	ND_01-ND_03

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Systemy operacyjne**	
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:	**ETD009289**	
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

Krzysztof.Urbanski@pwr.edu.pl

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)	S2ems_W17	C01	Le_01-Le_07	ND_01-ND_03, ND_05
PEK_U01 (skills)	S2ems_U21	C02	La_01-La_07	ND_02, ND_04, ND_06
PEK_K01 (competences)	S2ems_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:	**Sensory**	
Name in English:	**Sensors**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009290**	
Group of courses:	**NO**	

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45		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 geometrical and wave optics
2. Basic knowledge of chemistry
3. Basic knowledge of physics
4. Completed: Fiber optics I and Fiber optics II
5. Completed: Materials Science

SUBJECT OBJECTIVES

C01 To gain knowledge of the fiber optic sensor systems use in the measurement of selected physical and chemical parameters
C02 To gain knowledge of the construction of chemical, biochemical sensors and electrochemical noses
C03 To gain knowledge of operating rules, construction and technology of microelectronic physical sensors
C04 To gain skills of analysis of construction and characteristics of microelectronic sensors
C05 Participation in the research of sensor developed at the Faculty

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Has knowledge about technology, construction and operation of microelectronics, optical, chemical sensors

Relating to skills

PEK_U01 Is able to design, analyze the characteristics and specify the parameters of the physical sensors

Relating to social competences

PEK_K01 Student understands the need of sensors application to improve the safety and speed of diagnosis in various technical fields

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Characteristics of fiber optical measuring systems - the criteria for classification	2
Le_02	Fiber sensors with light wave amplitude modulation	2
Le_03	Optical fiber interferometers	2
Le_04	Fiber-optic sensors with polarization state modulation	2
Le_05	Fiber-optic sensors with wavelength modulation	2
Le_06	Fiber Bragg gratings and their application in sensor systems (temperature and stress measurement)	2
Le_07	The applications of fiber optic sensors in medicine	1
Le_08	Fiber-optic sensor systems in the chemical industry and the energy industry	2
Le_09	Physicochemical properties of water and detection methods of water vapor	2
Le_10	Chemical gas sensors - materials and constructions	2
Le_11	Physicochemical processes occurring in chemical gas sensors	2
Le_12	Electrolytes and reference electrodes	2
Le_13	Electrochemical sensors	3
Le_14	Biosensors	2
Le_15	Electronic nose	2
Le_16	Resistive temperature sensors	2
Le_17	Metallic and semiconductor thermocouples	2
Le_18	Converters for rms (root mean square) value measurements	1
Le_19	Infrared radiation detectors	2
Le_20	Flow sensors	2
Le_21	Thermal pressure sensors	2
Le_22	Thin- film strain sensors	2
Le_23	Thermal conductive sensors	2
	TOTAL	45

Form of classes - Laboratory		Quantity
La_01	Reflective longitudinal displacement sensor (single-fiber and multi-fiber measuring head)	3
La_02	Measuring characteristic of microbend sensor	3
La_03	Application fiber Bragg grating in sensor systems	3
La_04	Characterization of resistive gas sensors	3
La_05	Characterization of humidity sensors (or biosensors)	3
La_06	Characterization of electrochemical sensors with solid electrolyte	3
La_07	Temperature sensors	3
La_08	Flow sensors	3
La_09	Infrared radiation detectors	3
La_10	Additional course hours	3
	Total	30

TEACHING TOOLS USED	
ND_01	Traditional lecture with presentations
ND_02	Tests before classes
ND_03	Consultations on the issues presented in the lecture and measurement results obtained during laboratory
ND_04	Students own work - preparation for classes including the correct writing tests and efficient conduct measurements under tutor supervision
ND_05	Students own research preparation for the exam

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. Francis T. S. Yu, Shizhuo Yin, Marcel Dekker, Fiber Optic Sensors, Inc., 2002
2. J. Dakin, B. Culshaw, Optical Fiber Sensors: principles and components, vol. one, Artech House , 1988
3. J. Dakin, B. Culshaw, Optical Fiber Sensors: systems and applications, vol. two, Artech House, 1988
4. L. Hozer, Półprzewodnikowe materiały ceramiczne z aktywnymi granicami ziaren, PWN, 1998
5. P. Ciureanu, S. Middelhoek, Thin film resistive sensors, Inst. Of Phisics Publ. , 1992
6. W. Gopel, J. Hesse, J. N. Zemel, Sensors, VCH Publ. INC, New York , 1989
7. W. Jakubowski, Przewodniki superjonowe, Właściwości fizyczne i zastosowania, WNT, 1988
8. Z. Kaczmarek, Światłowodowe czujniki i przetworniki pomiarowe, Agenda Wydawnicza PAK, 2006

Secondary literature

1. Conference materials from Czujniki optoelektroniczne i elektroniczne Conference
2. Conference materials from Eurosensors Conference

SUBJECT SUPERVISOR

Anna.Sankowska@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Sensors

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)	S2ems_W16	C01-C05	Wy_01-Wy_23	ND_01, ND_03, ND_05
PEK_U01 (skills)	S2 ems_U20	C01-C05	La_01-La_09	ND_02-ND_04
PEK_K01 (competences)	S2ems_K08	C01-C05	La_01-La_09	ND_02-ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Zastosowanie analogowych i cyfrowych układów scalonych**	
Name in English:	**Application of analogue and digital integrated circuits**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009282**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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

SUBJECT OBJECTIVES

C01 To acquaint students with advanced linear, nonlinear and signal acquisition designed with integrated circuits
C02 To acquaint students with design of advanced electronic circuits
C03 To gain competence how to select electronic components to fulfill technical and operational requirements
C04 Participation of the students in the carried out research connected with application of analogue and digital integrated circuits

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Students have systematic and theoretically founded knowledge of the function of analog and digital integrated circuits

Relating to skills

PEK_U01 Students have systematic and theoretically founded knowledge of the function of analog and digital integrated circuits

Relating to social competences

PEK_K01 Students are able to identify priorities needed to realize defined engineer project, whose aim is design, valuation and measurement of electronic circuit parameters

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Properties and characteristics of operational amplifiers	2
Le_02	Linear and nonlinear circuits designed basing on operational amplifiers	2
Le_03	Properties and characteristics of instrumental amplifiers	2
Le_04	Photodetector signal circuits	2
Le_05	Current and voltage sources	2
Le_06	Analog to digital and digital to analog converters	2
Le_07	Input and output circuits for analog to digital and digital to analog converters	2
Le_08	Test in writing	1
	TOTAL	15

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

TEACHING TOOLS USED
ND_01 Lecture with discussion ND_02 Multimedia lecture ND_03 Consultation ND_04 Individual work - study on selected lecture related cases ND_05 Individual work - preparation for test in writing ND_06 Individual work - analysis of indicated project tasks

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Test in writing
P2 = F2 (project)	PEK_U01, PEK_K01	Laboratory reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Laboratory instructions prepared by the laboratory team of Electronic Circuits Laboratory, WEMiF, 2007
2. J. Baranowski, G. Czajkowski, Układy analogowe nieliniowe i impulsowe, WNT, Warszawa, 2004
3. Kuta, Układy elektroniczne cz.1, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 2000
4. M. Niedźwiecki, M. Rasiukiewicz, Nieliniowe elektroniczne układy analogowe, WNT, Warszawa, 1992

Secondary literature

1. A. Prałat, Laboratorium układów elektronicznych cz.2, Oficyna wydawnicza PWr
2. P. Górecki, Wzmacniacze operacyjne, Wydawnictwo BCT, 2004
3. P. Horowitz, W. Hill, Sztuka elektroniki, Wydawnictwo Komunikacji i Łączności, 2009
4. S. Kuta, Elementy i układy elektroniczne cz.2, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 2000

SUBJECT SUPERVISOR

Teodor.Gotszalk@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Application of analogue and digital integrated 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)	S2ems_W03	C01	Le_01-Le_15	ND_01-ND_05
PEK_U01 (skills)	S2ems_U22	C02-C04	Pr_01-Pr_15	ND_03, ND_06

PEK_K01 (competences)	S2ems_K01	C03	Pr_01-Pr_15	ND_03, ND_06

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Elektronika polimerowa i molekularna**	
Name in English:	**Polymer and Molecular Electronics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009293**	
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. General knowledge from the area of: Micro- nano- technologies, Optoelectronics

SUBJECT OBJECTIVES

C01 Knowing the passive components and active devices of organic electronics

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 The student has an ordered knowledge about basic technological processes, characteristic for polymer and molecular electronics, as well as about basic materials, passive components and active devices of organic electronics

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Organic materials - general characteristics	2
Le_02	Electrical properties of polymeric and molecular materials	2
Le_03	Percolation theory - selected issues	2
Le_04	Composites type powdered filler/organic vehicle	2
Le_05	Passive components based on composites type powdered filler/organic vehicle	2
Le_06	Electronic adhesives	2
Le_07	Sensors components and /or devices based on composites type powdered filler/organic vehicle	2
Le_08	Charge transport mechanism in low-and high molecular weight materials	2
Le_09	The mechanism of electron-hole pairs recombination. Photon absorption in low-and high molecular weight materials	1
Le_10	Organic transistors	2
Le_11	Light emitters: the construction of the instrument; the methods of the manufacturing. The color of the emitted radiation. The materials used for the cathode and the anode	2
Le_12	Displays: building, manufacturing methods and applications	2
Le_13	Photodetectors - building, manufacturing methods. The materials used for the cathode and the anode. Solar cells	2
Le_14	Organic, polymeric and ferro-electric polymer memory	1
Le_15	Chemical sensors based on organic semiconductors	2
Le_16	Test	2
	TOTAL	30

TEACHING TOOLS USED
ND_01 Traditional lecture with presentations and discussion
ND_02 Own work - self-made literature studies
ND_03 Own work - preparation for the test
ND_04 Consultation

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. Nano and molecular electronics handbook, ed. Lyshevski Sergey Edward, CRC Press, 2007
2. Godlewski Jan, Wstęp do elektroniki molekularnej, Wydawnictwo Politechniki Gdańskiej, Gdańsk, 2008
3. Harper, Charles A. (Editor), Electronic Packaging and Interconnection handbook, Mc Graw-Hill, 2000
4. Klauk, Hagen (ed.), Organic Electronics. Materials, Manufacturing and Applications,, Wiley-VCH, Weinheim, 2006
5. Müllen, Klaus, Scherf, Ullrich (eds.), Organic Light Emitting Devices. Synthesis, Properties and Applications, Wiley-VCH, Weinheim, December, 2005
6. Petty Michael C., Molecular Electronics. From Principle to Practice, John Wiley &Sons, Ltd, 2007

7. Przygodzki W, Włochowicz A., Fizyka polimerów, Wydawnictwo Naukowe PWN, W-wa, 2000
8. Zallen Richard, Fizyka ciał amorficznych, Wydawnictwo Naukowe PWN, W-wa, 1994

Secondary literature

1. Adamczyk Katarzyna, Organiczne emitery promieniowania, pr. dyplomowa, WPPT PWr, 2004
2. Dziedzic Andrzej, Grubowarstwowe rezystywne mikrokompozyty polimerowo-węglowe, Oficyna Wydawnicza PWr, 2001
3. Pięda Marcin, Przyrządy elektroniki organicznej, Wydział Elektroniki PWr, diploma thesis, 2005

SUBJECT SUPERVISOR

Andrzej.Dziedzic@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Polymer and Molecular 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)	S2ems_W22	C01	Wy_01-Wy_15	ND_01-ND_04

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Elementy i układy optoelektroniczne II**	
Name in English:	**Optoelectronic Elements and circuits II**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009381**	
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			1	2	
Including number of ECTS points for direct teacher-student contact (BK) classes			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 Presentation of APSYS Crosslight software. Design and simulation of the simple optoelectronic components such as: PIN and MSM photodetectors, LED diodes with bulk and quantum active regions

C02 Consolidation of practical skills in the field of simple optoelectronic components designing and team work

C03 Participation of the students in the conducted researches related to technical sciences, in terms of disciplines such as electronics, materials engineering, telecommunications

SUBJECT EDUCATIONAL EFFECTS

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 - 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 the photoluminescence spectra of the chosen device epitaxial structures	3
La_03	Measurements of the absorbance characteristics of chosen semiconductor epitaxial structures, determination of the absorption edge and compositions of the following layers of the investigated structures	3
La_04	Measurements of a free carrier distribution along the chosen semiconductor epitaxial structures	3
La_05	Comparison of the cut-of frequencies of the silicon discrete photodetectors	3
	TOTAL	15

Form of classes - Project		Quantity
Pr_01	Introduction to the project - safety instruction, organization of the semester and rules of evaluation	2
Pr_02	Introduction to the software employed during realized classes (Linux, putty, WinSPC, APView)	2
Pr_03	Introduction to the simulation APSYS software	2
Pr_04	Computer simulation of the MSM photodiode	2
Pr_05	Computer simulation of the PIN photodiode	2
Pr_06	Computer simulation of the LED diode	2
Pr_07	Computer simulation and elaboration of reports containing achieved results	18
	Total	30

TEACHING TOOLS USED

ND_01 Laboratory: short tests at the beginning of the classes, exercises realized by group
ND_02 Project: Elaboration of the reports with achieved simulation results
ND_03 Consultations
ND_04 Individual work - preparation for realized laboratory exercises
ND_05 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 (lab)	PEK_U01, PEK_K01	Tests and reports
P2 = F2 (project)	PEK_U01, PEK_K01	Reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

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

Secondary literature

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

SUBJECT SUPERVISOR

Beata.Sciana@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Optoelectronic Elements and circuits II

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_U01 (skills)	S2eot_U03	C01-C03	La_01-La_05, Pr_01-Pr_07	ND_01-ND_05
PEK_K01 (competences)	S2eot_K04	C02, C03	La_01-La_05, Pr_01-Pr_07	ND_01-ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**MEOMS-y**	
Name in English:	**MEOMS**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009383**	
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. 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
Jan.Dziuban@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

MEOMS

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)	S2eot_W06	C01	Wy_01-Wy_07	ND_01, ND_03
PEK_U01 (skills)	S2eot_U03	C02, C03	La_01-La_05	ND_02-ND_04
PEK_K01 (competences)	S2eot_K04	C02	La_01-La_05	ND_02-ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Technika laserowa**	
Name in English:	**Laser Techniques**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009384**	
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. Physics 2
2. Mathematical analysis 2
3. The ability to self-education
4. Ability to work in a team

SUBJECT OBJECTIVES

C01 Introduction to advanced topics related to laser: Pulsed lasers, harmonic generation, modulation of the laser radiation, control and stabilization of the laser frequency

C02 Introduction to the issues associated with the use of laser technology in the industry: the use of technology (machining and micromachining), optical metrology, optical telecommunications, lasers in medicine

C03 Acquiring skills for experimentation in the field of laser technology

C04 The ability to use elementary equipment used in laser technology

C05 Learning of interpretation of the obtained results

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 It has a broader and deeper knowledge of the physics necessary to understand the physical phenomena of electronics

Relating to skills

PEK_U01 He can carry out experiments in the field of laser technology. He uses equipment used in laser technology. He is able to interpret the results

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction. Light modulation	3
Le_02	Pulse laser operation (modelocking, Q-switching), higher harmonic generation,	2
Le_03	Frequency stabilization of laser radiation.	2
Le_04	Laser metrology (interferometry, vibrometry, rangefinders, holograpohy,	2
Le_05	Technological applications of lasers (machining and micromachining)	2
Le_06	Generative laser technique (SLA -Styereo litography, SLA, SLS, SLM - selective sintering powders	1
Le_07	Optical communications	1
Le_08	Laser applications in medicine	1
Le_09	Test	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Organizational meeting. Safety at work.	1
La_02	Pulse fiber laser	2
La_03	Fiber interferometers	2
La_04	The analysis of state of polarization of laser radiation	2
La_05	The analysis of geometry of laser beams	2
La_06	Laser micromachining 1 (galvo-system with fiber laser)	2
La_07	Laser micromachining 2 (ploter-system based on CO_2 laser)	2
La_08	Compensatory term	2
	Total	15

TEACHING TOOLS USED

ND_01 Classroom (blackboard and chalk)
ND_02 Projector, computer with software (for example PowerPoint)
ND_03 Laboratory equipped into modern laser equipment
ND_04 Manuals for the laboratory experiments
ND_05 Discussing problems during the laboratory experiments
ND_06 Individual study of selected parts of the program
ND_07 Stand-alone work

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Written test
P2 = F2 (lab)	PEK_U01	Evaluation of the preparations for the lab and for measurements results report

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. B. Ziętek, Optoelektronika, Wydawnictwo Naukowe UMK, Toruń, 2011
2. F. Träger, Handbook of Lasers and Optics, Springer, 2007
3. K. Shimoda, Wstęp do fizyki laserów, PWN, Warszawa, 1993
4. F. Kaczmarek, Wstęp do fizyki laserów, PWN, Warszawa, 1978

Secondary literature

1. J.F Ready, Industrial Applications of Lasers 2nd ed., Academic Press, San Diego, 1997
2. A. Kujawiński, P. Szczepański, Lasery. Fizyczne podstawy, Oficyna Wydawnicza PW, 1999

SUBJECT SUPERVISOR

Krzysztof.Abramski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Laser 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)	S2eot_W05	C01, C02	Le_01-Le_08	ND_01, ND_02, ND_07
PEK_U01 (skills)	S2eot_U03	C03-C05	La_02-La_07	ND_03-ND_07

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Telekomunikacja światłowodowa**	
Name in English:	**Fiber Optics Telecommunication**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009385**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No requirements

SUBJECT OBJECTIVES

C01 Gaining basic knowledge of transport networks and their architecture, functioning, components and communication protocols

C02 Gaining basic knowledge of access networks and their architecture, functioning, components and communication protocols

C03 Getting skills on analyzing transport and access networks, using line measuring and quality examination devices and calculating power balance in telecommunication link

C04 Preparations for conducting scientific studies related to optical telecommunication networks

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Acquiring knowledge about development trends in optical fibre telecommunication networks
PEK_W02 Knows functions and capabilities of transport networks
PEK_W03 Knows functions and capabilities of access networks
PEK_W04 Is able to suggest a structure of transport and access network for specific requirements

Relating to skills

PEK_U01 Is able to analyze structures and protocols of transport and access networks
PEK_U02 Is able to use basic measurement devices to get parameters of components and create basic structures of transport and access networks

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introduction to transmission systems and networks	2
Le_02	FDM, TDM, WDM - general principles	2
Le_03	PDH systems and networks.	4
Le_04	SDH systems and networks.	2
Le_05	Optical Transportation Hierarchy (OTH)	2
Le_06	Optical access networks FITL (active AON and passive PON). Wireless access networks	3
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	OTDRs measurements of fiber optic links	3
La_02	Testing and measuring of analog fiber optic links	3
La_03	Testing and measuring of PDH	3
La_04	Testing and measuring of SDH	3
La_05	Testing and measuring of optical access network	3
	Total	15

TEACHING TOOLS USED

ND_01 Lectures using the board and slides
ND_02 Laboratory Materials and instructions in educational portal
ND_03 Practical exercises - the configuration of network devices and functional tests
ND_04 Consultations
ND_05 Reception of reports
ND_06 Own work - preparation for laboratory and preparation reports
ND_07 Self-study and preparation for pass the course

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01-PEK_W03	Final test
P2 = F2 (lab)	PEK_U01, PEK_U02	Checking the students preparation to the laboratory, the receipt and evaluation reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. S. Kula, Systemy teletransmisyjne, WKiŁ, Warszawa, 2004
2. S. Kula, Systemy i sieci dostępowe xDSL, WKiŁ, Warszawa, 2009
3. K. Perlicki, Systemy transmisji optycznej WDM, WKiŁ, Warszawa, 2007

Secondary literature

1. U. Black, Optical Networks Third Generation Transport Systems, Prentice Hall PTR, 2002
2. D. Derickson, Fiber Optic Test and Measurement, Prentice Hall PTR, 1998

SUBJECT SUPERVISOR

Zbigniew.Siwek@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Fiber Optics Telecommunication

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)	S2eot_W11	C01	Wy_01-Wy_04	ND_01, ND_04, ND_06
PEK_W02	S2eot_W11	C01	Wy_01-Wy_04	ND_01, ND_04, ND_06
PEK_W03	S2eot_W11	C02, C04	Wy_05	ND_01, ND_04, ND_06
PEK_W04	S2eot_W11	C01, C02, C04	Wy_06	ND_01, ND_04, ND_06
PEK_U01 (skills)	S2eot_U03	C03	La_01-La_05	ND_02-ND_07
PEK_U02	S2eot_U12	C03	La_01-La_05	ND_02-ND_07

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Miernictwo optoelektroniczne**	
Name in English:	**Optoelectronic Metrology**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009386**	
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	E		Z		
Number of ECTS points	1		2		
Including number of ECTS points for practical (P) classes	0		2		
Including number of ECTS points for direct teacher-student contact (BK) classes	0.6		1.4		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic skills and knowledge in electronics

SUBJECT OBJECTIVES

C01 Learn the basics of optoelectronic measurements, design and operation of measurement systems
C02 Learn how to perform basic measurements of the optoelectronic components, the size of the physical and mechanical interaction skills and teamwork
C03 The acquisition of skills in software that is designed to conduct measurements of optoelectronic
C04 Improving skills in catalogs and databases for optoelectronic metrology
C05 Building education skills in measurement techniques in the field of optoelectronics to conduct scientific research
C06 Participation of the students in the carried out research connected with optoelectronic metrology

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Knowledge and understanding of basic concepts in the field of opto-electronic surveying and surveying areas optoelectronic applications

Relating to skills

PEK_U01 Ability to independently compile basic measurement systems and to select the technique and data needed to complete the measuring task

Relating to social competences

PEK_K01 Develop 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: Basic definitions of measurements, optoelectronic	2
Le_02	The basic elements of optoelectronic measuring systems. Open discussion on the topic	2
Le_03	Review of optoelectronic circuits and measurement systems. Open discussion on the topic	2
Le_04	Laser Interferometry - working principle, system components and applications. Open discussion on the topic	2
Le_05	Optical methods for measuring the thickness of the layers. Open discussion on the topic	2
Le_06	Optical methods for measuring surface roughness. Open discussion on the topic	2
Le_07	Optical linear encoders and digital readers position. Open discussion on the topic	2
Le_08	Summary of the lecture. Prospects for the development of optoelectronic metrology techniques. Knowledge Test (test)	1
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Measurement of transmission characteristics for various thin films, optical coatings (eg layers of anti-reflective, diffuse) and ready optical components (eg filters) at different measurement configurations, Determination of the width of the optical bandgap for selected coatings	3
La_02	Measurements of reflectance characteristics of various thin films, optical coatings (e.g. anti-reflective layer, reflectance) and finished optical elements (e.g. filters) in different measurement configurations; Determination of film thickness from measurements of reflectance	3
La_03	Laser diffraction method of measuring the fibers diameter	3
La_04	The study of HeNe laser metrological parameters	3
La_05	The study of electrical, optical and thermal properties of semiconductor laser	3
	Total	15

TEACHING TOOLS USED	
ND_01	Traditional lecture with multimedia presentations
ND_02	Materials for the lecture and lab on-line
ND_03	Laboratory 15-minute tests in preparation for classes
ND_04	Implementation of the laboratory under the supervision of lecturer
ND_05	Own work - preparation for the lecture selected issues
ND_06	Own work - preparation for laboratory
ND_07	Self-study and preparation for test

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
P1 = F1 (lecture)	PEK_W01	Discussions and final test
P2 = F2 (lab)	PEK_U01, PEK_K01	Evaluation of the implementation of the tasks of laboratory and test

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Handbook of Optical Metrology. Pronciples and Applications, ed. by Toru Yoshizawa, CRC Press, 2009
2. B. Ziętek, Optoelektronika, Wydawnictwo Uniwersytetu Mikołaja Kopernika, Toruń , 2004
3. J.E. Midwinter, Y.L. Guo, Optoelektronika i technika światłowodowa, WKŁ , 1995
4. J.Piprek, Optoelectronic Devices, Springer-Verlag, 2005
5. K.Booth, Optoelektronika, WKŁ , 2001
6. M. Rusin, Wizyjne przetworniki optoelektroniczne, WKŁ, 1990
7. M. Szustakowski, Elementy techniki światłowodowej, (Cykl wydawniczy: „Fizyka dla przemysłu"), WNT, 1992
8. Group work under supervision of Jerzy Helsztyński, Laboratorium podstaw optoelektroniki i miernictwa optoelektronicznego, Oficyna Wydawnicza Politechniki Warszawskiej, 2003
9. Sz. Szczeniowski, Fizyka doświadczalna, Tom IV , PWN, 1983

Secondary literature

1. Journals: Elektronika praktyczna, Elektronizacja, Przegląd Telekomunikacyjny itp. and catalogues, 2012
2. G.C.Righini, A.Tajani, A.Cutolo, An Introduction to Optoelectronic Sensors, World Scientific Pub (London, Singapore, Taipei), 2009

SUBJECT SUPERVISOR

Jacek.Radojewski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Optoelectronic Metrology

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)	S2eot_W07, S2eot_W08	C01, C05	Wy_01-Wy_08	ND_01, ND_02, ND_05, ND_07
PEK_U01 (skills)	S2eot_U09, S2eot_U15	C02-C06	La_01-La_05	ND_03, ND_04, ND_06
PEK_K01 (competences)	S2eot_K04	C02-C05	La_01-La_05	ND_03, ND_04, ND_06

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Metody symulacji komputerowej w fotonice**	
Name in English:	**Computer Simulations in Photonics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009387**	
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 knowledge of solid state physics
2. Knowledge of the principles of operation of semiconductor devices in the frames of the course "Semiconductor Devices"
3. Knowledge of the fundamentals of wave optics in the frames of the course "Wave Optics"
4. Knowledge in the field of solid state physics in the frames of the course "Introduction to Solid State Physics"
5. Basic knowledge of optoelectronics in the frames of the course "Optoelectronics"

SUBJECT OBJECTIVES

C01 Consolidation and practical use of knowledge in the area of operation of optoelectronic components and devices

C02 Acquiring the skills of application of simple simulation software in the proces of photonic devices, networks and circuits design

C03 Deepening of knowledge in the area of optical phenomena taking place in semiconductor emitters, photodetectors and solar cells. Deepening knowledge on the impact of structural and material parameters and applied electrical, optical and thermal models in the SimWindows 1.5 on the operational parameter of the elements

C04	Improvement of the ability to work in a group and skills of interpretation, presentation and documentation of the results of computer modeling of the task of the project
C05	Acquiring skills to design computer networks using specialized CAD tools (on the example of Opnet software)
C06	Acquiring skills of modeling photonic devices and systems using specialized CAD tool (on the example of Optiperformer software)
C07	Development of skills of application of computer software for modelling photonic devices and phenomena in research work

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01	Has in-depth photonics theoretical knowledge, including knowledge necessary to understand operation of optical telecommunication systems and optical information storage and processing; has basic knowledge in the area of the algorithms used for modeling photonic devices and systems; knows and understands advanced numerical methods used in the design of photonic and electronic devices and systems

Relating to skills

PEK_U01	Can use obtained knowledge and mathematical models (if necessary modifying them) for analysis and design of electronic and photonic elements, circuits and systems

Relating to social competences

PEK_K01	Is able to think and operate in a creative and enterprising way

PROGRAMME CONTENT

Form of classes - Lecture		Quantity
Le_01	Introductory lecture: definition of photonics, basic requirements for modern programs simulating work of optoelectronic devices	2
Le_02	Refreshing of knowledge on SimWindows program (optoelectronic devices simulator). Deepening knowledge of the modeling of optical, electrical and thermal properties of optoelectronic devices	2
Le_03	Discussion of the impact of structural and material parameters and applied mathematical models (SimWindows) on the simulation results of the performance characteristics of optoelectronic structures	3
Le_04	Principles of modeling of complex photonic circuits and systems	2
Le_05	Presentation of CAD tools for modeling of photonic circuits and systems	2
Le_06	Principles of modeling of computer networks	2
Le_07	Presentation of a CAD tool for modeling of computer networks	2
	TOTAL	15

Form of classes - Laboratory		Quantity
La_01	Introductory lab - presentation o of terms of completion of the course, safety training, a reminder of the issues related to SimWindows software, selection of the subject of the project	2
La_02	Work on the project subject, simulations of operational characteristics of selected optoelectronic structures	2
La_03	Analysis of the impact of structural and material parameters and applied mathematical models of the SimWindows software on the results of simulations of operational characteristics	2

La_04	Preparation of reports on the obtained results of modeling	2
La_05	Design of a selected optoelectronic circuits using a CAD tool	2
La_06	Report on analysis of the results o design of optoelectronic device with a CAD tool	2
La_07	Design and analysis of a simple computer network with a specialized CAD tools	3
	Total	15

TEACHING TOOLS USED
ND_01 Classical lecture with presentations and discussion
ND_02 Computer simulations using SimWindows software
ND_03 Preparation and presentation of computer simulation results
ND_04 Consultations
ND_05 Own work - independent studies and preparation for realization of project task

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. B. Mroziewicz, M. Bugajski, Wł. Nakwaski, Lasery półprzewodnikowe, WNT, 1985
2. B. Ziętek, Optoelektronika, Wyd. UMK, 2004
3. David W. Winston, Instrukcja programu SimWin, University of Colorado, 1995
4. David Wells Winston, Physical simulation of optoelectronic semiconductor devices, praca doktorska, University of Colorado, 1996
5. J. E. Midwinder, Y. L. Guo, Optoelektronika i technika światłowodowa, WKŁ, 1995
6. J. I. Pankove, Zjawiska optyczne w półprzewodnikach, WNT, 1984
7. Group work, Instruction for Opnet software, Opnet, 2003
8. Group work, Instruction for Optiperformer software, Optiwave, 2012
9. Z. Bielecki, A. Rogalski, Detekcja sygnałów optycznych, WNT, 2001

SUBJECT SUPERVISOR

Sergiusz.Patela@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Computer Simulations in Photonics

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)	S2eot_W10	C01, C03, C05-C07	Le_01-Le_07	ND_01, ND_04
PEK_U01 (skills)	S2eot_U06	C01, C04-C07	La_01-La_07	ND_03-ND_05
PEK_K01 (competences)	S2eot_K01	C03, C04, C07	La_01-La_07	ND_03-ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Seminarium dyplomowe**	
Name in English:	**Diploma Seminar**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009389**	
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 Electonics and Telecommunication field of study and Optoelectronics and Optical-Fiber Technology 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 Electonics and Telecommunication field of study and Optoelectronics and Optical-Fiber Technology 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 informations, regular requirements obligatory in Politechnika Wrocławska, 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	Multimedial presentation of CV done by every seminar participant	4
Se_05	Discussion of the exam questions	8
Se_06	Thesis - multimedial 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 multimedial 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 Technology 2. Notes from lectures 3. Scientific publications from the field of the realised diploma thesis

SUBJECT SUPERVISOR
Zbigniew.W.Kowalski@pwr.edu.pl pl

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_W13, S2eot_W01-S2eot_W11	C01	Se_02-Se_07	ND_01, ND_02, ND_04
PEK_U01 (skills)	K2eit_U01-K2eit_U17, S2eot_U01-S2eot_U19	C01, C02	Se_02-Se_07	ND_01, ND_02, ND_04
PEK_K01 (competences)	S2eot_K01, S2eot_K04	C02	Se_02-Se_07	ND_01-ND_03

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Praca dyplomowa magisterska**	
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:	**ETD009390**	
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 Optoelectronics and Optical Fibre Technique

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 Optoelectronics and Optical Fibre Technique

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 Optoelectronics and Optical Fibre Technique

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

Zbigniew.W.Kowalski@pwr.edu.pl

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_W13, S2eot_W01-S2eot_W11	C01, C04	Pr_01	ND_01, ND_02, ND_04
PEK_U01 (skills)	K2eit_U01-K2eit_U17, S2eot_U01-S2eot_U19	C02, C04	Pr_02, Pr_03	ND_01, ND_02, ND_04
PEK_K01 (competences)	K2eit_K01-K2eit_K12, S2eot_K01-S2eot_K04	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:	**Postępy elektroniki i fotoniki**	
Name in English:	**Achievements in electronics and photonics**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009391**	
Group of courses:	**NO**	

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

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of electronics and optoelectronicss
2. The ability to search for information
3. The ability to create multimedia presentations

SUBJECT OBJECTIVES

C01 Capture and consolidate knowledge of the achievements of modern consumer and industrial electronics: microelectronics, optoelectronics (light sources, detectors and laser systems, etc.), large power and high temperature, microsystems

C02 The student should after the course have knowledge about the latest electronics applications

C03 To acquire and consolidate skills by students search for information on a given topic

C04 To acquire and consolidate skills make presentations, preparation for public speaking skills and formulation of studies in writing

C05 The ability to take an active part in the discussion in a public forum

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Student has an ordered and build on the theory of knowledge required for electronics and telecommunication studies and specialties optoelectronics and fibre optics

Relating to skills

PEK_U01 The student is able to evaluate the usefulness and the possibility of the use of new solutions (systems, consumer electronics and industrial systems) with an innovative

PEK_U02 The student can obtain information from literature, databases, and other sources

PEK_U03 The student can prepare a multimedia presentation

Relating to competences

PEK_K01 Student can prepare a presentation, training materials, participate in a discussion in a public forum

PROGRAMME CONTENT

	Form of classes - Seminar	Quantity
Se_01	Introduction to the course, assign issues to develop	2
Se_02	Rules for correct writing technical texts and for the preparation of multimedia presentations	2
Se_03	Student presentations of issues mandatory	2
Se_04	Student presentations of issues mandatory	2
Se_05	Student presentations of issues mandatory	2
Se_06	Student presentations of issues mandatory	2
Se_07	Student presentations of issues mandatory	2
Se_08	Student presentations of issues mandatory	2
Se_09	Student presentations of issues mandatory	2
Se_10	Student presentations of their own topics	2
Se_11	Student presentations of their own topics	2
Se_12	Student presentations of their own topics	2
Se_13	Student presentations of their own topics	2
Se_14	Student presentations of their own topics	2
Se_15	Student presentations of their own topics	2
	TOTAL	30

TEACHING TOOLS USED

ND_01 Presentation of selected issues and discussion
ND_02 Own work-independent studies and searching materials
ND_03 Own work-preparation of multimedia presentation given issues
ND_04 Own work-preparation of elaborate written issues presented
ND_05 Consultation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01, PEK_U01, PEK_U02	Assessment of the substantive content of the multimedia presentation and text design
F2	PEK_U03	Evaluation of multimedia presentation and development of the technical text
F3	PEK_W01	Part in the discussion
P1 (seminar) = 0,5*F1 + 0,25*F2 + 0,25*F3		

PRIMARY AND SECONDARY LITERATURE
Primary literature
1. Actual literautre, datasheets, Internet, scientific journals

SUBJECT SUPERVISOR
Ryszard.Korbutowicz@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Achievements in electronics and photonics

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_W13, S2eot_W01-S2eot_W11	C01-C03	Se_03-Se_15	ND_02-ND_05
PEK_U01 (skills)	K2eit_U01-K2eit_U17, S2eot_U18	C01-C04	Se_01-Se_15	ND_02-ND_05
PEK_U02	S2eot_U01	C03	Se_03-Se_15	ND_02-ND_05
PEK_U03	S2eot_U04, S2eot_U05	C04	Se_01-Se_15	ND_01-ND_05
PEK_K01 (competences)	S2eot_K01-S2eot_K04	C04, C05	Se_03-Se_15	ND_01-ND_05

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Czujniki światłowodowe**	
Name in English:	**Fiber Optic Sensors**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009392**	
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. Good understanding of physics, including geometrical and wave optics
2. Completing the course Fiber Optics I and Fiber Optics II

SUBJECT OBJECTIVES

C01 Getting familiar with the methods of modulating the parameters of a light wave
C02 Broadening knowledge regarding the use of optical fibers for the construction of the measuring sensor heads and the application of the active components in measuring systems
C03 Arrangement of knowledge about the design and use of modern fiber-optic sensor systems in contemporary technology
C04 Consolidating and developing the skills of teamwork
C05 Participation in the research of fiber sensor parameters developed at the Faculty

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Ordered and in-depth knowledge of the construction and application of optical measurement systems in modern technology and medicine

Relating to skills

PEK_U01 Use of known optical fiber sensors to measure and monitor the indicated amount of physical and chemical properties

Relating to social competences

PEK_K01 Understanding the effects of engineering activities as a result of measurement using different measurement techniques

PROGRAMME CONTENT		
Form of classes - Lecture		Quantity
Le_01	Characteristics of fiber optical measuring systems – the criteria for classification	2
Le_02	Overview of optical fibers used in fiber sensor systems (single-mode, multi-mode, polarization and photonic fiber)	2
Le_03	Active and passive components of sensor systems	2
Le_04	Demodulation and optical data read-out systems in fiber sensor systems	2
Le_05	Physical phenomena used to modulate the amplitude of light waves	2
Le_06	Fiber sensors with light wave amplitude modulation	2
Le_07	Optical fiber interferometers	2
Le_08	Fiber-optic sensors with polarization state modulation	2
Le_09	Fiber-optic sensors with wavelength modulation	2
Le_10	Fiber Bragg gratings and their application in sensor systems (temperature and stress measurement)	2
Le_11	Application of polymer fibers in measurement systems	2
Le_12	Mechanical stress measurements using fiber optic sensors	2
Le_13	The applications of fiber optic sensors in medicine	2
Le_14	Fiber optic sensor systems in chemical and energy industry	2
Le_15	Fiber optic sensors in the protection of natural environment	2
	TOTAL	30

Form of classes - Laboratory		Quantity
La_01	Introductory class	3
La_02	Fiber optic reflective sensor (single-fiber and multi-fiber measuring head)	3
La_03	Microbend sensor with mechanical transducer	3
La_04	Microbend sensor with twisted fiber	3
La_05	Fiber Bragg grating as a strain sensor	3
La_06	Fiber Bragg grating as a temperature sensor	3
La_07	Fiber optic polarization state sensor	3
La_08	Fiber-optic angle displacement sensor	3
La_09	Fiber optic protection against electric arc	3
La_10	Additional course hours	3
	Total	30

TEACHING TOOLS USED
ND_01 Lecture – presentation and discussion ND_02 Consultation (regarding the lecture and the 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 exam
P2 = F2 (lab)	PEK_U01, PEK_K01	Laboratory tests and quizzes, lab reports

PRIMARY AND SECONDARY LITERATURE

Primary literature

1. Francis T. S. Yu, Shizhuo Yin, Marcel Dekker, Fiber Optic Sensors, Inc., 2002
2. J. Dakin, B. Culshaw, Optical Fiber Sensors: systems and applications, vol. two, Artech House, 1988
3. J. Dakin, B. Culshaw, Optical Fiber Sensors: principles and components, vol. one, Artech House, 1988
4. Z. Kaczmarek, Światłowodowe czujniki i przetworniki pomiarowe, Agenda Wydawnicza PAK, Warszawa, 2006

Secondary literature

1. Conference materials from Eurosensors Conference
2. Conference materials from Czujniki optoelektroniczne i elektroniczne Conference

SUBJECT SUPERVISOR

Anna.Sankowska@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Fiber Optic Sensors

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)	S2eot_W07	C01-C05	Le_01- Le_15	ND_01, ND_02, ND_05
PEK_U01 (skills)	S2eot_U19	C03-C05	La_01-La_10	ND_02-ND_04
PEK_K01 (competences)	S2eot_K03	C03-C05	La_01-La_10	ND_02-ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Projektowanie urządzeń optoelektronicznych**	
Name in English:	**Design and Construction of Optoelectronic Circuits**	
Main field of studies:	**Electronics and Telecommunications**	
Level and form of studies:	**II level**	**/ Full time**
Kind of subject:	**Obligatory**	**/ Faculty**
Subject code:	**ETD009393**	
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 Telekomunikacyjn 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

Jacek.Radojewski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Design and Construction of Optoelectronic Circuits

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

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)	S2eot_W07, S2eot_W11	C01, C05	Le_01-Le_08	ND_01, ND_04, ND_06. ND_07
PEK_U01 (skills)	S2eot_U11, S2eot_U19	C02-C05	Pr_01-Pr_07	ND_02, ND_03, ND_05-ND_08
PEK_K01 (competences)	S2eot_K04	C02, C05	Pr_01-Pr_07	ND_02, ND_03, ND_05-ND_08

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Sieci światłowodowe**	
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:	**ETD009394**	
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

Sergiusz.Patela@pwr.edu.pl

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)	S2eot_W02	C01, C02, C04, C06	Wy_01-Wy_07	ND_01, ND_02
PEK_U01 (skills)	S2eot_U20	C03, C05, C06	Pr_01-Pr_06	ND_03, ND_04
PEK_K01 (competences)	S2eot_K04	C03, C05, C06	Pr_01-Pr_06	ND_03, ND_04

Attachment no. 4 to ZW 33/2012

Faculty of Microsystem Electronics and Photonics

SUBJECT CARD

Name in Polish:	**Matematyka**	
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:	**MAP001206**	
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 the basic concepts, theorems, methods, and applications of ordinary differential equations using the equations of first and second order and linear systems of ordinary differential equations of the first order

C02 Study of basic concepts, theorems and methods for simple partial differential equations and integral equations of Volterr's and Fredholm type

C03 Understanding the classification and probabilistic issues for multi-dimensional random variables

C04 Understanding the basic concepts of stochastic processes, Markov processes and renewal process

C05 The use of the acquired knowledge to create and analyze mathematical models to solve theoretical and practical technology

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEK_W01 Have a basic understanding of ordinary differential equations, particular the equations of first and second order, and systems of linear ordinary differential equations of the first order

PEK_W02 Have a basic knowledge of partial differential equations of the first order and the type of Volterr's and Fredholm's integral equations

PEK_W03 Have a basic knowledge of linear space, normalized, unitary, Gilbert, L2

PEK_W04 Have a basic knowledge of stochastic processes, Markov processes and renewal processes

Relating to skills

PEK_U01 Can solve equations of the first order with separated variables, linear, homogeneous and Bernoulli, second-order reducible to first-order equations and equations with constant coefficients, systems of linear ordinary differential equations of the first order

PEK_U02 Can solve simple partial differential equations and use iterative methods for solving integral equations of Volterr's and Fredholm's type

PEK_U03 Can use the stochastic processes to model the technical issues. Can analyze the processes of the second order and stationary

PEK_U04 Can apply Markov processes with discrete time and continuous and renewal processes for modeling technical issues

Relating to social competences

PEK_K01 Cn 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	Ordinary differential equations of the first order. Cauchy's theorem on the existence and uniqueness of the solution. The initial value problem for the equation of the first order	2
Le_02	Linear differential equations of the first order. The method of integrating factor. Bernoulli's equation. Orthogonal curves	2
Le_03	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 the first order	2
Le_04	Linear homogeneous and heterogeneous ordinary differential equations of second order. Homogeneous systems of linear differential equations. Euler's method. The method of variation of constants for heterogeneous systems	2
Le_05	Partial differential equations of the first order. Homogeneous linear integral equations. Clairaut equation. Transport equation	2
Le_06	Integral equations of the first and second kind – Fredholm's and Volterr's equations. Examples of Abel integral equation. Fredholm's equation with degenerate kernel	2
Le_07	Finite and infinite dimensional vector space. Examples. Normed spaces. Unitary spaces, Hilbert spaces. Examples. The space L2	3
Le_08	Multivariate random variable. The independence of random variables. Covariance matrix. A multi-dimensional normal distribution	2
Le_09	The concept of a stochastic process. Examples. Poisson process. Wiener process	2
Le_10	The processes of the second order. Covariance function. Karhunen-Loeve expansions	2
Le_11	Stationary processes. The spectral analysis. Spectral density. Prediction and filtration. Ergodicity. ARMA time series	2
Le_12	Markov chains with discrete time and a finite number of states. Stationarity and ergodicity	2
Le_13	Markov chains with continuous time. Kolmogorov equations. The processes of birth and death	2

Le_14	Renewal processes. Asymptotic properties. Gaussian Markov processes	3
	TOTAL	30

Form of classes - Classes		Quantity
Cl_01	Solving first-order differential equations with separated variables, linear, homogeneous, and Bernoulli.	4
Cl_02	Solving second-order differential equations and their applications. Solving systems of linear differential equations	4
Cl_03	Applications. Solving systems of linear differential equations	4
Cl_04	Solving partial differential equations of the first order. Solving equations of Volterr's and Fredholm's type	4
Cl_05	Analysis of issues related to the concepts of space: linear, normalized, unitary, Gilbert, L2	4
Cl_06	Testing of independence of random variables. Solving tasks related tomulti-dimensional random variables	4
Cl_07	Solving problems with stochastic processes. The spectral analysis	4
Cl_08	Solving problems related to Markov processes and renewal processes	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. W. Żakowski i W. Leksiński, Matematyka, Cz. IV, WNT, Warszawa 2002
2. M. Gewert i Z. Skoczylas, Równania różniczkowe zwyczajne. Teoria, przykłady, zadania, Oficyna Wydawnicza GiS, Wrocław 2006
3. A. Plucińska, E. Pluciński, Probabilistyka, WNT, Warszawa 2006
4. T. Inglot, T. Ledwina, Z. Ławniczak, Materiały do ćwiczeń z rachunku prawdopodobieństwa i statystyki matematycznej, Wydawnictwo Politechniki Wrocławskiej, Wrocław 1984

E. Wong, Procesy stochastyczne w teorii informacji i układach dynamicznych, WNT, Warszawa 1976

Secondary literature

1. J. Muszyński, A. D. Myszkis, Równania różniczkowe zwyczajne, PWN, Warszawa 1984
2. A. Palczewski, Równania różniczkowe zwyczajne, WNT, Warszawa 2004
3. A. N. Tichonow, A. A. Samarski, Równania fizyki matematycznej, PWN, Warszawa 1963
4. A. D. Wentzell, Wykłady z teorii procesów stochastycznych, PWN, Warszawa 1980

SUBJECT SUPERVISOR
Agnieszka.Wylomanska@pwr.edu.pl

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, C05	Le_01-Le_04	ND_01, ND_03, ND_04
PEK_W02	K2eit_W06	C02, C05	Le_05, Le_06	ND_01, ND_03, ND_04
PEK_W03	K2eit_W06	C03, C05	Le_07	ND_01, ND_03, ND_04
PEK_W04	K2eit_W06	C03-C05	Le_08-Le_14	ND_01, ND_03, ND_04
PEK_U01 (skills)	K2eit_U06	C01, C05	Cl_01, Cl_02	ND_02-ND_04
PEK_U02	K2eit_U06	C02, C05	Cl_05, Cl_04	ND_02-ND_04
PEK_U03	K2eit_U06	C03-C05	Cl_05, Cl_06	ND_02-ND_04
PEK_U04	K2eit_U06	C04, C05	Cl_07	ND_02-ND_04
PEK_K01 (competences)	K2eit_K02	C01-C05	Le_01-Le_09 Cl_01-Cl_06	ND_01-ND_04
PEK_K02	K2eit_K02	C01-C05	Le_01-Le_14 Cl_01-Cl_08	ND_01-ND_04