COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">CAD tools for designing telecommunication networks</td><td colspan="2">Course code</td><td>TS2D200010</td></tr>
<tr><td colspan="2">Course type</td><td>Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>30</td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with GIS tools. To familiarize students with CAD tools for the design and inventory of telecommunication networks.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture:
Basic legal acts related to the design of telecommunications networks. GIS systems as an instrument supporting the design of telecommunication networks. The GPS system and its accuracy. The structure of CAD systems for designing telecommunication networks. Topology of radio and mixed networks. The structure of CAD systems for network inventory.

Specialization Workshop:
Design of a small cable network with Cu cables. Design of cable network on telecommunications poles. Project of ground-based subscriber connections. Simulation analysis of radio link. Selection of radio link components in order to obtain a certain communication reliability. Radio link power budget calculation</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, specialisation workshop.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - written exam; Specialisation Workshop - evaluation of reports, verification of CAD tools used</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student has an elementary knowledge of geoinformatic systems and their accuracy of determining position,</td><td colspan="2">ET2_W05</td></tr>
<tr><td>LO2</td><td colspan="7">The student knows CAD tools for the design of telecommunication networks,</td><td colspan="2">ET1_W07</td></tr>
</table>

LO3	The student is able to plan and carry out an analysis of a small telecommunication network in wired and wireless technologies,	ET2_U14
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	final test	L
LO2	final test	L
LO3	evaluation of students' reports and preparation for laboratory classes	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance:	15
	Participation in specialised workshop:	30
	Work on reports:	15
	Participation in student-teacher sessions:	5
	Preparation for specialization workshop	10
	TOTAL:	75

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	50	2.0
Student workload – practical activities	55	2.2

Basic references	1. Godin L.: GIS in Telecommunications Management, Esri Press 2001 2. El-Rabbany A.: Introduction to GPS: The Global Positioning System, Artech House 2006 3. Manual for Arcadia software for designing telecommunication network 4. International and national standards for telecommunication networks
Supplementary references	1. Kabacinski W.: Sieci Telekomunikacyjne, WKiŁ, Warszawa 2008. 2. Longley P., Goodchild M., Maguire D., Rhind D.: Geographic Information Systems and Science, Wiley 2010.

Organisational unit conducting the course	Department of Telecommunication and Electronic Equipment	Date of issuing the programme
Author of the programme	Maciej Sadowski, Ph.D.	23.04.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Electromagnetic compatibility</td><td colspan="2">Course code</td><td colspan="2">TS2D200011</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td>30</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with the sources of electromagnetic disturbances, how they affect technical objects and electronic and electrical equipment and systems, and the hazards they pose. To acquaint students with the legal requirements as well as the resulting technical recommendations in electromagnetic compatibility (EMC) of electrical and electronic equipment placed on the market. To familiarize students with selected EMC testing methods and equipment. To develop the skills of conducting selected basic and suplementary EMC tests and working with basic testing apparatus. To develop students' skills of proper elaboration, analysis and evaluation of the results of performed tests.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture:</u> Introduction to EMC (electromagnetic compatibility), technical law, product certification and EMC standards. Sources of electromagnetic disturbances, their characteristics and hazards they pose. Rules of disturbing effects of various signals, electromagnetic couplings. Testing of immunity of electronic and electrical equipment to electromagnetic disturbances. Testing of emissions from electronic and electrical equipment. Practical aspects of electromagnetic compatibility.
<u>Laboratory class:</u> Surge generators. Attenuation effectiveness of electromagnetic shielding. Travelling wave phenomena in electrically long lines. Couplings between wire systems. Electromagnetic compatibility of TV-sets. Electrostatic discharge. Testing of radiated and conducted emissions from equipment.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Information lecture, laboratory experiments.</td></tr>
<tr><td>Assessment method</td><td colspan="9"><u>Lecture:</u> exam / presentation on a specific problem; <u>Laboratory class:</u> students' reports, preparation for classes, observation of work during classes.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
</table>

LO1	The student characterizes the phenomena related to generation, propagation and effects of electromagnetic disturbances on electronic and electrical equipment and systems.	ET2_W04
LO2	The student knows the general requirements in the area of electromagnetic compatibility (EMC) of electrical and electronic equipment and systems, describes selected methods of EMC testing and relates these issues to legal acts and technical standards.	ET2_W04 ET2_W09
LO3	The student is able to plan and perform selected basic and complementary tests in the area of EMC, as well as to develop technical documentation on the implementation of these tests, including interpretation of the results.	ET2_U03 ET2_U08
LO4	The student is able to work individually and in a team, including coordinating the work of the team keeping the schedule, observing the rules of health and safety of work, and taking into account the protection of incorporeal property.	ET2_U02 ET2_K02
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	written or oral exam	L
LO2	written or oral exam	L
LO3	students' reports, preparation for classes, observation of work during classes	LC
LO4	students' reports, preparation for classes, observation of work during classes	LC
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in laboratory classes	30
	Preparation for laboratory classes	9
	Work on reports	10
	Preparation for a final test / exam and participation in it	6
	Participation in student-teacher sessions	5
	TOTAL:	75
Quantitative indicators		HOURS / No. of ECTS credits
Student workload – activities that require direct teacher participation		52 / 2.1
Student workload – practical activities		49 / 1.9

Basic references	1. **Ott H. W., *Electromagnetic compatibility engineering*, NJ: Wiley, Hoboken, 2009.** 2. **Kodali V. P., *Engineering electromagnetic compatibility: principles, measurements, technologies and computer models,* The Institute of Electrical and Electronics Engineers. New York, 2000.** 3. **Williams T., *EMC for systems and installations,* Newnes, Oxford, 2000.** 4. **Williams T., *EMC for product designers: (meeting the European EMC directive)*, Newnes, Oxford, 2000.** 5. **Więckowski T. W., *Badania kompatybilności elektromagnetycznej urządzeń elektrycznych i elektronicznych,* Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2001.**	
Supplementary references	1. **Machczyński W., *Wprowadzenie do kompatybilności elektromagnetycznej*, Wydawnictwo Politechniki Poznańskiej, Poznań, 2010.** 2. **Augustyniak L., *Laboratorium kompatybilności elektromagnetycznej,* Oficyna Wydawnicza Politechniki Białostockiej, Białystok, 2010.** 3. **Ruszel P., *Kompatybilność elektromagnetyczna elektronicznych urządzeń pomiarowych*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2008.** 4. **Sroka J., *Niepewność pomiarowa w badaniach EMC: pomiary emisyjności radioelektrycznej,* Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2009.** 5. **Charoy A., *Zakłócenia w urządzeniach elektronicznych: zasady i porady instalacyjne. Tomy 1, 2, 3, 4,* Wydawnictwa Naukowo-Techniczne, Warszawa, 1999/2000.**	
Organisational unit conducting the course	**Department of Telecommunications and Electronic Equipment**	**Date of issuing the programme**
Author of the programme	**Renata Markowska, DSc PhD Eng**	**26.04.2019**

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Management of telecommunications networks and services</td><td colspan="2">Course code</td><td>TS2E200012</td></tr>
<tr><td colspan="2">Course type</td><td>Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>30</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Acquiring knowledge about the management of networks and services in the field of telecommunications and ICT systems.
The acquisition of practical skills related to the management of technical resources of ICT networks.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture</u>
Management layers, areas, processes and protocols. Contemporary standards in the management of telecommunications services. Standards and recommendations related to the process of managing telecommunications networks and services. Service quality management, SLA agreements. Selected systems and technologies for managing technical resources of ICT networks.

<u>Laboratory classes</u>
Principles of network devices configuration management. Configuring and examining of a centralized system for managing and monitoring devices in ICT networks using SNMP and RMON protocols. Dynamic management of routes in packet networks. Configuration of quality management techniques used in transmission services. Configuration and testing of the VoIP telephony system. Management and monitoring of the wireless local area network. The use of directory services to manage user databases and workstation configuration.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, laboratory classes</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture: written exam
Laboratory classes: evaluation of reports, written short tests, final oral test</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
</table>

LO1	The student describes in a detailed way the functioning of selected systems and technologies for managing the technical resources of ICT networks.	ET2_W05
LO2	The student explains the application of certain standards and recommendations related to the process of managing telecommunications networks and services in relation to the practical implementations of network technologies.	ET2_W05
LO3	The student configures and tests specific protocols and services in ICT networks in the context of managing the given functionalities of these networks and services.	ET2_U14
LO4	The student plans the test methods and performs a practical analysis of the operation of the given protocols and technologies of managing the ICT network resources.	ET2_U14
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	written exam	L
LO2	written exam	L
LO3	evaluation of reports and students' activity, final oral test	LC
LO4	evaluation of reports and students' activity, short written quiz, final oral test	LC
Student workload (in hours)		No. of hours
Calculation	lecture attendance	15
	revising of the content of subsequent lectures	7
	participation in student-teacher sessions (lecture – 2h, laboratory classes – 3h)	5
	preparation for the final exam (5h) and participation in it (2h)	7
	participation in laboratory classes	30
	preparation for laboratory classes and work on reports	11
	TOTAL:	75
Quantitative indicators		HOURS / No. of ECTS credits
Student workload – activities that require direct teacher participation		52 / 2.1
Student workload – practical activities		41 / 1.6
Basic references	1. Dooley K., Brown I.: Cisco IOS Cookbook. O'Reilly Media, Second Edition, 2006. 2. Stallings W.: SNMP, SNMPv2, SNMPv3, and RMON 1 and 2. Addison Wesley, Third Edition, 1998. 3. Wallingford T.: Switching to VoIP. O'Reilly Media, 2005. 4. Manuals and configuration guides for equipment used in laboratory exercises.	
Supplementary references	1. RFC documents (available on the Internet: http://www.rfc-editor.org) 2. Kevin R. Fall, W. Richard Stevens: TCP/IP Illustrated. Volume 1: The Protocols. 2nd Edition, Addison Wesley, 2011. 3. Holme D., Ruest N., et al.: MCTS Self-Paced Training Kit (Exam 70-640): Configuring Windows Server 2008 Active Directory. Microsoft Press, 2011.	

Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment	Date of issuing the programme
Author of the programme	Andrzej Zankiewicz, PhD Eng.	11.05.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Project in fiberoptic networks</td><td colspan="2">Course code</td><td colspan="2">TS2E200013</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td></td><td></td><td></td><td>30</td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">The principle objective of the course is to familiarize students with methods and basic problems in design of fiberoptic networks. Teaching the methodology of development of required project documentation. Developing the ability to make a multimedia presentation of a completed project task.</td></tr>
<tr><td>Course content</td><td colspan="9">During classes a fiberoptic telecommunication network project will be prepared on the basis of specific initial assumptions. The curriculum includes the development of a general concept of a given task. Detailed route development. Design calculations, including power balance, dispersion calculations. Selection of devices. Preparation of project documentation (including schemes and cost estimation). Preparation of a multimedia presentation. Project presentation and discussion.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Discussion with students</td></tr>
<tr><td>Assessment method</td><td colspan="9">Evaluation of the projects</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student knows types of devices used in Fiberoptic networks and their basic parameters.</td><td colspan="2">ET2_W07</td></tr>
<tr><td>LO2</td><td colspan="7">The student develops the route, selects the devices and performs the necessary calculations for the designed fiberopticlink</td><td colspan="2">ET2_U11</td></tr>
<tr><td>LO3</td><td colspan="7">The student is able to develop project documentation for fiberoptic link with respect to main legal conditions.</td><td colspan="2">ET2_U11</td></tr>
<tr><td>LO4</td><td colspan="7">The student can prepare a multimedia presentation of the project in a foreign language.</td><td colspan="2">ET2_K01</td></tr>
<tr><td>LO5</td><td colspan="7">The student can work alone and in a team.</td><td colspan="2">ET2_K02</td></tr>
</table>

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed	
LO1	evaluation of the prepared documentation and discussion	P	
LO2	evaluation of the prepared documentation and discussion	P	
LO3	evaluation of the prepared documentation	P	
LO4	observationduringclasses	P	
LO5	observationduringclasses	P	
Student workload (in hours)		No. of hours	
Calculation	Participation in projectclasses	30	
	Development of the project	15	
	Participation in student – teacher sessions	5	
	TOTAL:	50	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		35	1.4
Student workload – practical activities		50	2
Basic references	1. Chomycz B. Planning fiber optic networks. McGrow-Hill, New York, 2009. 2. standards for design and construction of Fiberoptic telecommunication technical infrastructure 3. ordinance of the Minister of Communications and others regarding the terms of design and construction of telecommunications lines (in Polish) 4. data of the manufacturers, catalogues of the devices		
Supplementary references	-		
Organisational unit conducting the course	Department of Power Engineering, Photonics and Lighting Technology	Date of issuing the programme	
Author of the programme	UrszulaBłaszczak, PhD Eng	16.04.2019	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">ICT network design</td><td colspan="2">Course code</td><td colspan="2">TS2D200014</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td></td><td></td><td></td><td>15</td><td></td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">To help students develop good practices in creating and presenting projects concerning information technology and ICT networks. Familiarize them with the methodology of preparing project documentation.</td></tr>
<tr><td>Course content</td><td colspan="9">Students prepare projects of a network structure for assumed parameters. During classes the following problems are discussed: modelling of network and its resources from the point of view of design, analysis of aims and limitations, scalability of network, level of accessibility, efficiency, characteristics, reporting and estimating network motion; selection of the strategy and mechanisms of network security; design of topology and network structure. A complete project should include a detailed analysis of demands, suggested solutions, diagrams of network structure and the estimate of costs. The projects are presented (usually in a form of multimedia presentation) and discussed during classes.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Implementation of projects, discussions</td></tr>
<tr><td>Assessment method</td><td colspan="9">Evaluation of students' projects</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student knows issues in the field of data transmission and devices included in ICT networks,</td><td colspan="2">EK2_W07</td></tr>
<tr><td>LO2</td><td colspan="7">The student understands the strategy and security mechanisms of ICT networks</td><td colspan="2">EK2_W05</td></tr>
<tr><td>LO3</td><td colspan="7">The student can develop documentation of the project task implementation, prepare and introduce a presentation on the implementation of the project task</td><td colspan="2">EK2_K01</td></tr>
<tr><td>LO4</td><td colspan="7">The student can choose solutions for the designed network, evaluate and compare design solutions</td><td colspan="2">EK2_U11</td></tr>
</table>

LO5	**The student is ready to work in a team, think and act creatively**	**EK2_K02**
Symbol of learning outcome	**Methods of assessing the learning outcomes**	**Type of tuition during which the outcome is assessed**
LO1	**documentation and discussion of the project**	**P**
LO2	**documentation and presentation of the project**	**P**
LO3	**documentation and presentation of the project**	**P**
LO4	**report on project implementation and discussion on the project**	**P**
LO5	**discussion on the project, observation of students 'work in classes**	**P**
Student workload (in hours)		**No. of hours**
Calculation	**Participation in classes**	**15**
	Preparation for classes	**15**
	Implementation of project tasks (including work on reports)	**15**
	Participation in student-teacher sessions related to the classes	**5**
	TOTAL:	**50**
Quantitative indicators		**HOURS** / **No. of ECTS credits**
Student workload – activities that require direct teacher participation		**20** / **0.8**
Student workload – practical activities		**50** / **2**
Basic references	**1. Pathan A.K.(Ed.), Monowar M.M.(Ed.), Fadlullah Z.M.(Ed.):** *Building next-generation converged networks: theory and practice*, **Boca Raton: CRC/Taylor & Francis, 2016.** **2. Iacobucci M.S.:** *Reconfigurable radio systems: network architectures and standards*, **Chichester: John Wiley a. Sons, 2013.** **3. Grzech A.(Ed.):** *Information systems architecture and technology : networks design and analysis*, **Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej, 2012.** **4. Borzemski L. (ED.):** *Information systems architecture and technology : designing, development and implementation of information systems*, **Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej, 2008.**	
Supplementary references	**1. Grzech A.(Ed.):** *Information systems architecture and technology : information systems and computer communication networks*, **Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej, 2008.** **2. Professional magazines on computer networks.** **3. Technical documentation of information technology products.**	
Organisational unit conducting the course	**Department of Telecommunications and Electronic Equipment**	**Date of issuing the programme**
Author of the programme	**Grażyna Gilewska, Ph. D.**	**15.04.2019**

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Antennas and propagation 2</td><td colspan="2">Course code</td><td>TS2E200015</td></tr>
<tr><td colspan="2">Course type</td><td>Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td></td><td></td><td>15</td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">Antennas and Propagation 1</td></tr>
<tr><td>Course objectives</td><td colspan="9">To numerically and experimentally confirm and extend students' knowledge gained during lectures on Antennas and Propagation 1. To train the skills of using software for computer-aided analysis and design of consumer antennas, taking the graphical environment of 4NEC2 as an example.
To acquaint students with measurement techniques of basic antenna parameters used in consumer equipment, including Wi-Fi networks, with electronic measuring apparatus and examples of automation of the measurement process.</td></tr>
<tr><td>Course content</td><td colspan="9">Specialization workshop: Introduction to NEC 2, list of control commands, introduction to 4NEC2 graphical environment. Calculations of characteristics of wire antennas in free space over perfectly conducting ground and over imperfect ground (a rigorous model using the Sommerfeld integrals). Characteristics of a folded dipole and Yagi-Uda antennas. Individual work on a project of a specified antenna system. A multimedia presentation of the completed project, comparative analysis of the results during discussion in the classroom.
Laboratory classes: Measurements of the impedance and matching parameters of radio and television antennas.
Measurements of the radiation characteristics of radio and television antennas.
Measurements of selected types of antennas operating in different frequency ranges, including Wi-Fi.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Specialisation workshop, laboratory classes</td></tr>
<tr><td>Assessment method</td><td colspan="9">Specialisation workshop - verification of preparation for workshop, evaluation of reports, completion, presentation and discussion of a final project;
Laboratory classes - verification of preparation for classes, evaluation of reports.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
</table>

LO1	The student has ordered knowledge on measurements of selected parameters of antennas;	ET2_W04
LO2	The student can obtain information from the literature and other sources, including that in a foreign language; can integrate the information;	ET2_U01
LO3	The student can work individually and in a small team;	ET2_U02
LO4	The student can elaborate documentation on the completion of a project and on the completion of an experiment;	ET2_U03
LO5	The student can prepare and give a presentation on the results of a project;	ET2_U04
LO6	The student can run an experiment: measurement of antenna parameters.	ET2_U08
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	evaluation of students' performance and theoretical background; evaluation of students' reports	LC
LO2	evaluation of students' performance and theoretical background;	LC, SW
LO3	evaluation of students' performance, evaluation of the student's reports	LC, SW
LO4	evaluation of students' reports on measurements or on the project task	LC, SW
LO5	final multimedia presentation concerning the project task	SW
LO6	evaluation of students' performance	LC
Student workload (in hours)		No. of hours
Calculation	Participation in laboratory classes	15
	Preparing for laboratory classes	5
	Work on laboratory reports	5
	Participation in specialisation workshops	15
	Implementation of project tasks and preparing a multimedia presentation of project results	5
	Participation in student-teacher sessions	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	45	1.8

Basic references	1. A. Voors: *4NEC2 - Antenna Modeler and Optimizer*, software available in the Internet. 2. *Laboratory notes*, pdfs available in the Internet: http://teleinfo.pb.edu.pl/ure/. 3. T. A. Milligan: *Modern Antenna Design*, IEEE Press, J. Wiley-Interscience, 2005. 4. J. F. White: *High Frequency Techniques - An Introduction to RF and Microwave Engineering*, Wiley-Interscience, 2004. 5. R. E. Collin: *Antennas and Radiowave Propagation*, McGraw-Hill, 1985.	
Supplementary references	1. G. J. Burke, A. J. Poggio: *Numerical Electromagnetics Code (NEC2) - Method of Moments*, Lawrence Livermore Lab., 1981. 2. I. Hickman: *Practical Radio Frequency Handbook*, Newnes, 2002. 3. *IEEE Antennas and Propagation Magazine*. 4. *IEEE Microwave Magazine*. 5. K. Aniserowicz: *Lecture notes*.	
Organisational unit conducting the course	Department of Telecommunications and Electronic Apparatus	Date of issuing the programme
Author of the programme	Karol Aniserowicz	12.04.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Electronic measurement equipment</td><td colspan="2">Course code</td><td>TS2D200016</td></tr>
<tr><td colspan="2">Course type</td><td>Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>30</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with modern measuring methods, instruments and measuring systems. To equip them with the skills of choosing appropriate electronic measuring instruments for measuring parameters and characteristics of selected systems and electronic devices.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture:
Signal processing in electronic measurement equipment. Measurements of digital signals. Measurement of modulated signals. Vector signal generators. Vector signal analazyers and spectrum analyzers. Vector and scalar network analyzers. Radiocommuncation testers.

Laboratory Classes:
Measurements of signal parameters using advanced digital oscilloscope functions. The use of vector signal analyzers in the measurement of telecommunications signals. Measurements of BER and SNR parameters of telecommunications signals. Measurements of modulated signals with spectrum analyzers. Measurements of selected telecommunications devices using vector network analyzers.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, laboratory</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - written exam,
Laboratory class - evaluation of reports, verification of preparation for classes</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student has a detailed and theoretically founded knowledge in the field of electronic measurements and has a detailed and theoretically founded knowledge on the generation and detection of measurement signals.</td><td colspan="2">ET2_W03, ET2_W04</td></tr>
</table>

LO2	The student is able to use the device's instruction manual and application cards for specialist measurements.	ET2_U01, ET2_U06
LO3	The student can perform measurements of the parameters and characteristics of selected systems and electronic devices.	ET2_U09, ET2_U10
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	written exam	L
LO2	preparation for the laboratory classes, discussion of student's reports	LC
LO3	preparation for the laboratory classes, discussion of student's reports	LC
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in laboratory classes	30
	Work on reports	15
	Participation in student-teacher sessions	5
	Preparation for laboratory classes	10
	TOTAL:	75

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	50	2.0
Student workload – practical activities	55	2.2

Basic references	1.Tumański S.: Principles of Electrical Measurements, Taylor & Francis, 2005. 2. Webster J.G., Electrical Measurement, Signal Processing, and Displays, CRC 2003. 3. Vankka J.: Direct Digital Synthesizer; Theory, Design and Applications. Helsinki University of Technology 2000. 4. Application Notes of Hewlett-Packard, Tektronix, Rohde-Schwarz and Agilent instruments.
Supplementary references	1. Northrop R.B.: Introduction to Instrumentation and Measurements, Taylor & Francis, CRC Press, 2005. 2. Manuals of modern instruments.
Organisational unit conducting the course	Department of Telecommunication and Electronic Equipment — Date of issuing the programme
Author of the programme	Maciej Sadowski, Ph.D. — 23.04.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Methods of modulation and detection of optical radiation</td><td colspan="2">Course code</td><td colspan="2">TS2E200017</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td>15</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Presentation selected issues in the field of sources and detectors of optical radiation. Familiarization students with methods of modulation and detection of optical radiation. Teaching metrology of selected parameters of radiation sources and detectors.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture:</u> Optical radiation properties - methods of light modulation. Materials used for optical radiation modulators. Amplitude, phase, frequency, polarization modulation. External modulation of radiation, modulators: elektro-optical, acosto-optical and magneto-optical. Internal modulation of radiation in light emitting diodes and in lasers. Optical fiber modulators. Usable characteristics of radiation sources and detectors. Direct and indirect, incoherent and coherent detection. Complex detection methods. Developmental trends in the construction of detectors and modulators.
<u>Classes:</u> Parameters of modulators: elektro-optical, acosto-optical and magneto-optical. Internal modulation of radiation in light emitting diodes and in lasers. Optical fiber modulators. Parameters of detectors and complex detection systems.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, classes.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture: final test
Exercises: written test</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student discusses the properties of the optical wave in the external physical field,</td><td colspan="2">ET2_W01</td></tr>
<tr><td>LO2</td><td colspan="7">The student lists and describes modulation methods of optical radiation,</td><td colspan="2">ET2_W02, ET2_W03</td></tr>
<tr><td>LO3</td><td colspan="7">The student explains working principles of optical radiation modulation systems,</td><td colspan="2">ET2_W04</td></tr>
</table>

LO4	The student lists and describes the methods of optical radiation detection,	ET2_W04, ET2_W06
LO5	The student designs system of modulation and detection of optical radiation with the use of specific elements,	ET2_U07, ET2_U12, ET2_K01
LO6	The student calculates and analyses the properties and parameters of modulation and detection of radiation.	ET2_U07, ET2_U12, ET2_K01
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	final test	L
LO2	final test	L
LO3	final test	L
LO4	final test	L
LO5	written test	C
LO6	written test	C
Student workload (in hours)		No. of hours
Calculation	Participation in lectures	15
	Participation in student –teacher sessions	5
	Preparation for a lecture test	5
	Participation in classes	15
	Preparation for classes	5
	Preparation for classes tests	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	20	0.8

Basic references	1. Robert G. Hunsperger, Integrated Optics, Theory and Technology, Springer 2009. 2. Janesick J.: Scientific Charge-Coupled Devices, SPIE Press, Washington, 2001. 3. Robert G. Hunsperger, Integrated Optics, Theory and Technology, Springer 2009 4. Jamal Deen A., Basu P.K., Silicon photonics : fundamentals and devices, Chichester : John Wiley a. Sons, 2012. 5. Jianjun Gao: Optoelectronic Integrated Circuit Design and Device Modeling, Wiley, 2011.
Supplementary references	1. Owsik J., Wiecek T., Optoelectronic metrology, SPIE, USA, 2000.

Organisational unit conducting the course	Department of Power Engineering, Photonics and Lighting Technology	Date of issuing the programme
Author of the programme	Lukasz Gryko, PhD Eng	10.04.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Power systems in optical telecommunication</td><td colspan="2">Course code</td><td colspan="2">TS2E200018</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>15</td><td>0</td><td>0</td><td>0</td><td>No. of ECTS credits</td><td colspan="2">1</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Acquiring the ability to design, develop documentation and presentation of power supply and transmission systems for applications in optical telecommunication.</td></tr>
<tr><td>Course content</td><td colspan="9">Power systems for semiconductor radiation emitters. Techniques of: amplitude modulation and pulse duration of an optical signal. Devices for conversion optical radiation into an electrical signal. Power systems for semiconductor detectors. Thermal point stabilization of emitters and detectors, thermal power dissipation. Computer tools supporting electronic and optical elements design process.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Project</td></tr>
<tr><td>Assessment method</td><td colspan="9">Realization of project, project defense.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student decomposes the system into component modules and designs each module</td><td colspan="2">ET2_U13</td></tr>
<tr><td>LO2</td><td colspan="7">The student correctly selects elements and use computer tools to design elements of transmission channel</td><td colspan="2">ET2_U07, ET2_U01, ET2_U08</td></tr>
<tr><td>LO3</td><td colspan="7">The student develops project documentation</td><td colspan="2">ET2_U03</td></tr>
<tr><td>LO4</td><td colspan="7">The student performs an approximate economic analysis of the project cost</td><td colspan="2">ET2_U12</td></tr>
<tr><td>LO5</td><td colspan="7">The student prepares and presents a presentation on the subject</td><td colspan="2">ET2_U04</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Methods of assessing the learning outcomes</td><td colspan="2">Type of tuition during which the outcome is assessed</td></tr>
</table>

LO1	project documentation and presentation of results	P	
LO2	project documentation and presentation of results	P	
LO3	project documentation and presentation of results	P	
LO4	project documentation and presentation of results	P	
LO5	project documentation and presentation of results	P	
Student workload (in hours)		No. of hours	
Calculation	Participation in project classes	15	
	Realization project and presentation	3	
	Participation in student –teacher sessions	5	
	Preparation for classes	2	
	TOTAL:	25	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		20	0.8
Student workload – practical activities		25	1
Basic references	1. Jianjun Gao: Optoelectronic Integrated Circuit Design and Device Modeling, Wiley, 2011. 2. Jurgen F., Virander K.J.: Optical Communications: Components and Systems : Analysis design optimization application, CRC Press. WKŁ, New Delhi, 2000. 3. Jamal Deen A., Basu P.K., Silicon photonics : fundamentals and devices, Chichester : John Wiley a. Sons, 2012.		
Supplementary references			
Organisational unit conducting the course	Department of Power Engineering, Photonics and Lighting Technology	Date of issuing the programme	
Author of the programme	Lukasz Gryko, PhD Eng	10.04.2019	

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Telecommunication systems of navigation and localization</td><td colspan="2">Course code</td><td colspan="2">TS2D200019</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">Information theory and coding</td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with the basic principles of radionavigation and radiolocation systems operation, methods of determining the user position in space and the use of radionavigation and radiolocation techniques. This knowledge will be expanded with practical skills gained in the specialization workshop.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Methods of geolocation with using radio waves. Measurements of the moving object range, velocity and angles. Global Positioning System (GPS): architecture, basic principles of operation, signal coding and modulation, accuracy and implementations. Geolocation in the cellular mobile communication systems. Hybrid systems GSM-GPS. Basics of the radar techniques. Radar signals. Ambiguity function. Pulse compression. Radar detection range. Doppler radars. MTI and MTD. SAR and ISAR radars. Radar signal and data processing algorithms. Mono- and bi-static radars. Implementations of the radionavigation and radiolocation systems in different fields of civil and military applications.
Specialization workshop: Signal processing of selected navigation and radiolocation systems for distance and speed measurement, and position determination; use of navigation and tracking methods.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, problem solving, numerical simulation experiments</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture – written test,
Specialization workshop – evaluation of reports and evaluation of the student's performance in workshop.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student has knowledge about the methods of determining the user position in space.</td><td colspan="2">ET2_W07</td></tr>
</table>

LO2	The student has knowledge about the operation principles of basic radionavigation and radiolocation systems, and the signal processing methods used.	ET2_W07
LO3	The student has knowledge about the areas of application of radionavigation and radiolocation devices and the main achievements in these areas.	ET2_U14
LO4	The student has practical skills in the field of signal processing to measure distance, speed and position, as well as the ability to use tracking and navigation methods.	ET2_U11
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	test	L
LO2	test	L
LO3	evaluation of student's performance at the workshop and evaluation of student's reports	SW
LO4	evaluation of student's performance at the workshop and evaluation of student's reports	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in workshop	15
	Preparation for the final test and workshop	10
	Work on reports	5
	Participation in student-teacher sessions	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	25	1

Basic references	1. Bekir E., Introduction to Modern Navigation Systems, World Scientific Publishing Company, 2007. 2. Laugier C., Chatila R. (Eds.), Autonomous Navigation in Dynamic Environments, Springer; 2007. 3. R. Zekavat, R. M. Buehrer (ed.), Handbook of Position Location: Theory, Practice and Advances,Wiley-IEEE Press, 2011. 4. Kaplan E. D., Hegarty C. (Eds.), Understanding GPS: Principles and Applications, Artech House, 2006. 5. M. Skolnik: Introduction to Radar Systems, McGraw-Hill, Boston, MA, 2001.

Supplementary references	**1. M. Adams, E. Jose, Robotic navigation and mapping with radar , Artech House, 2012.** **2. H. Meikle, Modern radar systems, Artech House, 2001.** **3. Fuller R., Koutsoukos X.D. (Eds.), Mobile Entity Localization and Tracking in GPS-less Environnments, Springer, 2009.** **4. . M. Adams, E. Jose, Robotic navigation and mapping with radar , Artech House, 2012.** **5. Tetley L.; Calcutt D., Electronic Navigation Systems, Elsevier, 2001.**	
Organisational unit conducting the course	**Department of Telecommunications and Electronic Equipment**	**Date of issuing the programme**
Author of the programme	**Dariusz Jańczak, Ph.D.**	**09.04.2019**

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Mobile applications</td><td colspan="2">Course code</td><td colspan="2">TS2E200101</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">The aim of the course is to obtain knowledge of programming mobile devices. The result of the course is to acquire practical skills in mobile application development.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture</u>: Mobile platforms, introduction to the Android system. XML, Java - preparation for programming in the Android system. Basic Android SDK tools. Application resources. A user interface concept. Intentions, fragments. A user interface - layouts. Content providers, services, notifications. Dialogues, sensors. Multimedia.
<u>Specialization workshop</u>: Configuration of the Android Studio. The basic Android Software Development Kit (SDK) tools. Introduction to the graphic design of the user interface. The fundamentals of programming for the Android system: basic GUI components, layouts, menu. The basics emelents of Android: Services, BroadcastReceivers, Notifications. Handling sensors using the Android sensor framework. Multimedia system.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture and specialization workshop</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - test; specialisation workshop - evaluation of reports</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student understands the cycle of life of mobile applications and knows the process of designing, developing and testing applications for mobile devices.</td><td colspan="2">ET2_W07</td></tr>
<tr><td>LO2</td><td colspan="7">The student is able to design and develop a fully functional application for mobile devices.</td><td colspan="2">ET2_W01, ET2_U12</td></tr>
<tr><td>LO3</td><td colspan="7">The student is able to develop graphical interfaces, which are</td><td colspan="2">ET2_U12</td></tr>
</table>

	controlled by the user via touch, voice and motion.	
LO4	The student is able to develop applications that support multimedia, network operations, and selected optional hardware components.	ET2_U13
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	tests on lecture content	L
LO2	evaluating students' reports, observation of work in class	SW
LO3	evaluating students' reports, observation of work in class	SW
LO4	evaluating students' reports, observation of work in class	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance:	15
	Participation in specialisation workshop:	15
	Required reading:	7
	Work on reports:	15
	Participation in student-teacher sessions:	5
	Preparation for specialisation workshop:	14
	Preparation for the final test:	4
	TOTAL:	75

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	44	1.8

Basic references	1. Griffiths D., Griffiths D., "Android: pprogramowanie aplikacji", tyt. oryg. "Head first Android development", Gliwice : Helion, 2018 2. Annuzzi J., Darcey L., Conder S. "Android : wprowadzenie do programowania aplikacji", tyt. oryg. "Introduction to Android application development : Android essentials", Gliwice : Helion, 2016. 3. Zapata B. C. "Studio : podstawy : najlepsze IDE dla programistów platformy Android!", tyt. oryg. "Android Studio essentials", Gliwice : Helion, 2016.
Supplementary references	1. Sillars D., "Wydajne aplikacje dla systemu Android : programuj szybko i efektywnie", tyt. oryg. "High performance Android Apps : improve ratings with speed, optimizations, and testing", Gliwice : Helion, 2017. 2. Verma P., Dixit A., "Bezpieczeństwo urządzeń mobilnych : receptury", tyt. oryg. "Mobile device exploitation cookbook", Gliwice : Helion, 2017.

Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment	Date of issuing the programme
Author of the programme	Krzysztof Konopko, Ph. D.	30.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Databases and data warehouses</td><td colspan="2">Course code</td><td colspan="2">TS2E200102</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">To familiarize students with the knowledge of database systems and database languages. To help them acquire the skills of designing and using databases and database processing in different systems.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture</u>: Introduction to database and data warehouse systems, basic terminology. History of database system development as well as their position and role in information system. Concept of relational model of data: terminology of relation, modelling of connections, notion of data integrity. Other models of data. Basics of SQL: definition and modification of data, queries, control of data. Design and management of a database: user interface, processing and optimisation of queries, protection, encoding and restoration of data. Processing of transactions. Problems of design and construction of a warehouse: design periods, definition of needs. Development trends of database and data warehouse systems.
<u>Seminar workshop</u>: verifications of data integrity, connections, queries, subqueries, transactions on testing data. Standards of SQL language: key words, identifiers, names, notation; definition, manipulation and connectivity of data. Design, programming and implementation of a database: modelling of a database and its constraints, forming and processing of queries, management of memory and transactions.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Informative and problem lecture, discussions, implementation of projects</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - written test; Seminar workshop - evaluation of projects, verification of preparation for classes</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student knows the basic concepts of a relational data model, design techniques and security of databases.</td><td colspan="2">ET2_W05</td></tr>
<tr><td>LO2</td><td colspan="7">The student can develop documentation of the project task</td><td colspan="2"></td></tr>
</table>

	implementation, prepare and introduce a presentation on the implementation of the project task.	ET2_U03
LO3	The student can choose solutions for the designed database, evaluate and compare design solutions and can discuss their results.	ET2_W01, ET2_U11, ET2_U12
LO4	The student is ready to work in a team, think and act creatively.	ET2_U02 ET2_K02
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	final test, documentation of the project	L, SW
LO2	documentation and presentation of the project	SW
LO3	report on project implementation and discussion on the project	SW
LO4	discussion on the project, observation of students 'work in classes	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in seminar workshop	15
	Preparation for seminar workshop	15
	Completion of project tasks (including work on reports)	15
	Participation in student-teacher sessions related to the classes	5
	Preparation for and participation in the final test	10
	TOTAL:	75

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	36	1.4
Student workload – practical activities	60	2.4

Basic references	1. Kroenke D.M., Auer D.J.: Database concepts, Upper Saddle River: Pearson Education, 2011. 2. Garcia-Molina H., Ullman J.D., Widom J.: Database systems: the complete book, Upper Saddle River: Prentice-Hall, 2002. 3. Elmasri R.A., Navathe S.B.: Fundamentals of database systems, Boston: Pearson Addison-Wesley, 2011. 4. Džeroski S. (Ed.), Lavrač N.(Ed.): Relational data mining, Berlin: Springer-Verlag, 2001. 5. Gryz J.: Database query optimization with soft constraints, Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej, 2008.
Supplementary references	1. Connolly T.M., Begg C.E., StrachanA.D.: Database systems: a practical approach to design, implementation and management, Harlow : Addison-Wesley Publ., 1996. 2. Ras Z.W.(Ed.), Dardzińska A.(Ed.): Advances in data management, Berlin: Springer, 2009. 3. Król D.(Ed.), Nguyen N.T.(Ed.), ShiraiK.(Ed.): Advanced topics in intelligent

	information and database systems, Cham: Springer, 2017.	
Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment	Date of issuing the programme
Author of the programme	Grażyna Gilewska, Ph. D.	15.04.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunication</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Digital radio links</td><td colspan="2">Course code</td><td>TS2E200103</td></tr>
<tr><td colspan="2">Course type</td><td>Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td></td><td>15</td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">Antennas and propagation 1</td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with the characteristics of propagation channels and the structure of digital radio and satellite broadcasting. To teach them how to design digital radio links and how to determine their structures, configurations, parameters and properties.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Radio channels of digital systems. Structure, parameters, properties, energy balance of digital radio links. Ultra-wideband digital systems, UWB signals, modulation, transmitters and receivers for UWB and UMTS systems. Satellite broadcasting, energy balance of a satellite link, transmission of digital signals and the structure of systems.
Project: Designing of digital radio links. Determination of antennas' height, energy balance, radio link parameters. Selection of appropriate equipment.
circuits.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, project</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - final test; Project - completion, presentation and discussion of the project</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student has knowledge in the field of signal and data transmission in digital radio systems</td><td colspan="2">ET2_W05</td></tr>
<tr><td>LO2</td><td colspan="7">The student has a detailed knowledge of the devices operating in radio digital networks</td><td colspan="2">ET2_W07</td></tr>
<tr><td>LO3</td><td colspan="7">The student can design digital radio link in accordance with the set requirements</td><td colspan="2">ET2_W01, ET2_U11, ET2_U12</td></tr>
<tr><td>LO4</td><td colspan="7">The student can acquire information from literature and other sources</td><td colspan="2">ET2_U01</td></tr>
<tr><td>LO5</td><td colspan="7">The student develops the technical documentation of the</td><td colspan="2">ET2_U03</td></tr>
</table>

	project of digital radio link		
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed	
LO1	final test	L	
LO2	final test	L	
LO3	observation of work in project classes, project documentation, discussion of the project	P	
LO4	observation of work in project classes, project documentation, discussion of the project	P	
LO5	project documentation, discussion of the project	P	
Student workload (in hours)		No. of hours	
Calculation	Lecture attendance	15	
	Participation in classes	15	
	Participation in student-teacher sessions	5	
	Completion of project tasks	25	
	Preparation for the final test	15	
	TOTAL:	75	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		35	1.4
Student workload – practical activities		40	1.6
Basic references	1. Budden K.G., The Propagation of Radio Waves: The Theory of Radio Waves, Cambridge University Press 1985. 2. Salema C., Microwave radio links: from theory to design, Wiley 2003.		
Supplementary references	1. Blaunstein N., Christodoulou C., Radio Propagation and Adaptive Antennas for Wireless Communication Links: terrestrial, atmospheric and ionospheric, Wiley 2007. 2. Angueira P., Romo J., Microwave Line of Sight Link Engineering, Wiley 2012. 3. Rodo G., Troposcatter radio links, Artech House 1988.		
Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment	Date of issuing the programme	
Author of the programme	Marek Garbaruk, Ph.D.	12.04.2019	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work,

S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Masters' degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Wave optics</td><td colspan="2">Course code</td><td colspan="2">TS2E200104</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Acquainted students with the method of radiation propagation analysis in homogeneous and heterogeneous media. Familiarization with the analysis of selected measurement systems using wave phenomena. Acquainted with the methods of polarization state analysis. Familiarization with selected measuring systems.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture</u>:
Geometric optics and wave optics. Wave phenomena in optics. Electromagnetic radiation - Maxwell's equations. Huygens principle. Interference of radiation and its application in metrology. Interferometers. Diffraction - exemplary measurement applications. Polarization state of radiation, the methods of analysis and synthesis of a specific state of polarization. Selected adaptive optics systems with distributed aperture. Propagation of radiation in heterogeneous media. Nanooptics.
<u>Laboratory</u>:
Interferometers. Diffraction phenomena.Two-point resolution. Polarization.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">lecture – presentations and problems discussion, laboratory – experiments conducted in the groups</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - written exam; Laboratory class - evaluation of reports, verification of preparation for classes</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student identifies and explains the essence of wave phenomena in optics.</td><td colspan="2">ET2_W01, ET2_W06</td></tr>
<tr><td>LO2</td><td colspan="7">The student describes structure and working principle of selected basic measurement systems using diffraction, interference and polarization phenomena.</td><td colspan="2">ET2_W01, ET2_W04, ET2_U12</td></tr>
<tr><td>LO3</td><td colspan="7">The student builds measurement systems and conducts simple experiments in the field of wave optics and analyses their results.</td><td colspan="2">ET2_W04, ET2_U08</td></tr>
</table>

LO4	The student is able to work individually and in a team.	ET2_U02	
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed	
LO1	written test	L	
LO2	written test	L	
LO3	observation of work during laboratory classes, evaluation of reports and verification of preparation for classes	LC	
LO4	observation of work during laboratory classes	LC	
Student workload (in hours)		No. of hours	
Calculation	Participation in lectures	15	
	Participation in laboratory classes	15	
	Preparation for a final test	15	
	Preparation for verification of preparation for laboratory classes	10	
	Work on reports	15	
	Participation in student-teacher sessions	5	
	TOTAL:	75	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		35	1.4
Student workload – practical activities		40	1.6
Basic references	1. Mansuripur M. Classical optics and its applications, Cambridge University Press, Cambridge, 2009 2. Born. M., Wolf. E.: Principles of optics 7th Edition, Pergamon Press 1999.		
Supplementary references	1. L.Nowotny, B.Hecht; Principles of nano-optics, Cambridge UniversityPress, 2007.		
Organisational unit conducting the course	Department of Electrical Power Engineering, Photonics and Lighting Technology	Date of issuing the programme	
Author of the programme	Urszula Błaszczak, dr inż.	17.04.2019	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master’s degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Optical sensors and microsystems</td><td colspan="2">Course code</td><td>TS2E100105</td></tr>
<tr><td colspan="2">Course type</td><td>elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">To familiarize students with the methods of measuring and equipment used in optoelectronic metrology and spectroscopic measurement methods. To get them acquainted with measuring methods utilizing the phenomenon of diffraction, interference and the analysis of the state of polarization of optical wave. To familiarize them with chosen methods of measurements in fiber optic networks and the principles and skills of application of optoelectronic measuring instruments.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: The measurement of optical power. Spectral methods and instrumentation. The use of diffraction and interference phenomena in optoelectronics. The application of analysis of the light beam polarization state in optoelectronic metrology. Optical fiber sensors. Specialized measurements in fiber optic microsystems.
Laboratory: Biochemical optical sensor. Fiber Bragg gratings. Polarisation sensors. Semiconductror microsensors and systems. Measurements of physical properties by optoelectronic devices. Sensor layers. Stimulated Enhanced Raman Scattering. Multipoint sensing and distributed sensor nets.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture - multimedia presentation; Laboratory classes - experiments, discussion.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - final test; Laboratory class - evaluation of reports, tests of preparation for classes.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student lists and classifies optoelectronic measurement methods, characterizes parameters of fiber optic networks</td><td colspan="2">ET2_W03, ET2_W04</td></tr>
<tr><td>LO2</td><td colspan="7">The student describes constructions of optoelectronic measurement devices</td><td colspan="2">ET2_W03, ET_W06</td></tr>
<tr><td>LO3</td><td colspan="7">The student applies appropriate measurement methods when characterizing optical properties,</td><td colspan="2">ET2_U05, ET2_U09, ET2_U12</td></tr>
</table>

LO4	The student is able to plan the testing process of selected photonic elements, indicates the usefulness of known measurement methods in technology.	ET2_W01, ET2_U11, ET2_U12
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	final test	L
LO2	final test	L
LO3	reports	LC
LO4	reports, observation during laboratory	LC
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Laboratory attendance	15
	Participation in consultations	5
	Preparation for the exam and participation in it	5
	Preparation for laboratory classes	15
	Development of results from laboratory exercises – reports	20
	TOTAL:	75
Quantitative indicators		HOURS / No. of ECTS credits
Student workload – activities that require direct teacher participation		35 / 1.4
Student workload – practical activities		50 / 2
Basic references	1. Kasap, Safa, Cambridge illustrated handbook of optoelectronics and photonics, Cambridge : Cambridge University Press, 2012. 2. M. Jamal Deen, P.K. Basu, Silicon photonics : fundamentals and devices, Chichester : John Wiley a. Sons, 2012. 3. Sergio Martellucci, et.all. Optical Sensors and Microsystems, Springer, 2000	
Supplementary references		
Organisational unit conducting the course	Department of Electrical Power Engineering, Photonics and Lighting Technology	Date of issuing the programme
Author of the programme	Jacek Zmojda,PhDDSc.	08.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Methods of artificial intelligence</td><td colspan="2">Course code</td><td>TS2E200107</td></tr>
<tr><td colspan="2">Course type</td><td>Optional</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td>3</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9"><u>Lecture:</u> to acquaint students with basic methods and tools of Artificial Intelligence (AI) and their application in electronics and telecommunication.
<u>Specialization workshop:</u> to acquire practical skills, enabling implementation of basic algorithms of AI to solve selected engineering problems in electronics and telecommunication.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture:</u>
Basic concepts, terms and areas of application of Artificial Intelligence. Models of an artificial neuron, basic architectures of neural networks: Multi-Layer Perceptrons (MLP), Radial Basis Functions (RBF), self-organizing networks (Kohonen maps, LVQ neural networks). Application of neural networks: approximation, prediction, classification, signal processing, modelling of dynamic systems.
Basic concepts and terms of fuzzy systems, fuzzy sets and fuzzy relations. Fuzzy models, fuzzy systems for pattern recognition, modelling, classification and control. Methodology of development fuzzy systems and fuzzy control.
Basic concepts of genetic algorithms: methods of chromosome construction, genetic operators, selection methods, population models. Application of genetic systems.

<u>Specialization workshop:</u>
Application of MLP and RBF neural networks to approximation of multi-dimensional mappings and classification of data sets. Solving classification problems with competitive and self-organizing networks. Neural modelling of dynamic systems and development of neural control structures.
Building fuzzy approximators of static mappings and fuzzy models of dynamic systems. Control of dynamic objects using fuzzy systems.
Application of genetic algorithms in static optimization tasks.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Informational lecture (using multimedia)
Specialization workshop – solving simulation tasks in small teams (in a specialized software environment)</td></tr>
</table>

Assessment method	Lecture: final (written) test, checking the fulfilment of learning outcomes Specialization workshop: evaluation of written reports, discussion on reports	
Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
LO1	The student describes basic architectures of artificial neural networks (ANN), learning algorithms and methodology of ANN application to solve selected engineering problems	ET2_W08
LO2	The student explains the concept of fuzzy systems, describes the structure of a fuzzy model and principles of developing fuzzy models	ET2_W08
LO3	The student explains the functioning of a genetic algorithm, enumerates and describes genetic operations and application methodology for genetic algorithms	ET2_W08
LO4	The student applies artificial neural networks to solve selected problems of function approximation, system modelling, data classification and control	ET2_W01, ET2_U12
LO5	The student builds a fuzzy system, appropriate for solving a given engineering problem in electronics and/or telecommunication	ET2_U12
LO6	The student applies a genetic algorithm to find an optimal solution of a selected problem from the field of electronics and/or telecommunication	ET2_U12
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	a written test, assessing learning outcomes in the area of knowledge	L
LO2	a written test, assessing learning outcomes in the area of knowledge	L
LO3	a written test, assessing learning outcomes in the area of knowledge	L
LO4	evaluation of student's reports and preparation to the workshop, discussion on student's reports	SW
LO5	evaluation of student's reports and preparation to the workshop, discussion on student's reports	SW
LO6	evaluation of student's reports and preparation to the workshop, discussion on student's reports	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Specialization workshop attendance	15
	Participation in the student-teacher sessions	5
	Preparation to the final test and participation in the test	12
	Preparation to the specialization workshop	12
	Work to complete the reports	16
	TOTAL:	75

Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		37	1.5
Student workload – practical activities		43	1.7
Basic references	1. S. Haykin: “Neural networks: a comprehensive foundation”, 2nd ed., Prentice-Hall, Upper Saddle River, 1999 2. R. Jensen: “Computational intelligence and feature selection: rough and fuzzy approaches”, John Wiley and Sons, Hoboken, 2008 3. M. Norgaard, et al.: “Neural networks for modelling and control of dynamic systems: a practitioner’s handbook”, Springer-Verlag, London, 2000 4. I. T. Nabney: “Netlab: algorithms for pattern recognition”, Springer-Verlag, London, 2002 5. R. Poli, et al.: “A field guide to genetic programming”, Lulu Enterprises, 2008.		
Supplementary references	1. V. Cherkassky: “Learning from data: concepts, theory, and methods”, 2nd ed., John Wiley and Sons, Hoboken, 2007 2. V. Kecman, Vojislav: “Learning and soft computing: support vector machines, neural networks, and fuzzy logic models”, Massachusets Institute of Technology, Cambridge, 2001 3. G.P. Liu: “Nonlinear identification and control : a neural network approach”, Springer-Verlag, London, 2001 4. B. M. Wilamowski, J. D. Irwin (eds.): “Intelligent systems”, CRC/Taylor & Francis, Boca Raton, 2011		
Organisational unit conducting the course	Department of Control Engineering and Electronics	Date of issuing the programme	
Author of the programme	Miroslaw Swiercz, PhD, DSc, Assoc. Prof.	3.04.2019	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work,

S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Digital signal processors
in telecommunication systems</td><td colspan="2">Course code</td><td>TS2DE00108</td></tr>
<tr><td colspan="2">Course type</td><td>Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with the knowledge related to Digital Signal Processor (DSP) software development and the implementation of basic methods of digital signal processing used in telecommunication. The above knowledge will be extended by practical skills gained in the laboratory classes, during which the student performs implementation of the telecommunications tasks on a selected DSP platform.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Digital Signal Processors characteristics and their use in telecommunications. Overview of currently produced DSP. DSP computer architecture. Designing systems using DSPs. Overview of the selected DSP processor used in telecommunications devices.
Overview of the whole process starting from the design of a digital signal processing method to the implementation on a DSP platform. Software development using C and assembler, software development tools, IDE, API, software optimization, real time data exchange and analysis. Programming tips. The use of the processor peripherals and external devices. Real-time performance. Dedicated real-time operating system. DSP implementation of selected methods used in telecommunication systems.
Laboratory class: Digital Signal Processor software development. DSP implementation of selected methods used in telecommunication systems. Student projects.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, laboratory class, problem solving, implementation on DSP system.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - test;
Laboratory class - evaluation of students' reports and performance in classes.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student knows issues of DSPs architecture and peripheral devices, and knows principles of using DSPs to perform basic tasks encountered in telecommunications.</td><td colspan="2">ET2_W07, ET2_W06</td></tr>
</table>

LO2	The student is familiar with the issues of software development and knows the principles of DSP implementation of selected methods used in telecommunications.	ET2_W07, ET2_W06
LO3	The student can develop software on a DSP system with the use of C and IDE, API and dedicated real-time operating system.	ET2_U07, ET2_U11, ET2_U12
LO4	The student can formulate the algorithm realisation of basic method used in telecommunication and is able to implement it on DSP system.	ET2_U07, ET2_U11, ET2_U12
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	test	L
LO2	test	L
LO3	evaluation of students' reports and performance in classes	LC
LO4	evaluation of students' reports and performance in classes	LC
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in laboratory classes	15
	Work on reports	8
	Participation in student-teacher sessions	5
	Preparation for laboratory classes and a final test	7
	TOTAL:	50
Quantitative indicators		HOURS / No. of ECTS credits
Student workload – activities that require direct teacher participation		35 / 1.4
Student workload – practical activities		28 / 1.1
Basic references	1. Kehtarnavaz N., Real-Time Digital Signal Processing: Based on the TMS320C6000. Newnes, 2005. 2. Welch T. B., Wright C.H.G., Morrow M.G., Real-time Digital Signal Processing from Matlab to C with the TMS320C6x DSPs, Taylor & Francis, 2012. 3. Texas Instruments, TMS320C6000 Programmer's Guide, 2006. 4. Texas Instruments, TMS320C6000 DSP Peripherals Overview, 2007.	
Supplementary references	1. Chassaing R., Digital Signal Processing and Applications with the C6713 and C6416 DSK, Willey&Sons, New York, 2005. 2. Dahnoum N., Digital Signal Processing Implementation using the TMS320C6000 DSP platform. Prentice Hall, 2000. 3. Kuo S M, Lee B. H., Tian W., Real-Time Digital Signal Processing. Implementations and Applications. Willey&Sons, New York, 2006. 4. Oshana R., DSP Software Development Techniques for Embedded and Real-Time Systems: Embedded Technology. Newnes, 2006.	
Organisational	Department of Telecommunications and Electronic	Date of issuing the

unit conducting the course	Equipment	programme
Author of the programme	Dariusz Jańczak, Ph. D.	09.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Software defined radio</td><td colspan="2">Course code</td><td>TS2E200109</td></tr>
<tr><td colspan="2">Course type</td><td>Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with the concept of a programmable radio (Software Defined Radio) and the techniques used for its implementation.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture:
Architecture and components of the radio system. Concept of a programmable radio (Software Defined Radio). Basics of design of programmable radio: analogue inputs, link power budget, C/N ratio. RF signals and their spectrum, sampling, sub-sampling, filtering, translation of frequency. Modulation and demodulation. Filters and structure of adaptive PLL. Synchronization and track carrier frequency and phase. Software and hardware platforms and programmable radio. Cognitive radio.

Specialization Workshop:
Familiarization with selected hardware platforms for programmable radio (RTL283U, Hack RF, USRP). Practical implementations of programmable radio - GNU Radio. Work in the GNU Radio environment. Construction of the signal flow graph. Simple applications for receiving radio signals (analogue radio). The use of RTL system (dongle) to receive radio signals.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, specialisation workshop.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - written exam; Specialisation Workshop - evaluation of reports, verification of preparation for classes.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student knows and understands the basic concepts of programmable radio technology;</td><td colspan="2">ET2_W06, ET2_W08</td></tr>
</table>

LO2	The student knows and understands basic algorithms used for programmable radio	ET1_W04, ET1_W07
LO3	The student can apply acquired methods and algorithms for the analysis and processing of radio signals;	ET2_U07
LO4	The student can design a simple SDR system and carry out measurements of its characteristics.	ET2_U11
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	final test	L
LO2	final test	L
LO3	evaluation of students' reports and preparation for laboratory classes	SW
LO4	evaluation of students' reports and preparation for laboratory classes	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in workshop	15
	Work on reports	10
	Participation in student-teacher sessions	5
	Preparation for the final test / exam	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	30	1.2

Basic references	1. Palicot J. (ed.): *Radio Engineering: From Software Radio to Cognitive Radio,* Wiley & Sons, ISTE, 2011. 2. Rondeau T.W., Bostian C.W.: *Artificial Intelligence in Wireless Communications*, Artech House, 2009. 3. Kennington P. B.: *RF and baseband techniques for Software Defined Radio*, Artech House, 2005.
Supplementary references	1. Iacobucci M.S.*: Reconfigurable Radio Systems: Network Architectures and Standards*, Wiley & Sons, 2013. 2. Biglieri E., Goldsmith A.J., Greenstein L.J., Mandayam N.B., Poor H.V., *Principles of Cognitive Radio*, Cambridge UP, 2012. 3. Burns P.: *Software Defined Radio for 3G*, Artech House, 2003.
Organisational unit conducting the course	Department of Telecommunication and Electronic Equipment — Date of issuing the programme
Author of the programme	Maciej Sadowski, Ph.D. — 23.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Wireless broadcasting systems</td><td colspan="2">Course code</td><td>TS2E200110</td></tr>
<tr><td colspan="2">Course type</td><td>Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">To enable students to become acquainted with the International Frequency Allocation Table, the block structure of broadcasting equipment, and the standards of digital television (DVB) family. To introduce them to analogue and digital radio standards</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture:
International organizations for broadcasting. International Telecommunication Union, Radio Regulations, World Radiocommunication Conference, The International Frequency Allocation Table, National Regulations for Frequency Assignment. Block structure of transmitters. Main functional blocks of transceivers. Antennas and antenna arrays of radio transmitters. Digital television - DVB family standards. Analogue radio. Digital radio standards DAB and DRM.
Laboratory classes:
Measurement of selected parameters of analogue radio receivers.Measurements of selected parameters of the receiving antennas. Analysis of the Transport Stream contents in the DVB stream.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, laboratory</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - written exam,
laboratory class - evaluation of reports, verification of preparation for classes</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student is able to determine the structure of radio devices,</td><td colspan="2">ET2_W03, ET2_W07, ET2_W06</td></tr>
<tr><td>LO2</td><td colspan="7">The student understands the principles of operation of digital TV standards,</td><td colspan="2">ET2_W03, ET2_W06</td></tr>
<tr><td>LO3</td><td colspan="7">The student performs measurements of functional blocks of radio devices,</td><td colspan="2">ET2_U08,</td></tr>
</table>

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed	
LO1	final test	L	
LO2	final test	L	
LO3	evaluation of students' reports and preparation for laboratory classes	LC	
Student workload (in hours)		No. of hours	
Calculation	Lecture attendance	15	
	Participation in classes	15	
	Preparation for laboratory classes	5	
	Work on reports	5	
	Participation in student-teacher sessions	5	
	Preparation for the final test / exam and participation in it	5	
	TOTAL:	50	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		35	1.4
Student workload – practical activities		25	1
Basic references	1.ETSI EN 300 744 V1.4.1. Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television . 2.Hoeg W., Lauterbach T.: Digital Audio Broadcasting. Principles and Applications of Digital Radio. Wiley and Sons 2003. 3.Radio Regulations and other ITU documents.		
Supplementary references	1. Alencar M.: Digital Television Systems. Cambridge UP 2009. 2. Kalivas G.: Digital Radio System Design. Wiley and Sons 2009.		
Organisational unit conducting the course	Department of Telecommunication and Electronic Equipment	Date of issuing the programme	
Author of the programme	Maciej Sadowski, Ph.D.	23.04.2019	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td>Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Diagnostics of telecommunication optical fiber networks</td><td colspan="2">Course code</td><td>TS2E200111</td></tr>
<tr><td colspan="2">Course type</td><td>elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Acquainting with contemporary diagnostic methods of optical fiber systems. Teaching methods for measuring operating parameters of optical fiber telecommunications networks. Acquainting and teaching the diagnostics and operation of passive and active elements of optical fiber networks. Teaching inspection of connectors and fiber terminations. Education of principles of application and service of specialized measuring and diagnostic devices used in optical fiber systems. Discussion of the latest trends in the development of optical fiber systems and their practical applications.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture:
Diagnostic methods of optical fiber systems in building infrastructure. Measurement methods with time and frequency domain. Operational diagnostics of separable connectors, welds, optical fiber tracks in existing fiber optic systems. Characterization and metrology of optical fiber system components: coupler, isolator, optical circulator. Optical amplifiers EDFA, EYDFA, TDFA in AON systems. Four-wave mixing. Aspects of reliability of optical fiber data transmission systems.
Laboratory:
Testing of optical fiber link parameters using tester, Measurement of optical fiber link attenuation using transmission method, Analysis of events in optical fiber links with the aid of reflectometer in the third and fourth transmission window, Analysis of optical fiber path parameters operating in the WDM system - OptiPerformer environment.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, laboratory class.</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture - final test; Laboratory class - evaluation of reports, tests of preparation for classes.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
</table>

LO1	The student describes the principle of operation of optical fiber networks	ET2_W02, ET2_W04, ET2_W07
LO2	The student describes diagnostic methods of optical fiber systems	ET2_W04, ET2_W02
LO3	The student describes multipexing methods - time and frequency division and their use in diagnostics and measuring the parameters of optical fiber systems	ET2_W02, ET2_W04
LO4	The student plans and performs operational measurements of fiber optics telecommunications and passive elements	ET2_U02, ET2_U09
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	final test	L
LO2	final test	L
LO3	final test	L
LO4	evaluation of the student's reports and preparation for the classes, discussion during classes	LC
Student workload (in hours)		No. of hours
Calculation	Participation in lectures	15
	Ongoing analysis and assimilation of the content of subsequent lectures	5
	Preparation for passing	5
	Participation in laboratory classes	15
	Preparing reports on laboratory exercises	5
	Participation in consultations	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1,4
Student workload – practical activities	25	1

Basic references	1. Chomycz B. „Planning fiber optic networks", McGrow-Hill, New York, 2009. 2. John M. Senior, Optical Fiber Communications: Principles and Practice Third edition, Prentice Hall 2009	
Supplementary references		
Organisational unit conducting the course	Department of Electrical Power Engineering, Photonics and Lighting Technology	Date of issuing the programme
Author of the programme	M. Kochanowicz,PhDAssoc. Prof.	08.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree
Full time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Statistical theory of communication</td><td colspan="2">Course code</td><td colspan="2">TS2E200112</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">Theory of Information and Coding</td></tr>
<tr><td>Course objectives</td><td colspan="9">To acquaint students with the principles of statistical theory of communication: signal detection, parameter and process estimation</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Statistical characteristics of interferences in radio and optical frequency range. Main concepts of probability theory, stochastic processes and theory of detection. Probability density function, Bayes methods, minimax and Wald sequential analysis. Optimal signal receivers. Parameter estimation of telecommunications signals, Cramer-Rao lower bound. Markov processes and filtration theory. Implementation examples of optimal signal and data processing methods in telecommunications.
Specialization workshop: Mathematical models and methods of signal detection and parameter estimation, filtering methods, receiver operational characteristics .</td></tr>
<tr><td>Teaching methods</td><td colspan="9">lecture, problem solving, numerical simulation experiments</td></tr>
<tr><td>Assessment method</td><td colspan="9">lecture – written test,
specialization workshop – evaluation of reports and evaluation of the student's performance in workshop.</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student has basic knowledge about signal detection methods, parameter estimation and filtering in telecommunication channels.</td><td colspan="2">ET2_W03, ET2_W05, ET2_W07</td></tr>
<tr><td>LO2</td><td colspan="7">The student understands mathematical description of stochastic processes in telecommunication channels.</td><td colspan="2">ET2_W03, ET2_W05</td></tr>
</table>

LO3	The student is able to use mathematical models and appropriate software for signal detection, estimation and filtering.	ET2_U07
LO4	The student can calculate operational characteristics of receivers.	ET2_U08
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	test	L
LO2	test	L
LO3	evaluation of student's performance at the workshop and evaluation of student's reports	SW
LO4	evaluation of student's performance at the workshop and evaluation of student's reports	SW
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in laboratory classes	15
	Preparation for lectures	5
	Work on reports	5
	Participation in student-teacher sessions	5
	Preparation for the final test	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	25	1

Basic references	1.. Haykin S.:Systemy telekomunikacyjne, t. I, II, WKŁ, Warszawa, 2004. 2. Liese F.,·Miescke K. L., Statistical Decision Theory, Springer, 2008. 3. Jeruchim M. C., Balaban P., Shanmugan K., Simulation of Communication Systems, Kluwer Academic Publishers, 2002.
Supplementary references	1. Proakis J.G., Salehi, M. Communication systems engineering. Prentice-Hall, 2002. 2. van Etten W. C., Introduction to random signals and noise.John Wiley & Sons, 2005.
Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment — Date of issuing the programme
Author of the programme	Jurij Griszin D.Sc., Dariusz Jańczak, Ph.D. — 09.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">System programming of embedded devices</td><td colspan="2">Course code</td><td colspan="2">TS2E200113</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>15</td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">The aim of the course is to acquire knowledge related to the operation, configuration and programming of embedded devices working under the control of the Linux operating system. The result of the course is the acquisition of practical skills to develop low-level software that communicates directly with the Linux kernel.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Concepts of Linux System Programming: files and the filesystem, processes and interprocess communication. Input and output operations. Process management. Memory management. Threading: multithreading, concurrency, synchronization. Specialization workshop: Work in the console: basic shell commands, shell scripts, program compilation. Configuration of the development environment for creating software for embedded systems. Thread-based implementations in Linux, programming interface for the Pthreads standard. Network tools.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">lecture and specialization workshop</td></tr>
<tr><td>Assessment method</td><td colspan="9">lecture - test; specialisation workshop - evaluation of reports</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student has knowledge of Linux shell tools, configuration and kernel compilation and develop of low-level software for embedded .</td><td colspan="2">ET2_W06</td></tr>
<tr><td>LO2</td><td colspan="7">The student has knowledge about the mechanisms of interprocess communication, process synchronization and their use in develop applications for embedded devices.</td><td colspan="2">ET2_W09</td></tr>
<tr><td>LO3</td><td colspan="7">The student is able to configure and run a Linux operating system dedicated to embedded devices.</td><td colspan="2">ET2_W08</td></tr>
</table>

LO4	The student is able to design, create and test multithreaded applications executing under the control of the Linux operating system.	ET2_U09, ET2_U10, ET2_U12	
L05	The student can work individually and in a team; can estimate the time needed to complete the assigned task.	ET2_U02	
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed	
LO1	tests on lecture content	L	
LO2	tests on lecture content	L	
LO3	tests on lecture content	L	
LO4	evaluating students' reports, observation of work in class	SW	
LO5	evaluating students' reports, observation of work in class	SW	
Student workload (in hours)		No. of hours	
Calculation	Lecture attendance	15	
	Participation in specialisation workshop	15	
	Work on reports	5	
	Participation in student-teacher sessions	5	
	Preparation for specialisation workshop	6	
	Preparation for the final test	4	
	TOTAL:	50	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		35	1.4
Student workload – practical activities		26	1
Basic references	1. Love R.: „Linux. Programowanie systemowe. Wydanie II", tyt. oryg. „Linux System Programming: Talking Directly to the Kernel and C Library," Helion, Gliwice, 2014 2. Love R.: „Jądro Linuksa : przewodnik programisty", tyt. oryg. „Linux Kernel Development"Helion, Gliwice, 2014.		
Supplementary references	1. Abbott D.: „Linux for embedded and real-time applications", Burlington : Newnes, 2003.		
Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment	Date of issuing the programme	
Author of the programme	Krzysztof Konopko, Ph. D.	30.04.2019	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">Communication interfaces in embedded systems</td><td colspan="2">Course code</td><td colspan="2">TS2E200114</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9"></td></tr>
<tr><td>Course objectives</td><td colspan="9">The aim of the course is to learn the intermodule communication standards used in modern electronic systems. The result of the course is the acquisition of practical skills in developing effective software for microprocessor systems that supports data transmission using modern teletransmission standards.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Configuration of the development environment for creating software for embedded systems. Communication interfaces: USART serial port support, I2C interface support, SPI interface support. TCP / IP stack implementation, lwIP library. Basics of the USB interface. Bluetooth standard.
Laboratory classes: Exercises based on development kits with 32-bit Cortex-M series processors. The subject matter of the course concerns the programming of communication interfaces (Rs-232, SPI, I2C), data transmission in the Ethernet network: (TCP/IP stack, methods of implementing typical network services) and USB interface support.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">lecture and laboratory classes</td></tr>
<tr><td>Assessment method</td><td colspan="9">lecture - test; laboratory classes - evaluation of reports</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student knows the intermodule communication standards used in modern embedded systems, knows the purposes and limitations of various communication standards,</td><td colspan="2">ET2_W06, ET2_W07</td></tr>
<tr><td>LO2</td><td colspan="7">The student has knowledge about designing, programming and testing communication interfaces, used in microprocessor systems,</td><td colspan="2">ET2_W08</td></tr>
</table>

LO3	The student can choose the intermodule communication standard according to the criterion appropriate for the task being carried out,	ET2_W08
LO4	The student can develop communication software for a multimoduled embedded system, test the correctness of its operation and detect and correct any errors,	ET2_U09, ET2_U12, ET2_U13
L05	The student can work individually and in a team; can estimate the time needed to complete the assigned task.	ET2_U02

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	tests on lecture content	L
LO2	tests on lecture content	L
LO3	tests on lecture content	L
LO4	evaluating students' reports, observation of work in class	LC
LO5	evaluating students' reports, observation of work in class	LC

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Participation in specialisation workshop	15
	Work on reports	5
	Participation in student-teacher sessions	5
	Preparation for specialisation workshop	6
	Preparation for the final test	4
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	26	1

Basic references	1. Peczarski M., „Mikrokontrolery STM32 w sieci Ethernet w przykładach", BTC 2011 2. Paprocki K., „Mikrokontrolery STM32 w praktyce", BTC, 2011. 3. Bai Y., „Practical microcontroller engineering with ARM technology", John Wiley & Sons, 2016.
Supplementary references	1. RM0008: STM32F101xx, STM32F102xx, STM32F103xx, STM32F105xx and STM32F107xx advanced ARM®-based 32-bit MCUs: www.st.com/resource/en/reference_manual/cd00171190.pdf, 2015 2. PM0056: STM32F10xxx/20xxx/21xxx/L1xxxx Cortex-M3 programming manual: www.st.com/resource/en/programming_manual/cd00228163.pdf, 2013 3. Townsend K.: „Getting Started with Bluetooth Low Energy. Tools and Techniques for Low-Power Networking" 2014.

Organisational unit conducting the course	Department of Telecommunications and Electronic Equipment	Date of issuing the programme
Author of the programme	Krzysztof Konopko, Ph. D.	30.04.2019

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Electronics and Telecommunications</td><td>Degree level and programme type</td><td>Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">Electronic Devices and Telecommunications</td><td>Study profile</td><td>General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Integrated circuits and systems</td><td>Course code</td><td>TS2E200115</td></tr>
<tr><td>Course type</td><td>Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>15</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Introduction to the basic issues of VLSI technology. Introduction to the functioning and application of modern systems and integrated circuits.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture:</u> Technologies of production and design of integrated monolithic and hybrid systems. Structure of analog integrated circuits and their typical components. Integrated (SOC, SiP) and mixed analog-digital circuits. MEMS microsystems. Development trends in microelectronics.

<u>Laboratory classes:</u> The basics of creating (preparation and compilation) applications in a selected integrated development environment (IDE). Development of an application using modern cooperative integrated components with the selected microcontroller.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Lecture, Laboratory classes</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture – written exam, Laboratory classes – evaluation of the reports</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student describes the various stages of manufacturing integrated circuits.</td><td colspan="2">ET2_W06</td></tr>
<tr><td>LO2</td><td colspan="7">The student classifies modern integrated circuits and systems and describes their typical applications.</td><td colspan="2">ET2_W06, ET2_W07</td></tr>
<tr><td>LO3</td><td colspan="7">The student describes and explains modern development trends in microelectronics.</td><td colspan="2">EL2_W05</td></tr>
<tr><td>LO4</td><td colspan="7">The student can create and test an application using integrated circuits and the selected microcontroller.</td><td colspan="2">ET2_U01, ET2_U03, EL2_U12, EL2_U13</td></tr>
</table>

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Pass the lecure	W
LO2	Pass the lecure	W
LO3	Pass the lecure	W
LO4	Laboratory exercises report	L
Student workload (in hours)		No. of hours
Calculation	Participation in lectures	15
	Participation in laboratory classes	15
	Preparation for laboratory exercises	5
	Preparation of laboratory reports	5
	Participation in consultations related to the lecture and laboratory classes	5
	Preparing to pass the lecture	5
	TOTAL:	50

Quantitative indicators	HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation	35	1.4
Student workload – practical activities	25	1

Basic references	1. **Sedra A.S., Smith K.C.:** *Microelectronic Circuits*, **Oxford Univ. Press, 2004.** 2. **Gołda A., Kos A.:** *Designing CMOS integrated circuits*, **WKŁ, 2010.** 3. **Camenzind H.:** *Designing analog integrated circuits*, **BTC, 2010.** 4. **Kempe V.:** *Inertial MEMS: principles and practice*. **Cambridge Univ. Press, 2011** 5. **Waczyński K., Wróbel E.:** *Microelectronic technologies: methods of producing of semiconductor materials and structures*, **Wyd. Pol. Śląskiej, 2006.**
Supplementary references	1. **Gray P.R., Hurst P.J., Lewis S.H., Meyer R.G. :** *Analysis and Design of Analog Integrated Circuits*, **John Willey & Sons, Inc., 2001.** 2. **Dobrowolski J.A. :** *CMOS integrated circuits for radio and microwave frequencies*, **OWPW, Warsaw 2007.** 3. **Znamirowski L.:** *Computer aided design of microelectronic systems. Part I*, **Publ. of the Silesian University of Technology 2006.** 4. **Tietze U., Schenk Ch.:** *Semiconductor systems*, **WNT, Warsaw 2009.**

Organisational unit conducting the course	Department of Automatics and Electronics	Date of issuing the programme
Author of the programme	Rafał Kociszewski, PhD	09.04.2019

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar

COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="5">Electronics and Telecommunications</td><td colspan="2">Degree level and programme type</td><td colspan="2">Master's degree, full-time</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="5">Electronic Devices and Telecommunications</td><td colspan="2">Study profile</td><td colspan="2">General-academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="5" rowspan="2">On chip digital systems</td><td colspan="2">Course code</td><td colspan="2">TS2E200116</td></tr>
<tr><td colspan="2">Course type</td><td colspan="2">Elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td colspan="2">2</td></tr>
<tr><td></td><td></td><td>30</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td colspan="2">2</td></tr>
<tr><td>Entry requirements</td><td colspan="9">Programmable digital circuits</td></tr>
<tr><td>Course objectives</td><td colspan="9">Improvement in support of communication modules, analog, analog-digital and peripheral devices using single-chip programmable systems.</td></tr>
<tr><td>Course content</td><td colspan="9">Frequency synthesis in FPGA systems. Multi-port and FIFO memory support. Discretization of analog control in peripheral operation. Controlling of peripheral analog-digital and digital systems. Synthesis of SPI and I²C transmission buses in FPGA structures. Support of selected radio communication modules. At the hardware level, control the optical transmission modules. Multi-channel transmission and control in single chip systems. Introduction to structural programmable analog-to-digital chips.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Laboratory class</td></tr>
<tr><td>Assessment method</td><td colspan="9">Evaluation of reports</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">The student designs and supports synchronous data block write layouts.</td><td colspan="2">ET2_U08, ET2_U10</td></tr>
<tr><td>LO2</td><td colspan="7">The student is able to handle digital circuits and peripheral devices.</td><td colspan="2">ET2_U08, ET2_U09</td></tr>
<tr><td>LO3</td><td colspan="7">The student designs and supports multi-channel control systems.</td><td colspan="2">ET2_U10, ET2_U09</td></tr>
<tr><td>LO4</td><td colspan="7">The student implements hardware buses in programmable circuits.</td><td colspan="2">ET2_U08, ET2_W06</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Methods of assessing the learning outcomes</td><td colspan="2">Type of tuition during which the outcome is assessed</td></tr>
<tr><td>LO1</td><td colspan="7">evaluation of laboratory reports</td><td colspan="2">LC</td></tr>
<tr><td>LO2</td><td colspan="7">evaluation of laboratory reports</td><td colspan="2">LC</td></tr>
</table>

LO3	evaluation of laboratory reports	LC	
LO4	evaluation of laboratory reports	LC	
Student workload (in hours)		No. of hours	
Calculation	participation in laboratory classes	30	
	preparation for laboratory classes	5	
	reports preparation involving laboratory classes	10	
	participation in student-teacher sessions	5	
	TOTAL:	50	
Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		35	1.4
Student workload – practical activities		50	2
Basic references	1. Deschamps J.P, Bioul G.J.A., Sutter G.D.: Synthesis of arithmetic circuits FPGA, ASIC and embedded systems, Hoboken, Wiley J., 2006 2. Adams R.D.: High performance memory testing : design principles, fault modeling, and self-test; Boston, Kluwer Academic Publ., 2003 3. Persson Ch.G.J., Smeets B.: Bluetooth security, Boston ; London, Artech House, 2004		
Supplementary references	1. Kilts S.: Advanced FPGA design : architecture, implementation, and optimization; Hoboken : John Wiley a. Sons, 2007.		
Organisational unit conducting the course	Department of Control Engineering and Electronics	Date of issuing the programme	
Author of the programme	Marian Gilewski, PhD Eng	23.04.2019	