4th of April 2022

COURSES OFFERED FOR ERASMUS+ STUDENTS AT FACULTY OF ELECTRONIC ENGINEERING IN ACADEMIC YEAR 2022/2023

No.	Course name	Study Level (B.Sc./M.Sc)	Semester (W/S)		Forms of duties, no. of Hours & Pass Criteria						ECTS	Institute (acronym)
					Lectures	Laboratories	Exercises	Project	Seminar	**Total**		
1.	Circuits and signals 1	B. Sc.	W	S	26	-	4	-	-	**30 - EV**	**5**	IES
2.	Circuits and signals 2	B. Sc.	W	S	24	-	6	-	-	**30 - EV**	**5**	IES
3.	Digital signal processing	B. Sc.	W	S	24	-	6	-	-	**30 - EV**	**5**	IES
4.	Antennas and waves propagation	B. Sc.	W	S	22	-	4	-	4	**30 - EV**	**5**	ICS
5.	Measurements of electromagnetic fields	B. Sc.	W	S	22	-	4	-	4	**30 - EV**	**5**	ICS
6.	Digital circuits	B. Sc.	W	S	20	10	-	-	-	**30 - EX**	**5**	ICS
7.	ASIC design	M. Sc.	W	S	20	10	-	-	-	**30 - EX**	**5**	ICS
8.	Acoustic signal processing	B. Sc.	W	S	12	16	-	-	2	**30 - EV**	**5**	ICS
9.	Signal analysis	B. Sc.	W	S	12	16	-	-	2	**30 - EV**	**5**	ICS
10.	Radio equipment programming	B. Sc.	W	S	21	8 - EV	-	-	1 - PR	**30 - EV**	**5**	ICS
11.	Microstrip antennas	B. Sc.	W	S	24	-	-	-	6	**30 - EV**	**5**	IRE
12.	Principles of acustoelectronic	B. Sc.	W	S	24	-	6	-	-	**30 - EV**	**5**	IRE
13.	Remote sensing principles	B. Sc.	W	S	24	6 - EV	-	-	-	**30 - EV**	**4**	IRE
14.	Wireless communications systems	B. Sc.	W	S	22	8	-	-	-	**30 - TE**	**6**	ICS
15.	Introduction to satellite communication	B. Sc.	W	S	14	2	-	-	-	**16 - TE**	**5**	ICS
16.	Programmable logic devices 1	B. Sc.	W	S	12	8 - EV	-	-	-	**20 - TE**	**4**	ICS
17.	Programmable logic devices 2	M. Sc.	W	S	10	4	-	14 - EV	2 - PR	**30 - EV**	**5**	ICS
18.	5G network application for the military	B. Sc.	W	S	22	8 - EV	-	-	-	**30 - EX**	**5**	ICS
19.	Modulation and demodulation techniques	B. Sc.	W	S	14	16 - EV	-	-	-	**30 - EX**	**4**	ICS

Pass Criteria:
- Presentation - PR
- Test (colloquium) - TE
- Evaluation - EV
- Exam - EX

Language, level: English, B2

Please note that all the courses are **one semester ones.**

Subject:	**CIRCUITS AND SIGNALS 1**
Faculty:	Electronic Engineering
Department:	Institute of Electronic Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**26**	**-**	**4**	**-**	**-**	**30 - EV**

Author(s): Prof. D.Sc. Ph.D. E.E. Stanisław Osowski

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Stanisław Osowski

THE COURSE COVERS:

Basic notions of circuits and signals. Circuit elements and their description: resistor, capacitor, inductor, independent and controlled sources. Ohm and Kirchhoff's laws. Simplification of resistive circuits. Sinusoidal signal and its description. Complex symbolic analysis of RLC circuits in steady state. Models o real coil and capacitor. Powers in electrical circuits: instantaneous, active, reactive and apparent power. Power matching in RLC circuits. Methods of analysis of complex circuits: Thevenin and Norton theorems, mesh and nodal analysis, superposition theorem. Magnetically coupled circuits: elimination of coupling, calculation of currents and voltages in magnetically coupled circuits. Transformer. Resonance phenomena in RLC circuits: series and parallel resonance, frequency characteristics. Non-sinusoidal signals: Fourier series, exponential form of Fourier series. Parseval theorem. Calculation of rms values of non-sinusoidal signals, power of non-sinusoidal signals and circuits. Calculation of currents and voltages in circuits at non-sinusoidal excitation. Three-phase circuits: star and delta topologies, calculation of currents and power in – phase circuits. Measurements of power in 3-phase circuits.

EFFECTS OF EDUCATION:

To gain fundamental knowledge on electrical circuits containing resistors, capacitors, coils including magnetic coupling and transformers. To be able to formulate and apply different methods and algorithms of analysis of circuits in steady states, including 3-phase circuits.

PRECEDING COURSES: None

Top of the document

Subject:	**CIRCUITS AND SIGNALS 2**
Faculty:	Electronic Engineering
Department:	Institute of Electronic Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**24**	**-**	**6**	**-**	**-**	**30 - EV**

Author(s): Prof. D.Sc. Ph.D. E.E. Stanisław Osowski

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Stanisław Osowski

THE COURSE COVERS:

Basic notions of transient state in electrical circuits. Commutation laws. Differential description of circuits. State space descriptions of circuits in transient state. Computer methods of solution of state space equations. Laplace transformation and its application in transient state analysis of RLC circuits. Transient state in RL, RC and RLC circuits. Transfer function, impulse and step response. Stability of circuits. Frequency characteristics of electrical circuits. Examples of typical transfer functions: differential and integral blocks, phase shifter, 2-nd order transfer functions. Two-port networks and their matrix descriptions. Connections of two-ports. Overview of typical two–ports: converters and inverters, gyrator, NIC, controlled sources. Ideal operational amplifier, its properties and applications. Signal flow graphs. Application of signal flow graphs for analysis of circuits containing operational amplifiers.

EFFECTS OF EDUCATION:

To learn different methods of analysis transient phenomena in electrical RLC circuits: their description and solution methods. To get acquainted with different arrangements of 2-port networks, their description and analysis in frequency and time domain and their application in filtering the signals.

PRECEDING COURSES: None.

Top of the document

Subject:	**DIGITAL SIGNAL PROCESSING**	
Faculty:	Electronic Engineering	
Department:	Institute of Electronic Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**24**	**-**	**6**	**-**	**-**	**30 - EV**

Author(s): Prof. D.Sc. Ph.D. E.E. Stanisław Osowski

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Stanisław Osowski

THE COURSE COVERS:

Discrete signals. Fourier transformation of signals: Discrete Fourier Transformation (DFT), FFT implementation of DFT, Practical aspects of discrete Fourier transformation. Z transformation of signals. Filtering of discrete signals: discrete filters, design of discrete filters: the analog prototype and direct methods of discrete filter design. Application of Matlab in filter design and analysis. Statistical processing of stochastic signals. Statistical moments, Correlation functions and their properties, Power spectral density, Estimation of spectra and statistical moments.

EFFECTS OF EDUCATION:

To learn different Fourier representations of discrete signals and description of discrete systems in complex plane. To learn the methods of designing discrete filters. To get acquainted with stochastic signals and their description in time and frequency domains.

PRECEDING COURSES: None.

Top of the document

Subject:	**ANTENNAS AND WAVE PROPAGATION**
Faculty:	Faculty of Electronics
Department:	Institute of Communications Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**22**	**-**	**4**	**-**	**4**	**30 - EV**

Author(s): Prof. D.Sc. Ph.D. E.E. Roman Kubacki

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Roman Kubacki

THE COURSE COVERS:

Theory of antennas and waves propagation with emphasis on their engineering applications. Explanation of the wave equations, plane wave propagation, Poynting's vector with Maxwell's equations as a starting point. The radiation theory for simple models of antennas such as elemental dipole and half-wave antenna. Explanation required for good understanding of the antenna theory in practical applications. Examples of new antenna technologies and forms of emission with the special attention on cellular base station antennas and microstrip antennas. Simple and practical calculations of the electromagnetic field emitted from popular antennas as well as the physical explanation of these phenomena. Examples of the newest form of emission from smart/adaptive antenna array in 5G cellular telephony system.

EFFECTS OF EDUCATION:

To gain the fundamental relationships of wave propagation staring with the elemental dipole and half-wave antenna and finishing on the smart/adaptive antenna array in 5G cellular telephony system. Knowledge of the practical engineering calculations of the electromagnetic field strength or power density in practical applications.

PRECEDING COURSES: None

Top of the document

Subject:	**MEASUREMENTS OF ELECTROMAGNETIC FIELDS**
Faculty:	Faculty of Electronics
Department:	Institute of Communications Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**22**	**-**	**4**	**-**	**4**	**30 - EV**

Author(s): Prof. D.Sc. Ph.D. E.E. Roman Kubacki

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Roman Kubacki

THE COURSE COVERS:

Ways of electromagnetic (EM) field measurements and parameters necessary to determine the level of radiation. The EM field metrology technique in relation of frequency, polarization and modulation. Aspects of measurements for electromagnetic compatibility as well as for human protection against electromagnetic radiation. Presentation of measuring instruments for different ranges of EM field covering frequencies from 50 Hz, through radio and microwave ranges until terahertz. Practical challenges will be posed to discuss the measurements of the electromagnetic field emitted from smart/adaptive antenna array used in 5G cellular telephony system.

EFFECTS OF EDUCATION:

To know the measurement techniques of the electromagnetic field depending on the type of the sources, as well as frequencies of emitted radiation and modulation forms. To gain knowledge on measuring apparatus and focusing on the newest meter solutions. Forms of metrology of electromagnetic fields emitted by currently existing cellular systems and system 5G with focusing to problems of smart/adaptive antenna array forms of radiation.

PRECEDING COURSES: None

Top of the document

Subject:	**DIGITAL CIRCUITS**	
Faculty:	Electronic Engineering	
Department:	Institute of Communication Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**20**	**10**	**-**	**-**	**-**	**30 - EX**

Author(s): Prof. D.Sc. Ph.D. E.E. Ryszard Szplet

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Ryszard Szplet

THE COURSE COVERS:

Theory of digital logic design and basic information about fundamental digital integrated circuits. Digital coding of data. Types of binary codes. Boolean algebra. Combinational circuits. Logic functions and logic forms. Gates and their symbols. Synthesis of combinational circuits. Minimization of logic forms. Hazard. Standard combinational modules. Sequential circuits. Basic theory, Mealy and Moore machines, transition graphs and tables. Latches and flip-flops. Synthesis of sequential circuits. Standard sequential modules. Introduction to VHDL. Integrated circuits, technologies and families: CMOS, ECL, TTL. CMOS building blocks with transmission gates. Memories: SRAM, DRAM, EPROM, EEPROM, Flash. Programmable circuits (PLD, CPLD, FPGA) and Application-Specific Integrated Circuits (ASIC).

EFFECTS OF EDUCATION:

To gain fundamental knowledge on theory of digital circuits and their design with the use of VHDL. Moreover, acquiring skills and knowledge related to the methods of logical synthesis of combinational and sequential circuits, information about the technology of manufacturing digital integrated circuits, as well as the structure and operation of basic logic gates and functional blocks.

PRECEDING COURSES: None

[Top of the document]

Subject:	**ASIC DESIGN**
Faculty:	Electronic Engineering
Department:	Institute of Communication Systems

Study level:	Language:	ECTS points:
M.Sc.	**English**	**5**

<table>
<tr><td colspan="2" rowspan="2">Semester</td><td colspan="6">Forms of duties, no. of Hours & Pass Criteria
(Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)</td></tr>
<tr><td>Lectures</td><td>Laboratories</td><td>Exercises</td><td>Project</td><td>Seminar</td><td>Total</td></tr>
<tr><td>Winter</td><td>Summer</td><td>20</td><td>10</td><td>-</td><td>-</td><td>-</td><td>30 - EX</td></tr>
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Author(s): Prof. D.Sc. Ph.D. E.E. Ryszard Szplet

Leading lecturer: Prof. D.Sc. Ph.D. E.E. Ryszard Szplet

THE COURSE COVERS:

Design of fundamental digital systems with the use of a CMOS ASIC technology - both the design process and main design tools.

Specifically: Introduction to ASIC, CMOS logic gate physical design, passive elements, interconnections, general purpose methods for circuit optimization, partitioning, floor planning, pin assignment, placement, routing, design and electrical rule checking, parameter extraction, gate level simulation and IC verification, clock signal and power distribution. Standard Cells and Gate Arrays methodologies. EDA tools for front to back end chip design.

EFFECTS OF EDUCATION:

To gain fundamental knowledge on the method of manufacturing ASIC integrated circuits, the rules of designing VLSI circuits, the principles of designing digital circuit topography, methods of power distribution and high-frequency signal distribution, input and output signal standards. Moreover, acquiring skills and knowledge related to models of computer simulation components, as well as the Cadence and Electric design environments.

PRECEDING COURSES: None

Top of the document

Subject:	**ACOUSTIC SIGNAL PROCESSING**
Faculty:	Electronic Engineering
Department:	Institute of Communication Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**12**	**16**	**-**	**-**	**2**	**30 - EV**

Author(s): D.Sc. Ph.D. E.E. Zbigniew Piotrowski

Leading lecturer: D.Sc. Ph.D. E.E. Zbigniew Piotrowski

THE COURSE COVERS:

Basic concepts of acoustic signal theory and practice. Among others the following topics: overall sound characteristic, acoustic wave propagation, articulation, sound perception in amplitude, frequency and time domains, sound effects, lossless compression, sound synthesis and analysis, speech intelligibility and quality, psychoacoustic modeling, vocoders, source sound localization methods.

Laboratory experiments explaining the topics based on simulation and prototyping tools: Matlab and Simulink environment.

EFFECTS OF EDUCATION:

To gain knowledge on principles of Acoustic Signal acquisition and modelling in audio and telecommunications channels.

To be able to implement audio processing algorithms in practical applications.

PRECEDING COURSES: None

Top of the document

Subject:	**SIGNAL ANALYSIS**
Faculty:	Electronic Engineering
Department:	Institute of Communication Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**12**	**16**	**-**	**-**	**2**	**30 - EV**

Author(s): D.Sc. Ph.D. E.E. Zbigniew Piotrowski

Leading lecturer: D.Sc. Ph.D. E.E. Zbigniew Piotrowski

THE COURSE COVERS:

Basic concepts of digital signal processing. Among others the following topics: continuous and discrete signals, theory and practice of signal acquisition, linear signals, superposition and convolution, sampling and quantization theory, Z transform, zeros and poles modeling, digital filtration theory, digital filters designing and prototyping, Fast Fourier Transform and based on FFT algorithms, correlation analysis, windowing and Power Spectrum Density estimation, adaptive algorithms and schemes as well as artificial intelligence methods. Described topics are exhaustively explained on

Laboratory experiments explaining the topics based on simulation and prototyping tools: Matlab and Simulink environment.

EFFECTS OF EDUCATION:

To gain knowledge on principles of time-frequency and space Signal Acoustic and modelling in telecommunications channels.

To be able to implement signal processing algorithms in practical applications.

PRECEDING COURSES: None

Top of the document

Subject:	**RADIO EQUIPMENT PROGRAMMING**	
Faculty:	Electronic Engineering	
Department:	Institute of Communication Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**21**	**8 - EV**	**-**	**-**	**1 - PR**	**30 - EV**

Author(s): D.Sc. Ph.D. E.E. Jerzy Łopatka

Leading lecturer: D.Sc. Ph.D. E.E. Jerzy Łopatka

THE COURSE COVERS:

Architecture, properties and programming principles of Software Defined Radios (SDR), specifically:

- Basic architecture of radio devices
- Architecture of Software Defined Radios
- Properties of GNU Radio environment

Laboratory exercises with the use of USRP devices and GNU Radio software environment.

EFFECTS OF EDUCATION:

To gain knowledge on principles of Software Defined Radio architecture and operation.
To be able to use GNU Radio environment for USRP programming in practical applications.

PRECEDING COURSES:

Principles of Signal Processing
Principles of Telecommunications

Top of the document

Subject:	**MICROSTRIP ANTENNAS**
Faculty:	Electronic Engineering
Department:	Institute of Radioelectronics

Study level:	Language:	ECTS points:
B.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**24**	**-**	**-**	**-**	**6**	**30 - EV**

Author(s): D.Sc. Ph.D. E.E. Mateusz Pasternak

Leading lecturer: D.Sc. Ph.D. E.E. Mateusz Pasternak

THE COURSE COVERS:

Analyses of the fundamental properties of microstrip structures as an radiating elements of planar antennas - both theoretical and practical aspects.
Specifically: analytical and numerical methods of microstrip structures modelling, methods and systems of planar antennas feeding, multi-band and multi-polarized microstrip antennas construction, methods of planar antennas design, antenna metrology aspects, antenna manufacturing process.

EFFECTS OF EDUCATION:

To gain fundamental knowledge on planar antennas, design, construction and manufacturing including analytical modelling, engineering calculations, design of feeding and matching structures and antenna measurements skills.
To be able to chose the appropriate antenna type for given purpose, to calculate their geometry, manufacture the laboratory model and measure the real properties of it.

PRECEDING COURSES: None

Top of the document

Subject:	**PRINCIPLES OF ACOUSTOELECTRONIC**		
Faculty:	Electronic Engineering		
Department:	Institute of Radioelectronics		
Study level: **B.Sc.**	Language: **English**	ECTS points: **5**	

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**24**	**-**	**6**	**-**	**-**	**30 - EV**

Author(s): D.Sc. Ph.D. E.E. Mateusz Pasternak

Leading lecturer: D.Sc. Ph.D. E.E. Mateusz Pasternak

THE COURSE COVERS:

Fundamental properties of elastic vibrations and waves in solids. The methods of excitation and detection of acoustic bulk and surface waves in solids. Basic knowledge about design the acoustoelectronic devices like filters, resonators, sensors, actuators and special devices. Metrological aspects of the devices.

EFFECTS OF EDUCATION:

To gain fundamental knowledge on properties of elastic vibrations and waves in solids. To be able to design simple acoustoelectronic device and apply it as an element of the electronic system.

PRECEDING COURSES: None

Top of the document

Subject:	**REMOTE SENSING PRINCIPLES**
Faculty:	Electronics
Department:	Institute of Radioelectronics

Study level:	Language:	ECTS points:
B.Sc.	**English**	**4**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**24**	**6 - EV**	**-**	**-**	**-**	**30 - EV**

Author: D.Sc. Ph.D. E.E. Jerzy Pietrasiński

Leading lecturer: D.Sc. Ph.D. E.E. Jerzy Pietrasiński

THE COURSE COVERS:

Remote sensing definition and utilized kind of waves characterization. Remote sensors in different monitoring systems applications for situational awareness goals. Elements of radar fundamentals:
- radar basis, radar classifications, primary radar and secondary radar,
- radar cross section, radar range, radar coverage diagram,
- chosen problems of radar signal synthesis and processing including chirp signals.

Examples of radar applications: radar in air control systems, automotive radar, ground – penetrating radar, SAR (synthetic aperture radar), meteo radar etc.

EFFECTS OF EDUCATION:

To gain fundamental knowledge on remote sensors essence, solutions and applications especially with relation to radars.
To be able to estimate basic features of different remote sensing solutions.

PRECEDING COURSES:

- antennas and wave propagation
- probability theory
- random signal processing
- testing statistical hypotheses.

Top of the document

Subject:	**WIRELESS COMMUNICATION SYSTEMS**	
Faculty:	Electronic Engineering	
Department:	Institute of Communications Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **6**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**22**	**8**	**-**	**-**	**-**	**30 - TE**

Author(s): D.Sc. Ph.D. E.E. Jarosław Michalak

Leading lecturer: D.Sc. Ph.D. E.E. Jarosław Michalak

THE COURSE COVERS:

Theoretical basics and applications of the wireless communications systems, specifically:

- Classification of wireless systems. Denotations of radio emissions. Radio access methods.
- Cellular and Trunking systems
- HF communications
- VHF communications. Software Defined Radio and Cognitive Radio
- Relay Lines and Satellite communications
- PAN and WLAN

Laboratories exercises with use od HF, VHF and UHF transceivers, computers with Matlab-Simulink software for simulation tests as well as specialized communication testers (operation and testing of real radio devices based on selected radio stations and computer simulation systems).

EFFECTS OF EDUCATION:

Basic knowledge of wireless communication systems and techniques.
Basic ability to configure, run and test radio devices with the use of built-in and external measuring instruments.

PRECEDING COURSES: None

Top of the document

Subject:	**INTRODUCTION TO SATELLITE COMMUNICATION**	
Faculty:	Electronic Engineering	
Department:	Institute of Communications Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	14	2	-	-	-	**16 - TE**

Author(s): Lt. Col. Ph.D. E.E. Mariusz Bednarczyk

Leading lecturer: Lt. Col. Ph.D. E.E. Mariusz Bednarczyk

THE COURSE COVERS:

Essential elements of satellite communications systems, specifically basic technical information on how the systems are designed and operate.

EFFECTS OF EDUCATION:

To be able to:

- identify the structure and key features of satellite communication,
- provide a description of the functional elements of the communication satellites,
- specify the frequency bands and MAC techniques used in satellite communication, as well as how is the route of the signals from the calling terminal to the called one designated,
- understand the physics of the radio link between the Earth station and the satellite and covers the factors that are under the designer's control as well as those that are not,
- describe typical satellite network architectures in terms of topology, connectivity, TCP/IP protocol and its enhancements for satellite networks,
- distinguish the technology used for satellite communication systems, fixed and mobile very small aperture terminal (VSAT) applications, and mobile satellite services.

PRECEDING COURSES: None

Top of the document

Subject:	**PROGRAMMABLE LOGIC DEVICES 1**
Faculty:	Electronic Engineering
Department:	Institute of Communication Systems

Study level:	Language:	ECTS points:
B.Sc.	**English**	**4**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**12**	**8 - EV**	**-**	**-**	**-**	**20 - TE**

Author(s): Ph.D. E.E. Paweł Kwiatkowski

Leading lecturer: Ph.D. E.E. Paweł Kwiatkowski

THE COURSE COVERS:

Principles and practices of digital logic design using programmable logic devices (PLDs), specifically:

- brief history of programmable devices,
- concept and architecture of PLDs,
- configurable logic elements and dedicated functional blocks in field-programmable gate array (FPGA) devices,
- introduction to hardware description languages (HDLs),
- electronic design automation (EDA) tools and common design techniques.

Laboratory exercises on implementation of digital circuits, both combinational (logic gates, arithmetic modules, multiplexers, comparators, etc.) and sequential (flip-flops, registers, counters, state machines, etc.), in an FPGA device.

EFFECTS OF EDUCATION:

To gain basic knowledge of programmable logic devices and be able to design digital circuits using HDL.

PRECEDING COURSES:

Digital circuits.

Top of the document

Subject:	**PROGRAMMABLE LOGIC DEVICES 2**
Faculty:	Electronic Engineering
Department:	Institute of Communication Systems

Study level:	Language:	ECTS points:
M.Sc.	**English**	**5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**10**	**4**	**-**	**14 - EV**	**2 - PR**	**30 - EV**

Author(s): Ph.D. E.E. Paweł Kwiatkowski

Leading lecturer: Ph.D. E.E. Paweł Kwiatkowski

THE COURSE COVERS:

Extended knowledge of programmable logic device (PLD) architectures and design techniques, specifically:

- complex PLD architectures (SoC/RF FPGAs, heterogeneous computing platforms),
- construction, capabilities and applications of dedicated functional blocks available in FPGAs,
- timing analysis, using design constraints to improve circuit performance,
- VHDL coding tips and tricks.

Individual project of a complex digital system implemented in a PLD device, defended in a seminar.

EFFECTS OF EDUCATION:

To extend knowledge of PLDs and be able to design complex digital circuits using VHDL.

PRECEDING COURSES:

Digital circuits, Programmable logic devices 1

[Top of the document]

Subject:	**5G NETWORK APPLICATION FOR THE MILITARY**	
Faculty:	Electronic Engineering	
Department:	Institute of Communications Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **5**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**22**	**8 - EV**	**-**	**-**	**-**	**30 - EX**

Author(s): D.Sc. Ph.D. E.E. Paweł Skokowski

Leading lecturer: D.Sc. Ph.D. E.E. Paweł Skokowski

THE COURSE COVERS:

Principles and practices of 5G, specifically:

- 5G network technologies
- 5G use cases and system concept
- 5G Network Architecture
- 5G architecture elements and functionalities/roles
- Millimeter wave communications
- Device-to-device (D2D) communications
- The 5G radio-access technologies
- Machine-type communications
- Massive multiple-input multiple-output (MIMO) systems
- 5G Network Miltary Gaps
- 5G network Military Application and use cases:
  - 5G network in Spectrum Situation Awareness application (workshop)
  - 5G network Military Application and use cases (own work/seminar/workshop with teacher support)

Laboratories/workshops using 5G hardware, computers with dedicated for 5G technology software.

EFFECTS OF EDUCATION:

To be familiar with 5G technology both in civilian and military aspects.

PRECEDING COURSES:

If possible: Modulation and Demodulation Techniques

Top of the document

Subject:	**MODULATION AND DEMODULATION TECHNIQUES**	
Faculty:	Electronic Engineering	
Department:	Institute of Communications Systems	
Study level: **B.Sc.**	Language: **English**	ECTS points: **4**

Semester		Forms of duties, no. of Hours & Pass Criteria (Presentation - PR; Test (colloquium) - TE; Evaluation – EV; Exam – EX)					
		Lectures	Laboratories	Exercises	Project	Seminar	**Total**
Winter	**Summer**	**14**	**16 - EV**	**-**	**-**	**-**	**30 - EX**

Author(s): D.Sc. Ph.D. E.E. Paweł Skokowski

Leading lecturer: D.Sc. Ph.D. E.E. Paweł Skokowski

THE COURSE COVERS:

Basic principles and methods of forming and transmitting information signals, enabling them to be effectively transmitted using radio-waves, specifically:

- Introduction to modulation and demodulation techniques.
- Analog and digital modulation types.
- AM, PM, FM analog modulation.
- PSK, ASK, FSK digital modulation.
- QAM and OFDM modulation.
- FHSS and DSSS: spread spectrum modulation techniques. 2h
- PSK signal detection. Bit Error Rate and Symbol Error Rate metrics. 2h

Laboratory exercises:

- Analysis of time and frequency dependencies of ASK, FSK, and QAM modulated signals.
- Analysis of time and frequency dependencies of OFDM modulated signals.
- Analysis of time and frequency dependencies of FHSS, and DSSS modulated signals.
- Bit Error Rate and Symbol Error Rate analysis for PSK, FSK, QAM modulation techniques.

EFFECTS OF EDUCATION:

To gain basic knowledge of modulation and demodulation techniques, to understand the purpose of its application, to be able to estimate radio communication systems effectiveness based on used signal transmission techniques.

PRECEDING COURSES: None

Top of the document