

<b>STUDY MODULE DESCRIPTION FORM</b>		
Name of the module/subject <b>Line-of-sight radio links</b>		Code <b>1010812121010840981</b>
Field of study <b>Electronics and Telecommunications</b>	Profile of study (general academic, practical) <b>general academic</b>	Year /Semester <b>1 / 2</b>
Elective path/specialty <b>Radio Communications</b>	Subject offered in: <b>Polish</b>	Course (compulsory, elective) <b>elective</b>
Cycle of study: <b>Second-cycle studies</b>	Form of study (full-time, part-time) <b>full-time</b>	
No. of hours Lecture: <b>2</b> Classes: <b>1</b> Laboratory: <b>1</b> Project/seminars: <b>-</b>		No. of credits <b>5</b>
Status of the course in the study program (Basic, major, other) <b>other</b>		(university-wide, from another field) <b>from field</b>
Education areas and fields of science and art <b>technical sciences</b> <b>Technical sciences</b>		ECTS distribution (number and %) <b>5 100%</b> <b>5 100%</b>
<b>Responsible for subject / lecturer:</b> eng. Jarosław Szóstka, Ph. D. email: szostka@et.put.poznan.pl tel. 616653895 of Electronics and Telecommunications ul. Polanka 3		
<b>Prerequisites in terms of knowledge, skills and social competencies:</b>		
1	<b>Knowledge</b>	K1_W01, K1_W02, K1_W05, K1_W07, K1_W15, K1W_18
2	<b>Skills</b>	K1_U01, K1_U05
3	<b>Social competencies</b>	K1_K01
<b>Assumptions and objectives of the course:</b> Understanding of operation principle and design, construction, measurements and maintenance of line-of-sight microwave radio links; learning of the basic activities of an engineer.		
<b>Study outcomes and reference to the educational results for a field of study</b>		
<b>Knowledge:</b>		
1. Is conversant with problems and methods related to electromagnetic radiation. - [K2_W04 ] 2. Has a basic knowledge of management, including quality management, intellectual property rights, patent law and social , technical and economical constraints referring to an engineer?s work. - [K2_W15 ]		
<b>Skills:</b>		

<p>1. Is able to prepare a scientific paper or technical report and give a presentation (in English or in Polish) on solving a problem in the area of electronics and/or telecommunication; is able to participate in a discussion related to the presented problem. - [K2_U02 ]</p> <p>2. Is able to measure EM radiation of devices; is able to propose measures against its hazardous influence on other devices and systems, and on humans. - [K2_U06 ]</p> <p>3. Knows the rules of operation of Polish and international standardization bodies (ITU, ISO, ETSI, CISPR, 3GPP, etc.). Knows the standardization procedures. - [K2_U08 ]</p> <p>4. Is able to analyze, design, construct and exploit advanced telecommunications systems and various networks and devices which are part of them, ensuring that the designed systems and networks will have required technical parameters. - [K2_U16 ]</p> <p>5. Is able to use already known mathematical models and methods to analyze and design telecommunication devices and systems. Is able to formulate a design specification of a complex electronic and telecommunication system, taking into consideration legal issues including intellectual property rights, and other non-technical issues such as environmental protection; - [K2_U18 ]</p> <p>6. Can effectively implement the occupational health and safety principles. - [K2_U19 ]</p>
<b>Social competencies:</b>
<p>1. Understands the legal framework of Polish and international standards in electronics and telecommunications. - [K2_K03 ]</p> <p>2. Is aware of the limitations of his/her current knowledge and skills; is committed to lifelong learning. - [K2_K04 ]</p> <p>3. Demonstrates responsibility for designed electronic and telecommunication systems. Is aware of the hazards they pose for individuals and communities if they are improperly designed or produced . - [K2_K06 ]</p> <p>4. Understands the dilemmas related to working in electronics and telecommunication. Is able to think and act in a businesslike way. - [K2_K08 ]</p>

<b>Assessment methods of study outcomes</b>	
1.	Written final exam (theory and design of LOS links)
2.	Teamwork design of LOS radio link with specified parameters
3.	Presentation of the project

<b>Course description</b>	
1.	Definition of LOS radio link, FEC, used modulations, link budget. Frequency bands for LOS links, channel plans, The Radio Regulations
2.	Friis transmission formula, Fresnel zones, troposphere, refraction types, rain attenuation, gas attenuation, scattering and beam focusing, clearance criteria, fading types, scintillation.
3.	Link design for troposphere - ITU-R recommendations, link profile, antenna height, calculation of flat and selective fading, signatures and their measurements, multipath depolarization, calculation of rain, fog and gas attenuation, cross-polarization due to rain
4.	Fading countermeasures - system techniques, diversity, design techniques
5.	Noise, co-channel and adjacent channel interference, nodal and overshoot interference, link design with interference checking, assignment of frequency channels, ITU-R frequency plans, channel reuse, antenna selection, calculation of interference, frequency co-ordination
6.	Reliability and availability - reference link, ITU-R recommendations, calculation of link reliability, MTBF, MTTR, calculation of link availability, improvement of availability
7.	Link design - initial phases, customer needs, choice of architecture, clearance checking, site survey, channel allocation, calculation of hop reliability/availability, link budget without fading, fading margin calculation, interference analysis, technical documentation, link construction, antenna alignment.
8.	Typical engineering tasks - preparation of documentation, business presentations, business communication, contacts with customers, advertisement and marketing, patent protection, preparation for manufacturing (standards, certificates, technical tests, etc.), exhibitions and fairs, accreditation of testing labs (EN 17025), ISO quality management.

<b>Basic bibliography:</b>	
1.	J. Szóstka , Horyzontowe linie radiowe. Wyd. Politechniki Poznańskiej, Poznań 2011.

<b>Additional bibliography:</b>	
1.	J. Szóstka, Mikrofałe. Układy i systemy. Wyd. Komunikacji i Łączności, Warszawa 2006.
2.	J. Szóstka, Fał i anteny (wyd. III), Wyd. Komunikacji i Łączności, Warszawa 2006.
3.	T. Manning, Microwave Radio Transmission Design Guide, Artech House 2005.
4.	R.L. Freeman, Radio System Design for Telecommunications, John Wiley & Sons 2007.

<b>Result of average student's workload</b>	
Activity	Time (working hours)

1. Lecture		30
2. Laboratory/design exercises		15
3. Preparation for labs		15
4. Preparation of the project		15
5. Preparation for the exam and the exam		23
<b>Student's workload</b>		
<b>Source of workload</b>	<b>hours</b>	<b>ECTS</b>
Total workload	125	5
Contact hours	65	3
Practical activities	45	2