



## Subject card

Subject name and code	Radiotransmission methods in biomedical applications, PG_00053370						
Field of study	Biomedical Engineering, Biomedical Engineering, Biomedical Engineering						
Date of commencement of studies	February 2023		Academic year of realisation of subject		2023/2024		
Education level	second-cycle studies		Subject group		Optional subject group Subject group related to scientific research in the field of study		
Mode of study	Full-time studies		Mode of delivery		at the university		
Year of study	1		Language of instruction		Polish		
Semester of study	2		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Department of Biomedical Engineering -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Sławomir Ambroziak				
	Teachers		dr hab. inż. Sławomir Ambroziak  dr inż. Adam Bujnowski				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	30		4.0		41.0	75
Subject objectives	The aim of the course is to familiarize students with issues related to radiocommunication systems and networks in terms of possible applications in biomedicine.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_U03] can design, according to required specifications, and make a complex device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment		Student is able to design, build and configure a radiocommunication network for medical data transmission in accordance with valid standards and with the use of appropriate engineering methods.		[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools		
	[K7_W05] Knows and understands, to an increased extent, methods of process and function support, specific to the field of study.		Student knows and deeply understands the methods of designing of radiocommunication networks for biomedical applications.		[SW1] Assessment of factual knowledge		
	[K7_W03] Knows and understands, to an increased extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum.		Student knows and deeply understands the structure and principles of operation of radiocommunication systems and networks for biomedical applications.		[SW1] Assessment of factual knowledge		

Subject contents	Lecture scope:  <ol style="list-style-type: none"><li>1. Basic notions in telecommunications (telecommunications, information, sources of information, signal, telecommunication service, telecommunication system, telecommunication channel, telecommunication network).</li><li>2. Analog signals description in time and frequency domain; logarithmic measures of signal level.</li><li>3. Transmission media and their parameters; baseband and band-pass signals transmission.</li><li>4. Basic notions in radio communications (radio link, radio wave propagation, link equation, radio frequency bands, free space propagation, basic radio waves propagation mechanisms, role of the antenna in radio communication system and its parameters).</li><li>5. Radio communication networks operating within and in the immediate vicinity of the human body (BAN definition, classification, frequency bands)</li><li>6. Electrical properties of the human body.</li><li>7. Selected issues of the lower layers of the OSI model in BAN (narrowband modulations used, ultra-wideband techniques, channel coding).</li><li>8. Antenna issues in BAN (miniaturized antennas, implantable antennas, wearable antennas, examples of antenna solutions).</li><li>9. Radio channel in various types of BAN networks (characteristics of radio channel, empirical and simulation methods of radio channel modelling, overview of radio channels).</li><li>10. BAN power sources.</li><li>11. Human safety aspects (SAR definition, methods of its analysis and assessment).</li><li>12. Issues of data security in BAN networks.</li><li>13. Assessment of the quality of BAN network operation of various types (bit error rate, radio link budget, coverage issues).</li><li>14. Legal and standardization conditions (regulations regarding UWB, ISM, MICS, WMTS, LP-AMI, SRD, standards that can be used in BAN networks: IEEE 802.11, IEEE 802.15.1, IEEE 802.15.4, IEEE 802.15.6).</li></ol> Laboratory scope:  <ol style="list-style-type: none"><li>1. Basics of analog modulation and demodulation (Matlab, Python).</li><li>2. Digital modulation and demodulation systems.</li><li>3. Configuration and operation of the mesh network in the ZigBee standard.</li><li>4. Configuration and operation of communication in Bluetooth and BLE (with a focus on medical data).</li><li>5. Transmission of medical data over WiFi networks.</li></ol>		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Laboratory	50.0%	40.0%
	Lecture	50.0%	60.0%
Recommended reading	Basic literature	<ol style="list-style-type: none"><li>1. S.J. Ambroziak, "Kanał radiowy w sieciach WBAN", WKŁ, 2020.</li><li>2. IEEE 802.15.6-2012, <i>IEEE Standard for Local and Metropolitan Area Networks - Part 15.6: Wireless Body Area Networks</i>, 2012.</li><li>3. Wang J., Wang Q., <i>Body Area Communications: Channel Modeling, Communication Systems, and EMC</i>, Wiley, 2013.</li><li>4. Li H.-B., Yazdandoost K.Y., Zhen B., <i>Wireless Body Area Network</i>, River Publishers, 2010.</li><li>5. Gupta S.K.S., Mukherjee T., Venkatasubramanian K.K., <i>Body Area Networks Safety, Security, and Sustainability</i>, Cambridge University Press, 2013.</li></ol>	
	Supplementary literature	<ol style="list-style-type: none"><li>1. Hall P.S., Hao Y., <i>Antennas and Propagation for Body-Centric Wireless Communications - Second Edition</i>, Artech House, USA, 2012.</li><li>2. Gabriel C., Compilation of the Dielectric Properties of Body Tissues at RF and Microwave Frequencies, <i>Brooks Air Force Technical Report</i>, 1996.</li><li>3. Molisch A.F., <i>Wireless Communications Second Edition</i>, Wiley, 2011.</li><li>4. Yazdandoost K.Y., Sayrafian K., <i>Channel Model for Body Area Network (BAN)</i>, IEEE P802.15-08-0780-09-0006, 2009.</li><li>5. Yuce M.R., Khan J.Y., <i>Wireless Body Area Networks Technology, Implementation, and Applications</i>, Pan Stanford Publishing, 2012.</li><li>6. Zimmermann T., Personal Area Networks: Near-Field Intrabody Communications, <i>IBM System Journal</i>, tom 35, nr 3&amp;4, str. 609-617, 1996.</li></ol>	
	eResources addresses	Adresy na platformie eNauczanie: Metody radiotransmisji w aplikacjach biomedycznych - 2023/2024 - Moodle ID: 30733 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30733">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30733</a>	
Example issues/ example questions/ tasks being completed	Will be given during the lecture.		
Work placement	Not applicable		