



## Subject card

Subject name and code	Digital Modulation Techniques, PG_00048147						
Field of study	Electronics and Telecommunications						
Date of commencement of studies	October 2023	Academic year of realisation of subject			2026/2027		
Education level	first-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	4	Language of instruction			Polish		
Semester of study	7	ECTS credits			5.0		
Learning profile	general academic profile	Assessment form			exam		
Conducting unit	Department of Radiocommunication Systems and Networks -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Jacek Stefański					
	Teachers	prof. dr hab. inż. Jacek Stefański					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	0.0	60
	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	60	5.0		60.0	125	
Subject objectives	To familiarize students with selected types of digital modulation used in radio communication systems.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_U06] can analyse the operation of components, circuits and systems related to the field of study, measure their parameters and examine technical specifications	During laboratory exercises, students experimentally verify some of the issues presented in the lecture.			[SU3] Assessment of ability to use knowledge gained from the subject		
	[K6_W34] Knows the characteristics of telecommunications channels, methods of securing information, modulation systems, methods of access to the channel.	The student knows the modulation techniques in modern radiocommunication systems with particular emphasis on block diagrams of selected modulators as well as demodulators and digital detectors. He knows the criteria for assessing the quality of transmission in digital systems and is able to explain which system parameters and how they affect the quality of transmission.			[SW1] Assessment of factual knowledge		

Subject contents	<p>1. Role of modulation and encoding in radiocommunication system 2. Digital passband transmission. 3. Multilevel modulation techniques MPSK. Signal constellation. 4. Signal envelope, bandwidth, and spectrum efficiency for phase keying modulation. 5. Multilevel modulation techniques: QPSK, OQPSK and Pi/4 DQPSK. 6. Reception of phase keying signals. 7. Noise characteristics for received signals with phase keying: bit and symbol error rate. 8. Phase and amplitude keying system. QAM signal constellation. Es/No ratio. 9. Block diagrams of QAM modulator and demodulator. 10. Minimum frequency keying modulation MSK features and applications. 11. Minimum frequency keying with Gaussian filter GMSK. 12. Intersymbol interference of GMSK signals. Parameters selection of pre-modulation filter. 13. Reception of GMSK signals. 14. Bit error rate as a function of BT for GMSK modulation. 15. Spectrum compactness of continuous phase signals. 16. Trellis coded modulation TCM and BCM. 17. Advantages of trellis coded modulation. 18. Principle of TCM modulation, mapping of coding sequences into the modulation symbols. 19. Free distance and Hamming distance. 20. Asymptotic coding gain (ACG). 21. TCM signals decoding. Calculation of a free distance. 22. Examples of signal constellation, selection of a convolutional code and ACG evaluation for TCM modulations. 23. The target of multi-carrier radiocommunication systems. 24. Selection of distance between sub-carriers. 25. Orthogonal frequency division multiplexing (OFDM). 26. Properties of OFDM signals in the radio fading channel. 27. Application of OFDM in the DAB system. 28. Application of OFDM in the DVB and DRM systems. 29. Role of a protective distance and its selection. 30. Example of a transceiver for OFDM system.</p>		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Practical exercise	50.0%	30.0%
	Written exam	50.0%	70.0%
Recommended reading	Basic literature	1. Wilson S., Digital Modulation and Coding, Prentice Hall, 2000. 2. Knoch L., Ekiert T., Modulacja i detekcja, WKŁ, 1979	
	Supplementary literature	No requirements	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	No issues / questions.		
Work placement	Not applicable		