GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Radio Communication Antennas and MIMO Techniques, PG_00064148		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Optional subject group Specialty 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	English
Semester of study	2	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Radiocommunication Systems and Networks -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Jarosław Magiera	
	Teachers	dr inż. Jarosław Magiera	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	0.0	15

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	15	2.0	8.0	25

Subject objectives

Familiarization with the construction and operation of the main types of radio antennas.

Familiarization with MIMO transmission technique: its fundamentals, variants and state of the art.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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	Knows and understands physical phenomena occurring in the antenna, associated with the conversion of an electric current into an electromagnetic field and vice versa.	[SW3] Assessment of knowledge contained in written work and projects
[K7_W01] knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study	Knows and understands the mathematical description used in electromagnetic analysis and design of linear antennas	[SW3] Assessment of knowledge contained in written work and projects
[K7_W02] knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the field of study	Knows and understands the structure and operation of various types of radio antennas as well as the structure and operation of MIMO multi-antenna links.	[SW3] Assessment of knowledge contained in written work and projects

Subject contents	Part 1: 1.Fundamentals od antenna theory field and circuit properties 2.Antenna selection for given requirements 3.Linear antennas 4.E-M analysis of linear antenna 5.Aperture antennas 6.Antenna arrays 7.Antenna measurements 8.Antenna size reduction Part 2: 1.Fundamentals of MIMO technique 2.Spatial multiplexing 3.Algorithms of detection in a link with spatial multiplexing 4.Channel coding in MIMO 5.MIMO in frequency-selective channels 6.Spatial diversity 7.Transmit diversity space-time coding 8.Antenna diversity for reception 9.Multi-user MIMO (MU-MIMO) 10.Cooperative MIMO 11.Massive MIMO
Prerequisites and co-requisites	
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Final test	50.0%	100.0%

<table>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Huang, Yi. Antennas: from theory to practice. John Wiley & Sons, 2021.

Hampton, Jerry R. Introduction to MIMO communications. Cambridge university press, 2013.

Kshetrimayum, Rakhesh Singh. Fundamentals of MIMO wireless communications. Cambridge University Press, 2017.</td></tr>
<tr><td>Supplementary literature</td><td>Balanis, Constantine A. Antenna theory: analysis and design. John wiley & sons, 2016.

Oestges, Claude, and Bruno Clerckx. MIMO wireless communications: from real-world propagation to space-time code design. Academic Press, 2010.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Antenna part:

1. Parameters describing a radiocommunication antenna

2.Criteria for selecting a radiocommunication antenna

3. Construction and properties of linear antennas: dipole, monopole, helical antenna

4. Construction and properties of Uda-Yagi and LPDA antennas

5. Aperture antennas: horn and reflector

6. Construction, properties and models of microstrip patch antenna

7. Antenna arrays: general description, pattern multiplication principle, effect of antenna number and location on array pattern, adaptive antenna arrays

8. Measurement of circuit parameters of antenna , measurement of antenna pattern

MIMO part:

1. MIMO channel model

2. Spatial multiplexing - principle, multiplexing gain, detection algorithms (ML, zero forcing, MMSE)

3. Spatial diversity - principle, diversity gain, differences from spatial multiplexing

4. Space-time block coding (STBC): matrix description, Alamouti code, properties of codes: orthogonality, rate, real/complex code

5. Space-time trellis coding (STTC): principle, differences from STBC, coder scheme, methods of describing a code</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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