

## Specification for the book of courses

<b>Study program</b>		Communications and Information Technologies		
<b>Module</b>		System Engineering and Radio-Communications		
<b>Type and level of studies</b>		Master studies		
<b>The name of the course</b>		Adaptive antennas and MIMO systems		
<b>Lecturer (for lectures)</b>		Dončov S. Nebojša, Stanković Ž. Zoran		
<b>Lecturer/associate (for exercises)</b>		Dimitrijević Ž. Tijana		
<b>Lecturer/associate (for OFE)</b>				
<b>Number of ECTS</b>		4	<b>Course status (obligatory/elective)</b>	Elective
<b>Prerequisites</b>				
<b>Course objectives</b>		The acquisition of theoretical and practical knowledge of the spatial signal processing techniques in wireless communications which are based on the use of adaptive antennas and MIMO (Multiple Input - Multiple Output) systems.		
<b>Course outcomes</b>		Knowledge of the basic techniques of signal spatial processing and working principles of the adaptive antennas. The ability to apply basic methods of shaping the antenna array radiation pattern in the construction of adaptive antennas. Knowledge of techniques of signal transmission using MIMO (multiple-input and multiple-output) antennas (MIMO systems). The ability to apply adaptive antennas and MIMO systems in practice.		
<b>Course outline</b>				
<b>Theoretical teaching</b>		Electromagnetic waves characterization in the space-time domain. Spatial filtering of the signal and SDMA concept. Antenna arrays with controllable radiation patterns. Butler's matrix. Scanning antenna arrays. Algorithms for determining the direction of arrival (DoA) of EM radiation (MUSIC, ESPRIT). Adaptive antenna arrays. Adaptive beamforming in the temporal and spatial domain. Wiener solution. MIMO systems. (architecture, spatial communication channel, processing in the space-time domain). Application of antenna arrays in wireless communications.		
<b>Practical teaching (exercises, OFE, study and research)</b>		Solving practical problems related to antenna array beamforming. Solving practical problems related to DoA estimation of the electromagnetic signals.		
<b>Textbooks/references</b>				
1	B. Allen, M. Ghavami, Adaptive Array Systems: fundamentals and applications, Wiley, 2005.			
2	S. Chandran, Adaptive Antenna Arrays: trend and applications, Springer, 2004.			
3	F. Gross, Smart Antennas with MATLAB, Second Edition: Principles and Applications in Wireless Communication, McGraw Hill Professional, 2015.			
4	G. Thoulos, MIMO System Technology for Wireless Communications, CRC Taylor & Francis Group, 2006.			
5	J. S. Seybold, Introduction to RF Propagation, Wiley, 2005.			
<b>Number of classes of active education per week during semester/trimester/year</b>				
<b>Lectures</b>	<b>Exercises</b>	<b>OFE</b>	<b>Study and research work</b>	<b>Other classes</b>
2	1	0	0	0
<b>Teaching methods</b>		Lectures, auditory exercises, seminar paper, homework, consultations.		
<b>Grade (maximum number of points 100)</b>				
<b>Pre-exam duties</b>		<b>Points</b>	<b>Final exam</b>	<b>Points</b>
<b>Activity during lectures</b>		5	<b>Written exam</b>	20
<b>Exercises</b>			<b>Oral exam</b>	20
<b>Colloquia</b>		30		
<b>Projects</b>		25		