



## Subject card

Subject name and code	Echolocation Methods, PG_00047487						
Field of study	Automatic Control, Cybernetics and Robotics						
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		English		
Semester of study	2		ECTS credits		2.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Marine Electronic Systems -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Henryk Lasota				
	Teachers		dr hab. inż. Henryk Lasota				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	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		16.0	50
Subject objectives	The aim of the course is to acquaint student with the principle of operation, construction, and parameters of radars, sonars and aeroacoustic systems used in automatic control and give him the knowledge of methods and techniques of generation, emission, detection and imaging.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W21] Knows and understands, to an advanced extent, methods and techniques of design and operation of automatic control systems, control and robotics systems, as well as the use of computers in the control and monitoring of dynamic objects	knows and understands the advanced methods and techniques of design and operation of radiolocation, hydrolocation and aerolocation systems used in automation	[SW1] Assessment of factual knowledge
	[K7_U21] can individually carry out an in-depth analysis of controlling, diagnostics and signal processing problems; and, to an advanced extent, is able to individually design, tune and operate automatic regulation, control and robotics systems; and use computers to control and monitor dynamic systems	can independently make an in-depth analysis of signal processing in echolocation systems used in automation	[SU2] Assessment of ability to analyse information
	[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 the construction and operating principles of radar, hydrolocation and aerolocation systems used in automation in a deeper degree; knows methods and techniques of generation, emission, detection and visualization of echolocation signals	[SW1] Assessment of factual knowledge
	[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	is able to design, in accordance with a given specification, elements of the echolocation system, using appropriately selected methods, techniques and tools, using engineering standards and norms	[SU3] Assessment of ability to use knowledge gained from the subject
Subject contents	1 General characteristics of echolocation systems 2 Electromagnetic and acoustic waves 3 Propagation of waves in real physical media 4 Operation parameters of echolocation systems 5 Radars - operating principle, classification 6 Sonars - operating principle, classification 7 Echolocation laser systems - the principle of operation 8 Echolocation signals 9 Detection methods 10 Antennas of echolocation systems 11 Fourier's method of antenna analysis and design 12 Multibeam technology 13 High resolution methods of space spectrum estimation 14 Modern methods in echolocation systems 15 Engineering design of echolocation systems 16 Sonars developed and built at the Department of Marine Electronics Systems 17 Overview of technical solutions of echolocation systems in automation, robotics and natural resources exploration		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Written exam	60.0%	100.0%
Recommended reading	Basic literature	M. Skolnik: Introduction to Radar Systems, McGraw-Hill, New York 1962, 1980, 2001. R. Salamon: Systemy hydrolokacyjne (Sonar Systems), Wyd. GTN, Gdańsk 2006.	

	Supplementary literature	<p>M. Skolnik (ed.): Radar Handbook, McGraw-Hill, New York 1970, 1998, 2008 (with contributions by 30 world experts).</p> <p>D. L. Mensa: High resolution radar cross-section imaging, Artech House, Boston 1981, 1984, 1990, 1991.</p> <p>R. Urick: Principles of Underwater Sound, McGraw-Hill, New York 1967, 1975, 1996.</p> <p>D. Martinez et al., High Performance Embedded Computing Handbook: A System Perspective, CRC Press, Boca Raton 2008</p>
	eResources addresses	<p>Adresy na platformie eNauczanie:</p> <p>Echolocation Methods - 2023/24 - Moodle ID: 30817</p> <p><a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30817">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30817</a></p>
Example issues/ example questions/ tasks being completed	<p>Determine the possibilities of echolocation systems. Compare the impact of the operating environment of systems on their functions and parameters. Discuss the similarities and differences in the properties of electromagnetic and acoustic waves and their impact on the construction of radars and sonars. Compare the operating features and design specificity of systems using narrowband pulses and special signals. Discuss the relationship between directional characteristics of radar and sonar antennas with the diffraction of coherent light on openings. Give examples of the use of a two-dimensional Fourier transform for the synthesis of aperture antennas and antenna arrays required directional characteristics. Explain the idea of the so-called synthetic aperture and indicate its benefits and limitations. What methods of echolocation we encounter in the animal world. Give examples of technical solutions of echolocation systems used at present in automatic control and robotics as well as in underwater exploration of natural resources.</p>	
Work placement	Not applicable	