



Subject card

Subject name and code	Matrix Algebra, PG_00053205						
Field of study	Automation, Robotics and Control Systems						
Date of commencement of studies	October 2021	Academic year of realisation of subject			2022/2023		
Education level	first-cycle studies	Subject group			Obligatory subject group in the field of study		
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	2	Language of instruction			Polish		
Semester of study	3	ECTS credits			1.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Control Systems Engineering -> Faculty of Electrical and Control Engineering						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Rafał Łangowski					
	Teachers	dr inż. Rafał Łangowski					
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	The aim of the course is to present tools in the form of matrices and matrix algebra as well as elements of linear algebra in the scope allowing efficient modelling, analysis and synthesis of control systems.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K6_U07	The student uses matrices and matrix algebra to efficient modelling, analysis and synthesis of control systems, especially of continuous processes. The student uses vector-matrix notation and matrix algebra in tasks from the field of control theory and engineering.			[SU3] Assessment of ability to use knowledge gained from the subject		
	K6_W01	Students will know and understand basic definitions, operations and properties of matrices and matrix algebra as well as elements of linear algebra.			[SW1] Assessment of factual knowledge		
	K6_K05	The student describes the surrounding reality using elements of linear algebra.			[SK5] Assessment of ability to solve problems that arise in practice		

Subject contents	LECTURES: W1: Organisation and programme of the course; Systems of linear equations and elements of vector arithmetic - A system of linear equations and its solution; notation of the system in vector-matrix form; vectors and scalars; vectors in the n-dimensional space of real numbers; basic operations on vectors. W2: Matrix and its basic types - Definition of matrix; matrix notation; basic types of matrix; transposed matrix; examples of the use of matrix notation, including in control theory and engineering; Operations on matrices Part I - Basic operations on matrices (addition, multiplication, etc.); main properties of operations on matrices. W3: Operations on matrices part II - Basic operations on matrices (addition, multiplication, etc.); main properties of operations on matrices; Determinant and rank of matrices - Determinant of matrices and its properties; calculation of determinant of matrix; rank of matrix; calculation of rank of matrix; examples of use of determinant and rank of matrix in control theory and engineering. W4: Inversion of matrices - Inversion of square and rectangular matrices; attached and inverse matrix; examples of use of matrix inversion in control theory and engineering; Solving systems of linear equations using matrices -Solving systems of linear equations using matrices; Kronecker-Cappelli theorem. W5: Characteristic polynomial and eigenvalues of matrices - Characteristic polynomial and characteristic equation of matrices; eigenvalues of matrices; spectrum of matrices; singular values of matrices; examples of use of eigenvalues of matrices in control theory and engineering; Eigenvectors of matrices - Eigenvectors of matrices and how to determine them. W6: Norms of vectors and matrices - Norms of vectors and matrices and their properties; Quadratic forms and their determinacy - Quadratic form; determinacy of form; determinacy of matrix; examples of use of quadratic forms in control theory and engineering. W7: Selected decompositions of matrices - Diagonalization of matrices; decomposition according to singular values; Cholesky decomposition; Jacobi matrix and Hessian matrix - Gradient; Jacobi matrix (Jacobian); Hessian matrix (Hessian); W8: Colloquium.		
Prerequisites and co-requisites	The Pre-Requisites: Mathematics terms 1,2.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Midterm colloquium	50.0%	100.0%
Recommended reading	Basic literature	1. Leksiński W., Nabiałek I., Żakowski W.: Matematyka Definicje, twierdzenia, przykłady, zadania. Wydawnictwa Naukowo-Techniczne, Warszawa, 2003.2. Kaczorek T.: Wektory i macierze w automatyce i elektrotechnice. Wydawnictwa Naukowo-Techniczne, Warszawa, 1998.3. Singh K.: Linear Algebra, Step by Step. Oxford University Press, Oxford, UK, 2014.	
	Supplementary literature	1. Puchalski B.: Operacje na macierzach materiały pomocnicze do przedmiotu Metody Numeryczne. Politechnika Gdańska, 2021.2. Petersen K. B., Pedersen M. S.: The Matrix Cookbook. Technical University of Denmark, 2012.3.Ogata K. Modern Control Engineering. 4th edition. Prentice Hall, 2002.4. Nise N.S. Control System Engineering. 3th edition. John Wiley & Sons, 2000.	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	1) Calculating the determinant of a matrix;2) Determination of inverse matrix, transposed matrix, etc;3) Calculating the rank of a matrix;4) Construction of the characteristic equation of a matrix;5) Determination of eigenvalues of a matrix;		
Work placement	Not applicable		