GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Matrix Algebra, PG_00053205		
Field of study	Automation, Robotics and Control Systems		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
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 Intelligent And Decision Support Systems -> Faculty Of Electrical And Control Engineering -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Rafał Łangowski	
	Teachers		

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_W01] has basic knowledge in the field of mathematics including algebra, geometry, mathematical analysis, probabilistics, numerical methods - necessary to describe and analyze automation and robotics systems	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_U07] can build and analyze models of systems and systems in the field related to control systems and automation	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_K05] can think and act in an entrepreneurial way	The student describes the surrounding reality using elements of linear algebra.	[SK5] Assessment of ability to solve problems that arise in practice

<table>
<tr><td>Subject contents</td><td>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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Fundamentals of electrical circuits, DC motors and physics of simple mechanical, heat transfer and hydraulic systems. Linear time invariant and scalar differential equations, Laplace transforms, complex numbers. The Pre-Requisites: Mathematics terms 1,2; Physics term 1, Elektrotechnics term 1.</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Midterm colloquium</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>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.</td></tr><tr><td>Supplementary literature</td><td>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.</td></tr><tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>• Calculating the determinant of a matrix;
• Determination of inverse matrix, transposed matrix, etc;
• Calculating the rank of a matrix;
• Construction of the characteristic equation of a matrix;
• Determination of eigenvalues of a matrix;</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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