GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00070312		
Field of study	Mathematics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Nonlinear Analysis and Statistics -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Marek Izydorek	
	Teachers	prof. dr hab. Marek Izydorek	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	0.0	30.0	60
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	60	0.0	0.0	60

Subject objectives	The aim of the lecture is to introduce basic notions in the theory of differential forms.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U08] in a selected field, examines evidence, in which also can use tools from other branches of mathematics,	A student understands and is able to carry out proofs of fundamental theorems, as well as describe and justify selected properties of differential forms.	[SU4] Assessment of ability to use methods and tools
[K7_U10] understands the mathematical foundations of the analysis of algorithms and computational processes, constructs algorithms with good numerical properties, used to solve typical and unusual mathematical problems	A student is familiar with advanced techniques, theorems, and facts concerning the analytical and topological properties of differentiable manifolds. They apply numerical algorithms to determine geometric and topological invariants.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_W02] has enhanced knowledge of a selected branch of mathematics,theoretical or applied, knows classical definitions and theorems and their proofs and connections with other fields,understands problems being examined	A student acquires advanced concepts and techniques of the theory of differential forms in the context of their applications to integration on manifolds, as well as in algebraic topology and field theory.	[SW1] Assessment of factual knowledge
[K7_W03] demonstrates knowledge advanced computation techniques, supporting the work of a mathematician and understand their limitations.	A student acquires various schemes used in algebraic computations and solves classical problems of exterior algebra and the theory of differential forms.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture The space of p-vectors. Exterior products. LInear transformations. Inner products of p-vectors. The Hodge's operator. Differential form. Exterior derivative. Mappings and change of coordinates. Examples from mechanics. Converse to the Poincare Lemma. Moving frames .The Laplacian and orthogonal coordinates. Manifolds. Tangent bundles. Differential forms on manifolds. Euclidean simplices. Chains and boundaries. Integration of forms. Stoke's Theorem on manifolds. Periods and De Rham's Theorems. Course content – seminar Selected topics based on the textbook: Michael Spivak, *Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus*, Addison-Wesley Publishing Company, New York, 1995.
Prerequisites and co-requisites	Mathematical analysis I-III. Topology. Differential geometry.
Assessment methods and criteria	see table below

Subject passing criteria	Passing threshold	Percentage of the final grade
Homeworks	50.0%	25.0%
An oral presentation of a selected subject	60.0%	35.0%
Activity during the classes	50.0%	25.0%
Test	60.0%	15.0%

Recommended reading	Basic literature	1. Harley Flanders, Differential Forms with Applications to the Physical Sciences, Dover Publications, Inc. New York 1989. 2. Michael Spivak, Calculus on Manifolds, a Modern Approach to Classical Theorems of Advanced Calculus, Addison-Wesley Publishing Company, The Advanced Book Program, New York 1995. 3. David Bachman, A Geometric Approach to Differential Forms, Birkhauser 2006.
	Supplementary literature	Jurgen Jost, Riemannian Geometry and Geometric Analysis,Universitext, Springer-Verlag Berlin Heidelberg, 2008.
	eResources addresses	
Example issues/ example questions/ tasks being completed	Operator Alt defined on the space of k-tensors, properties, basic theorems together with sketches of proofs and examples.. Two hours presentation.	
Practical activites within the subject	Not applicable	