## Subject card

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| Subject name and code | , PG_00070312 |
| Field of study | Mathematics |

| Date of commencement of studies | October 2024 | Academic year of realisation of subject | 2025/2026 |
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| Education level | second-cycle studies | Subject group | Specialty subject group<br>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 |

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| 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 |
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| | 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 | | | | | | |
| | eNauczanie source addresses:<br>Moodle ID: 5245 Formy różniczkowe 2025/2026<br>https://enauczanie.pg.edu.pl/2025/course/view.php?id=5245 | | | | | | |

| 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 |

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| 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<br>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. |
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| | Course content – seminar<br>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 | Subject passing criteria | Passing threshold | Percentage of the final grade |
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| | 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. |
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| | 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. |
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| Practical activites within the subject | Not applicable |

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