

**Subject card**

<b>Subject name and code</b>	Calculus on manifolds, PG_00152983						
<b>Field of study</b>	Mathematics						
<b>Date of commencement of studies</b>	October 2024	<b>Academic year of realisation of subject</b>			2024/2025		
<b>Education level</b>	postgraduate studies	<b>Subject group</b>			Optional subject group Specialty subject group		
<b>Mode of study</b>	full-time studies	<b>Mode of delivery</b>			at the university		
<b>Year of study</b>	1	<b>Language of instruction</b>			Polish Polish or English		
<b>Semester of study</b>	2	<b>ECTS credits</b>			6.0		
<b>Learning profile</b>	academic	<b>Assessment form</b>					
<b>Conducting unit</b>	Instytut Matematyki -> Faculty of Mathematics, Physics and Informatics -> Rektor						
<b>Name and surname of lecturer (lecturers)</b>	<b>Subject supervisor</b>		dr hab. Andreas Zastrow				
	<b>Teachers</b>						
<b>Lesson types</b>	<b>Lesson type</b>	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	<b>Number of study hours</b>	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 0.0						
<b>Learning activity and number of study hours</b>	<b>Learning activity</b>	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	<b>Number of study hours</b>	60		10.0		80.0	150
<b>Subject objectives</b>	<p>To familiarize students with the main foundations of the theory of differential manifolds, basic concepts and tools, main theorems and proofs of some of them.</p> <p>Developing students' ability to understand problems abstractly and use the theory of differential manifolds in mathematical scientific work</p>						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[MATMU2_U05] can perform proofs in a selected field and, if necessary, also use tools from other areas of mathematics	The student is able to perform proofs in the field of analysis on manifolds, using as well standard methods of analysis, of algebra and of topology.	[SU1] oral statement/conversation/discussion [SU8] observation of student's independent or team work
	[MATMU2_U07] is able to define his/her interests and develop them; in particular, is able to establish contact with specialists in his/her field, e.g. understand their lectures intended for young mathematicians	The student is able to define his/her interests and develop them; in particular, he is able to establish contact with specialists in the field of manifold analysis, e.g. understand their lectures intended for young mathematicians.	[SU1] oral statement/conversation/discussion [SU8] observation of student's independent or team work
	[MATMU2_K02] is ready to precisely formulate questions to deepen his/her understanding of a given topic or find missing elements of reasoning	In the field of analysis on manifold, the student is ready to precisely formulate questions to deepen his or her understanding of a given topic or find missing elements of reasoning.	[SK2] presentation/project/paper/report [SK8] observation of student's independent or team work
	[MATMU2_W02] knows and understands well the role and importance of the construction of mathematical reasoning	The student knows and understands well the role and importance of constructions of mathematical reasoning in the field of analysis on manifolds.	[SW1] oral statement/conversation/discussion
	[MATMU2_U03] can understand mathematical texts of various types from selected fields of mathematics	The student is able to understand mathematical texts of various types, in the field of analysis on manifolds.	[SU8] observation of student's independent or team work
	[MATMU2_W03] knows and understands in-depth a selected field of theoretical or applied mathematics and is able to understand the formulations of issues in this field that are still at the research stage and knows the connections of issues in this field with other areas of mathematics	The student knows and understands analysis on manifolds in-depth and is able to understand the formulations of issues remaining at the research stage and knows the connections of issues with other areas of mathematics, in particular mathematical analysis, algebra or topology.	[SW4] test/exam - oral or written
	[MATMU2_U06] is able to apply methods and examples from a selected field of mathematics in related fields	The student is able to solve problems in the field of analysis on manifolds, using as well standard methods of mathematical analysis, algebra and topology, as well as the definitions, properties and theorems learned during the lecture.	[SU1] oral statement/conversation/discussion [SU8] observation of student's independent or team work
	[MATMU2_U01] can construct mathematical reasoning: prove theorems and refute hypotheses through construction and selection of counterexamples	In the field of analysis on manifolds, the student is able to construct mathematical arguments: prove theorems and refute hypotheses through construction and selection of counterexamples.	[SU2] presentation/project/paper/report [SU8] observation of student's independent or team work
	[MATMU2_W01] knows and understands in-depth the theory of selected areas of mathematics	In the field of analysis on manifold, the student knows and understands in-depth the relevant theory. Especially in this field he/she can communicate about basic definitions and formulae, knows examples and counterexamples of defined objects, and correctly formulates and proves basic theorems.	[SW4] test/exam - oral or written
	[MATMU2_K06] is ready to formulate opinions on basic mathematical issues	The student is ready to formulate opinions on basic mathematical issues in the field of analysis on manifolds.	[SK1] oral statement/conversation/discussion
	[MATMU2_U04] is able, at an advanced level and including modern mathematics, to apply and present, orally and in writing, methods of at least one selected branch of mathematics	The student is able to present mathematical arguments orally and in writing at an advanced level in the field of analysis on manifolds	[SU1] oral statement/conversation/discussion [SU5] implementation of a problem task
	[MATMU2_K04] is ready to understand and appreciate the importance of intellectual honesty in one's own and other people's actions; ethical conduct	The student is ready to understand and appreciate the importance of intellectual honesty in his own and other people's actions; ethical conduct	[SK1] oral statement/conversation/discussion [SK8] observation of student's independent or team work

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Subject contents	<ol style="list-style-type: none"> <li>1. Topological and differentiable manifolds, atlas and differentiable structure.</li> <li>2. Mappings between manifolds, the rank of a mapping.</li> <li>3. Definition of submanifolds.</li> <li>4. Properties of immersions, submersions and embeddings.</li> <li>5. Tangent spaces and -bundles, the derivative of mappings.</li> <li>6. Approximation theorem.</li> <li>7. Transversality.</li> <li>8. The orientation of manifolds.</li> <li>9. Manifolds with boundary.</li> <li>10. The degree of a mappings.</li> <li>11. Differential forms, integrals with respect to them, and Stokes' Theorem.</li> </ol>												
Prerequisites and co-requisites	None												
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Example issues/ example questions/ tasks being completed	<p>Credit for the lecture on the basis of the results of the oral exam in the range described in the required learning outcomes.</p> <p>Credit for the auditorium class on the basis of the results of the presented solutions in the range described in the required learning outcomes</p>												
Work placement	Not applicable												

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