



Subject card

Subject name and code	Fixed point theory, PG_00021051						
Field of study	Mathematics						
Date of commencement of studies	October 2023	Academic year of realisation of subject			2023/2024		
Education level	second-cycle studies	Subject group					
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	1	Language of instruction			Polish		
Semester of study	2	ECTS credits			4.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Differential Equations and Mathematical Applications -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. Grzegorz Graff				
	Teachers		prof. dr hab. Grzegorz Graff Patryk Topór				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	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		5.0		35.0	100
Subject objectives	The aim of the course is to introduce the student to issues related to the theory of fixed points. Listeners will be familiar with the classical theorems on the existence of fixed points. The related issues are also on the occurrence of periodic points. The lecture will be shown compounds fixed point theory with different areas of mathematics, particularly topology and the theory of dynamical systems, as well as applications in other fields of science.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_W05] Has enhanced knowledge of a selected branch of mathematics: knows most classical definitions and theorems and their proofs, Understands problems being examined, Knows relations between problems from particular field with other branches of mathematics, theoretical and applied		The student has an in-depth knowledge of Fixed Point Theory: he knows most of the classical definitions and theorems and their proofs, he is able to understand the formulations of issues remaining in the research stage, he knows the connections of Fixed Point Theory with other branches of theoretical and applied mathematics.		[SW1] Assessment of factual knowledge		
	[K7_U02] Has the ability to check the correctness of conclusions in constructing formal proofs, sees formal structures related to the basic areas of mathematics in mathematical issues and understands the importance of their properties.		The student has the ability to construct reasoning mathematical reasoning of the Theory of Fixed Points: proving theorems, as well as refuting hypotheses related to Fixed Point Theory through the construction and selection of counterexamples.		[SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment		

Subject contents	<p>1 Reminder basic information on the topological concepts.</p> <p>2 Retracts, absolute retracts, homotopy and their properties.</p> <p>3 Sperner Lemma, Brouwer fixed point Theorem.</p> <p>4 Kakutani Theorem .</p> <p>5 Spaces having the fixed point property.</p> <p>6 Banach fixed point theorem and its consequences.</p> <p>7 Kuratowski's measure of non-compactness, Kuratowski's and Sadowski's theorem .</p> <p>8 Borsuk theorem for antipodal and its consequences.</p> <p>9 Theorem Badger-Lusternik-Schnirelman and Borsuk Ulam theorem.</p> <p>10 Fixed point index and its properties.</p> <p>11 Hairy ball theorem.</p> <p>12 The existence of periodic points.</p> <p>13 Methods for detection of invariant sets.</p> <p>14 Applications of fixed point theory in other areas of mathematics.</p> <p>15 Review of non-mathematic applications of fixed point theory.</p>														
Prerequisites and co-requisites	<p>Algebra</p> <p>Mathematical analysis</p> <p>Topology</p>														
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>Activity</td> <td>50.0%</td> <td>30.0%</td> </tr> <tr> <td>Exam</td> <td>50.0%</td> <td>30.0%</td> </tr> <tr> <td>Exam</td> <td>50.0%</td> <td>40.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Activity	50.0%	30.0%	Exam	50.0%	30.0%	Exam	50.0%	40.0%
Subject passing criteria	Passing threshold	Percentage of the final grade													
Activity	50.0%	30.0%													
Exam	50.0%	30.0%													
Exam	50.0%	40.0%													
Recommended reading	Basic literature	<p>1. J. Dugundji, A. Granas, <i>Fixed Point Theory</i>, vol. 1, PWN Warszawa, 1982.</p> <p>2. J. Gulowski, W. Marzantowicz, <i>Wstęp do analizy nieliniowej, część I; Teoria stopnia</i>, Wydawnictwo Naukowe UAM, Poznań 2003.</p> <p>3. J. Jezierski, W. Marzantowicz, <i>Homotopy methods in topological fixed and periodic points theory</i>, Series: Topological Fixed Point Theory, Springer 2005.</p>													
	Supplementary literature	K. Goebel, W. A. Kirk, <i>Zagadnienia metrycznej teorii punktów stałych</i> , Wydawnictwo UMCS 1999.													
	eResources addresses	Adresy na platformie eNauczanie: Teoria punktów stałych [2023/2024] (Matematyka, WFTiMS) - Moodle ID: 37824 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=37824													
Example issues/ example questions/ tasks being completed	<p>1) Prove that there is no retraction ball $(n + 1)$-dimensional at its edge, ie dimensional sphere. Explain what is the relationship of this fact with the theory of fixed points.</p> <p>2) What is the index of the fixed point for the sink, and for the source for mapping the plane?</p>														
Work placement	Not applicable														