

A COURSE SYLLABUS – DOCTORAL SCHOOL
REGARDING THE QUALIFICATION CYCLE FROM 2023/2024 TO 2027/2028.

GENERAL INFORMATION ABOUT COURSE				
Course title	OPTIONAL SPECIALISED SUBJECT: Selected topics in category theory			
Name of the unit running the course	Doctoral School at the University of Rzeszów			
Type of course (<i>obligatory, optional</i>)	optional specialised			
Year and semester of studies	year III, semester: VI			
Discipline	mathematics			
Language of Course	Polish/English			
Name of Course coordinator	Prof. dr hab. Mykhaylo Zarichnyy			
Name of Course lecturer	Prof. dr hab. Mykhaylo Zarichnyy			
Prerequisites	Knowledge of the following topics: <ul style="list-style-type: none"> ✓ Set theory, ✓ Algebra, ✓ Mathematical logic, ✓ Functional analysis, ✓ Topology 			
BRIEF DESCRIPTION OF COURSE (100-200 words)				
<p>Category theory occupies a central place in contemporary mathematics and also finds applications in computer science and theoretical physics. Contemporary teaching of various mathematical disciplines, particularly algebraic geometry and homological algebra, is based on category theory.</p> <p>Category theory studies the properties of relations between mathematical structures, regardless of their internal structure; it abstracts from sets and functions to diagrams where objects are connected by morphisms (arrows).</p> <p>A category-theoretic analysis of the foundations of homology theory led to the identification of so-called Abelian categories, within which it turned out to be possible to carry out the main constructions of homological algebra.</p> <p>As a generalization of the main constructions of set theory and set theory itself, the elementary topos was introduced – a Cartesian closed category with a classifier of subobjects. Topos theory developed in the second half of the 20th century, and its current main development is directed towards finding applications of the theory to various areas of mathematics and its applications. Thus, the construction of axiomatic theories is naturally described in topos theory.</p>				
COURSE LEARNING OUTCOMES AND METHODS OF EVALUATING LEARNING OUTCOMES				
Learning outcome	The description of the learning outcome defined for the course	Relation to the degree programme outcomes (symbol)	Learning Format (Lectures, classes,...)	Method of assessment of learning outcomes (e.g. test, oral exam, written exam, project,...)
Knowledge (NO.)	<i>Knows and understands, expresses knowledge</i>			
P8S_WG1	He possesses extensive theoretical knowledge and is familiar with current scientific achievements, including global ones, in the field of category	P8S_WG	seminar	Written exam

	theory and its applications in various fields of contemporary mathematics.			
P8S_WG2	He is familiar with the development trends and latest research achievements in category theory, including those with a global reach.	P8S_WG	seminar	Written exam
P8S_WG3	He possesses interdisciplinary knowledge and knows and understands the scientific terminology used in his discipline, both in his native and foreign languages.	P8S_WG	seminar	Written exam
P8S_WK1	Knows and understands the impact of the development of exact and natural sciences, including the discipline of mathematics, on the progress of civilization.	P8S_WK	seminar	Written exam
Skills (no.)	<i>Able to</i>			
P8S_UW1	Based on their knowledge, they can identify and solve a research problem, define the research goal, formulate a hypothesis and the subject of research, develop research techniques, methods, and tools, and draw conclusions based on research results.	P8S_UW	seminar	Written exam
P8S_UW2	They can select and utilize available scientific literature to diagnose and solve research problems and innovative activities related to their research, as well as apply appropriate procedures to create new elements of scientific achievement.	P8S_UW	seminar	Written exam
P8S_UW3	They utilize their extensive scientific knowledge to analyze and evaluate research results, formulating opinions based on them, including critical judgments.	P8S_UW	seminar	Written exam
P8S_UK6	They are able to conduct research based on foreign-language literature, speak publicly to present research results, and participate in discussions on scientific and professional topics in an international environment.	P8S_UK	seminar	Written exam
<i>Social competence (no.)</i>	<i>Ready to</i>			
P8S_KK3	Thanks to his knowledge, he solves cognitive and practical problems related to the category theory.	P8S_KK	seminar	Written exam

LEARNING FORMAT – NUMBER OF HOURS						
Semester (no.)	Lectures	Seminars	Lab classes	Internships	others	ECTS
VI	-	-	15	-	-	2
METHODS OF INSTRUCTION						
<ul style="list-style-type: none"> - traditional tutorials/laboratories; - activities with multimedia presentations; - project; - discussion. 						
COURSE CONTENT						
<p>Seminar/Lab:</p> <ol style="list-style-type: none"> 1. Categories, functors, natural transformations. 2. Universal arrows. Yoneda's lemma. 3. Adjoint functors. 4. Triples (monads). Kleisli and Eilenberg-Moore categories. 5. Triable (monadic) functors. Sufficient conditions for triable (monadic) function. 6. Freyd's representation theorems. 7. Abelian categories. 						
COURSE ASSESSMENT CRITERIA						
<p>The written exam is administered after each semester of the course (semester 4). The doctoral student prepares a written paper on topics related to the course content.</p> <p>To obtain a passing grade, the appropriate percentage of points obtained is calculated as follows:</p> <ul style="list-style-type: none"> - up to 50% - unsatisfactory (the written paper does not meet the criteria) - 51% - 60% - satisfactory (the written paper contains a narrow scope of knowledge, supported by the core literature for the course) - 61% - 70% - satisfactory plus (the written paper contains a range of knowledge, supported by the core literature for the course); - 71% - 80% - good (the written paper contains a range of knowledge, supported by the core and supplementary literature for the course); - 81% - 90% - good plus (the written paper contains a broad scope of knowledge, supported by the core and supplementary literature for the course). - 91% - 100% - very good (the written work contains a wide range of knowledge, supported by literature going beyond that required for the subject). 						
TOTAL PhD STUDENT WORKLOAD REQUIRED TO ACHIEVE THE INTENDED LEARNING OUTCOMES – NUMBER OF HOURS AND ECTS CREDITS						
Activity			Number of hours			
Scheduled course contact hours			15			
Other contact hours involving the teacher (consultation hours, examinations)			5			
Non-contact hours – student's own work (preparation for classes or examinations, project, etc.)			40			
Total number of hours			60			
Total number of ECTS credits			2 ECTS			

INSTRUCTIONAL MATERIALS

Compulsory literature:	<p>Michael Barr, Charles Wells, <i>Toposes, Triples and Theories</i>, Reprints in Theory and Applications of Categories, vol. 12. 2005.</p> <p>Saunders Mac Lane, <i>Categories for the Working Mathematician</i>. Graduate Texts in Mathematics. Vol. 5 (2nd ed.). Springer-Verlag, 1988. ISBN 978-0-387-98403-2.</p> <p>Robert Goldblatt, <i>Topoi: The Categorical Analysis of Logic</i>. Studies in logic and the foundations of mathematics. Vol. 94. Dover. 2006. ISBN 978-0-486-45026-1.</p> <p>Jiří Adámek, Horst Herrlich, George E. Strecker, <i>Abstract and Concrete Categories, The Joy of Cats</i>, Dover Publications, 2009, ISBN 10: 0486469344 / ISBN 13: 9780486469348</p> <p>Carl Clifton Faith, <i>Algebra 1 Rings, Modules, Categories</i>, Berlin ; New York : Springer-Verlag, 1973.</p>
Complementary literature:	<p>Zbigniew Semadeni, Antoni Wiweger, <i>Wstęp do teorii kategorii i funktorów</i>, PWN, Biblioteka Matematyczna t. 45, 1978.</p> <p>P. T. Johnstone, <i>Topos Theory</i>. Academic Press, New York, 1977.</p>

**(1 ects credit correspondes to 25–30 hours of total workload of the doctoral student, needed to achieve the intended outcomes)*

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Date and signature of the subject instructor

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Approval of the Head of the Unit or an authorized person