## Załącznik Nr 1 do zarządzenia Nr 182/2023 z dnia 21 lipca 2023 r.

## SYLLABUS FOR THE DOCTORAL SCHOOL

Lp.	Syllabus elements	Description
1	Course/module name in Polish and English	Teoria grafów Graph theory
2	Scientific discipline	Mathematics
3	Name of organizational unit organizing education	Doctoral College of Mathematics
4	Unit conducting the course/module	Institute of Mathematics
5	Course/module code	
6	Type of course/module	Optional
7	Year of studies	If applies
8	Semester	Winter
9	Forms and methods of instruction	Lectures and problem sessions
10	Educational contents	<ol> <li>Basic concepts: graphs, paths and cycles, complete and bipartite graphs.</li> <li>Matchings: Hall's Marriage theorem and its variations.</li> <li>Forbidden subgraphs: complete bipartite and r- partite subgraphs, chromatic numbers, Turán's theorem, asymptotic behaviour of edge density, Erdős-Stone theorem.</li> <li>Hamiltonian cycles (Dirac's Theorem), Eulerian circuits.</li> <li>Connectivity: connected and k-connected graphs, Menger's theorem.</li> <li>Ramsey theory: edge colourings of graphs, Ramsey's theorem and its variations, asymptotic bounds on Ramsey numbers.</li> <li>Planar graphs and colourings: statements of Kuratowski's and Four Colour theorems, proof of Five Colour theorem, graphs on other surfaces and Euler characteristic, chromatic polynomial, edge colourings and Vizing's theorem.</li> <li>Random graphs: further asymptotic bounds on Ramsey numbers, Zarankiewicz numbers and their bounds, graphs of large girth and high chromatic number, complete subgraphs in random graphs.</li> <li>Algebraic methods: adjacency matrix and its eigenvalues, strongly regular graphs, Moore graphs and their existence.</li> </ol>
11	Language of instruction	English
12	Intended learning outcomes regarding:	Symbols of learning outcomes:

	Knowledge: Student knows the foundations of graph theory and is familiar with graph- theoretic concepts.	SD_W01, SD_W02
	extremal problems in graph theory and with Ramsey theory. Student understands the statements and proofs of the main results in graph theory, such as Hall's Marriage, Menger's, Turan's, Ramsey's and Five Colour theorems	
	Skills: Student can apply the main theorems in graph theory in graph-theoretic and other mathematical problems. Student can compute connectivity, edge connectivity and chromatic numbers of small graphs.	SD_U01, SD_U02, SD_U05, SD_U07
	Student can decide if a given small graph is bipartite, planar, Hamiltonian or Eulerian. Student can use random graph methods to prove existence results. Student uses English language.	
	Social competences: Student understands the importance of continuous improvement and learning. Student communicates using English. Student is aware of the role and importance mathematics and graph theory in solving cognitive problems.	SD_K02, SD_K04
13	Methods of verifying intended learning outcomes	Activity at the problem sessions A written final exam
14	PhD student's workload	
	PhD student's activity form	Average number of hours for completing the activity
	Numbers of class hours (according to the study plan) with teacher:	60 class hours in total
	- Lecture: 30	
	- Problem sessions: 30	
	- Laboratory:	

	- Seminar:	
	- Others:	
	PhD student's own work, such as:	
	- Preparing classes:	
	- Developing results:	
	<ul> <li>Reading the suggested literature:</li> </ul>	Preparing for the classes: 20 hours
	- Writing a class report:	Preparing for the exam: 20 hours
	- Preparing for exam:	
	- Others:	
	Total hours:	100
	Number of credits (if required)	
15	Conditions for crediting the course/module, including the rules for admitting to the exam, and the form and conditions for crediting individual forms of classes included in the given course.	Activity at the problem sessions A written final exam
16	Literature	<ul> <li>[1] Béla Bollobás, Modern Graph Theory, Graduate Texts in Mathematics, vol. 184, Springer, 1998.</li> <li>[2] Reinhard Diestel, Graph Theory (2nd ed.), Springer, 2000.</li> <li>[3] Robin J. Wilson, Introduction to Graph Theory (4th ed.), Longman, 1996.</li> </ul>

\* wykład, seminarium, ćwiczenia, warsztaty, lektoraty, laboratoria

\*\* prezentacja, projekt, analiza przypadku, dyskusja, metoda problemowa \*\*\* stacjonarnie/zdalnie