Program	Type of studies (cycle)	Third cycle
	Name of the program	Doctoral Studies in Mathematical and Computer Science

Course

Course title	**Spectral Graph Theory**			
Course code	Semester	Course status	ECTS credits	Contact hours
PMAT 670	II	Elective	10	30

Aims and intended learning outcomes	The course develops knowledge and techniques in spectral graph theory by studying finite, infinite, and quantum graphs and their discrete and differential operators. Graphs arise in theoretical and applied mathematics, physics, chemistry, and computer science. Quantum graphs have received particular attention as models of physical and mathematical processes. A quantum graph has edges identified with closed intervals and carries a differential or pseudodifferential operator acting on functions defined on the graph. The course focuses on adjacency matrices and Laplacians, their spectra, and connections with the geometric, combinatorial, and dynamical structure of graphs. Topics include spectral characterization of graphs, eigenvalue estimates and bounds, quantum graph spectra, trace formulas, and spectral asymptotics. Upon completion, students will be able to independently study contemporary research literature and apply spectral methods in discrete mathematics and complex network analysis.

Course content/topics

- Spectra of finite graphs
- Spectral characterization of graphs
- The Laplacian on finite graphs
- Spectra of Laplacians on finite graphs
- The Laplacian on infinite graphs
- Spectral properties of infinite graphs
- Geometric and spectral eigenvalue bounds
- Quantum graphs and differential operators on graphs
- Spectra of quantum graphs
- Trace formulas on graphs
- Weyl's law and spectral asymptotics on graphs

LITERATURE

[1] Grigor'yan, Introduction to Analysis on Graphs, University Lecture Series 71, American Mathematical Society, Providence, RI, 2018.

[2] G. Berkolaiko and P. Kuchment, Introduction to Quantum Graphs, American Mathematical Society, 2013.

[3] A. E. Brouwer and W. H. Haemers, Spectra of Graphs, Springer, 2011.

[4] P. Exner and O. Post, Mathematical Analysis of Quantum Graphs, Proceedings of Symposia in Pure Mathematics 77, American Mathematical Society, Providence, RI, 2008.

[5] Relevant project papers, selected in consultation with individual students.

Grading

	Criterion	Points	Cut-off points
1.	Homework		
2.	Project	50	
3	Final exam	50	
	Total	100	55