

SYLLABUS

REGARDING THE QUALIFICATION CYCLE FROM 2026 TO 2029

ACADEMIC YEAR 2028/2029

1. BASIC COURSE/MODULE INFORMATION

Course/Module title	Graph Theory
Course/Module code *	
Faculty (name of the unit offering the field of study)	Faculty of Exact and Technical Sciences
Name of the unit running the course	Institute of Mathematics
Field of study	Mathematics
Qualification level	First-cycle studies (Bachelor's)
Profile	General academic
Study mode	Full-time
Year and semester of studies	Year 3, Semester 5
Course type	Specialisation course
Language of instruction	English
Coordinator	Prof. Mykhaylo Zarichnyy, PhD, DSc
Course instructor	Prof. Mykhaylo Zarichnyy, PhD, DSc

* - as agreed at the faculty

1.1. Learning format – number of hours and ECTS credits

Semester (no.)	Lectures	Classes	Laboratories	Seminars	Practical classes	Internships	others	ECTS credits
5	15	30						3

1.2. Course delivery methods

traditional classroom-based instruction

no distance learning / or optional use of distance learning methods and techniques

1.3. Course/Module assessment (exam, pass with a grade, pass without a grade)

Classes – pass with a grade

Lecture – pass without a grade

2. PREREQUISITES

Logic and set theory. Linear algebra with analytic geometry. Differential and integral calculus.

3. OBJECTIVES, LEARNING OUTCOMES, COURSE CONTENT, AND INSTRUCTIONAL METHODS

3.1. Course/Module objectives

C ₁	Familiarization students with basic concepts and theorems of graph theory, as well as network and flow theory.
C ₂	Presenting wide applications of graphs in solving practical everyday problems.
C ₃	Introducing examples of mathematical modelling using graph theory.

3.2. COURSE/MODULE LEARNING OUTCOMES (TO BE COMPLETED BY THE COORDINATOR)

Learning Outcome	The description of the learning outcome defined for the course/module	Relation to the degree programme outcomes
LO_01	The student knows and understands basic concepts and theorems of graph theory.	K_Wo1, K_Wo2, K_Wo7
LO_02	The student knows and understands the concepts of path, cycle, Eulerian and Hamiltonian graphs, and basic theorems concerning them.	K_Wo1, K_Wo2, K_Wo7
LO_03	The student knows and understands examples of mathematical modelling using graph theory.	K_Wo1, K_Wo2, K_Wo7
LO_04	The student is able to apply graph theory to solve shortest path problems in various situations.	K_Uo1, K_Uo2, K_U16
LO_05	The student is able to construct a network model of a project and determine the critical path.	K_Uo1, K_Uo2, K_U16
LO_06	The student is able to use appropriate tools and methods of graph theory to solve simple everyday problems.	K_Uo1, K_Uo2, K_U16
LO_07	The student is able to independently develop and test a simple mathematical model in terms of graphs.	K_Uo1, K_Uo2, K_U16
LO_08	The student is ready to acknowledge the limits of their knowledge, understands the need for further education and practical application of acquired knowledge, and is able to prioritise tasks using expert opinions.	K_Ko3, K_Ko5

3.3. Course content (to be completed by the coordinator)

A. Lectures

Content outline
Basic definitions of graph theory (directed and undirected graphs, subgraphs, graph isomorphism, line graph, adjacency matrix, incidence matrix).
Paths and cycles, Eulerian and Hamiltonian graphs. Chinese Postman Problem, Travelling Salesman Problem. Selected graph search algorithms, shortest path algorithms, Euler cycle algorithms.
Planar graphs, chromatic number of a graph, Brooks' theorem, graph colouring.
Matchings in graphs, Hall's theorem, transversal theory, connectivity types, Menger's theorem.
Activity networks in project planning. Critical path method. PERT method. Network flows.

B. Classes, laboratories, seminars, practical classes

Content outline
Basic definitions of graph theory (directed and undirected graphs, subgraphs, graph isomorphism, line graph, adjacency matrix, incidence matrix).
Paths and cycles, Eulerian and Hamiltonian graphs. Chinese Postman Problem, Travelling Salesman Problem. Selected graph search algorithms, shortest path algorithms, Euler cycle algorithms.
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Matchings in graphs, Hall's theorem, transversal theory, connectivity types, Menger's theorem.
Activity networks in project planning. Critical path method. PERT method. Network flows.

3.4. Methods of Instruction

Classes: text analysis with discussion, problem solving, practical project, group work

Lectures: problem-based lecture / multimedia presentation lecture

4. Assessment techniques and criteria

4.1 Methods of evaluating learning outcomes

Learning outcome	Methods of assessment of learning outcomes (e.g. test, oral exam, written exam, project, report, observation during classes)	Learning format (lectures, classes,...)
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LO-01	test, observation during classes	lectures, classes
LO-02	test, observation during classes	lectures, classes
LO-03	test, observation during classes	lectures, classes
LO-04	test, observation during classes	lectures, classes
LO-05	test, observation during classes	lectures, classes
LO-06	test, observation during classes	lectures, classes
LO-07	test, observation during classes	lectures, classes
LO-08	observation during classes	lectures, classes

4.2 Course assessment criteria

Continuous assessment of learning outcomes during classes. Final grade reflects achieved learning outcomes.

Lecture is passed upon successful completion of a test.

Classes are passed based on a test and activity during classes.

Grading scale:

50–59% – satisfactory (3.0)

60–69% – satisfactory plus (3.5)

70–79% – good (4.0)

80–89% – good plus (4.5)

90–100% – very good (5.0)

5. Total student workload needed to achieve the intended learning outcomes – number of hours and ECTS credits

Activity	Number of hours
Course hours	45
Other contact hours involving the teacher (consultation hours, examinations)	5
Non-contact hours - student's own work (preparation for classes or examinations, projects, etc.)	30
Total number of hours	80
Total number of ECTS credits	3

* One ECTS point corresponds to 25-30 hours of total student workload

6. Internships related to the course/module

Number of hours	<i>Not applicable</i>
Internship regulations and procedures	<i>Not applicable</i>

7. Instructional materials

Compulsory literature: Reinhard Diestel, Graph Theory (free electronic edition, 2016) <https://diestel-graph-theory.com/index.html>

Øystein Ore, Theory of Graphs, American Mathematical Society Colloquium Publications, Vol. 38, Providence, RI, 1962.

Douglas B. West, Introduction to Graph Theory, Prentice Hall, Upper Saddle River, NJ, 2nd edition, 2001, ISBN: 0-13-014400-2

Béla Bollobás, Graph Theory. An Introductory Course. Graduate Texts in Mathematics (GTM, volume 63), 1979.

Complementary literature: J. A. Bondy; U. S. R. Murty, Graph Theory, Springer, Graduate Texts in Mathematics (GTM 244), London / New York, 2008.

Jacques Verstraete, Introduction to Graph Theory, 3 February 2021.

https://mathweb.ucsd.edu/~gmckinley/154_sp22/book.html

Approved by the Head of the Department or an authorised person