MINISTRY OF HIGHER EDUCATION, SCIENCE, AND TECHNOLOGY
UNIVERSITAS NEGERI SURABAYA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNDERGRADUATE PROGRAM OF MATHEMATICS EDUCATION
Ketintang Campus, Jalan Ketintang, C8 C9 Building, Surabaya 60231
Phone: +62 895335466373, email: s1-pmat@unesa.ac.id
Website: https://pendidikan-matematika.fmipa.unesa.ac.id/

Module Name:	Graph Theory Teori Graf
Module Level:	Sarjana (S-1) / Undergraduate
Abbreviation, if applicable:	8420203224
Sub-heading, if applicable:	-
Course included in the module, if applicable:	-
Semester/term:	7 / Fourth year
Module Coordinator(s):	Dr. Budi Rahadjeng, M.Si.
Lecturer(s):	Dr. Budi Rahadjeng, M.Si.
Language:	Indonesian
Classification within the curriculum:	Compulsory course~~/elective studies~~
Teaching format/class hours per week during the semester	Teaching format: expository lectures, discussion, inquiry, student presentations, demonstration with software, and quizzes Class hours per week: 2 x 170 minutes = 340 minutes (5.67 hours), of which 2 x 50 minutes are lectures
Workload:	16 weeks per semester consisting of: • 2 hours lectures (2 x 50 minutes) per week, • 2 hours structured assignments (2 x 60 minutes) per week, • 2 hours independent study (2 x 60 minutes) per week, Total workload: 16 x 2 x 170 minutes = 5,440 minutes = 90.67 hours = 3.18 ECTS*
Credit Point:	2 CU (3.18 ECTS)
Requirements:	Discrete Mathematics
Learning Goals :	**Programme Learning Outcomes (PLO) addressed:** PLO 5: Apply the basic principles of mathematics to solve simple mathematical problems PLO 9: Demonstrate mathematical knowledge and insight

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	Course Learning Outcomes (CLO): after completing this module, students are able to: CLO-1: Explain the concept of a graph, the ways of representing it, the types of graphs, and connectivity, including Euler and Hamilton graphs, and explain how real problems are modelled with graphs (PLO 9) CLO-2: Solve problems of shortest paths and minimum spanning trees with the Dijkstra, Kruskal, and Prim algorithms, and apply them to real-life problems (PLO 5) CLO-3: Explain planarity of graphs, including Euler's theorem and its extensions, and prove the non-planarity of a graph with the appropriate theorems (PLO 9) CLO-4: Solve problems of vertex colouring, edge colouring, and graph decomposition, including the scheduling of a tournament with the 1-factorisation theorem (PLO 5) CLO-5: Collaborate in a group, communicate mathematical ideas on graph theory orally and in writing, and develop a demonstration medium for graph theory using software such as MATLAB or Python (PLO 5, PLO 9)
Content:	This course covers the concepts of graph theory and the techniques of representing graphs; types of graphs; connectivity, including Euler and Hamilton graphs; shortest paths; trees and spanning trees, and the algorithms for finding a minimum spanning tree; planarity and the techniques for testing it; vertex and edge colouring; and graph decomposition, including matchings and 1-factorisation, together with their applications to related problems such as scheduling a tournament. Students learn to model problems with graphs, to solve them with the appropriate theorem or algorithm, and to demonstrate the ideas with software. Learning combines expository lectures, discussion, inquiry, presentations, and demonstrations, and students work both individually and in groups.
Study/exam achievements	• Students are considered competent and pass if the final score, calculated from presentations, individual and group assignments, quizzes, and the demonstration medium (55% in

total), the midterm formative examination (20%), and the final formative examination (25%), is at least 55 or C.

- Final score is calculated as follows:

Week	Course Learning Outcomes (CLO)	Programme Learning Outcomes (PLO)	Evaluation
1	CLO-1	PLO-9	3%
2	CLO-1	PLO-9	4%
3	CLO-1	PLO-9	4%
4	CLO-2	PLO-5	4%
5	CLO-2	PLO-5	4%
6	CLO-2	PLO-5	4%
7	CLO-2	PLO-5	4%
8	CLO-2	PLO-5	20%
9	CLO-3	PLO-9	4%
10	CLO-3	PLO-9	4%
11	CLO-3	PLO-9	4%
12	CLO-4	PLO-5	4%
13	CLO-4	PLO-5	4%
14	CLO-4	PLO-5	4%
15	CLO-5	PLO-5, PLO-9	4%
16	CLO-4	PLO-5	25%

- Final index is defined as follow:

Index	Converted Score	Score Range
A	4.00	$85 \leq A \leq 100$
A-	3.75	$80 \leq A- < 85$
B+	3.50	$75 \leq B+ < 80$
B	3.00	$70 \leq B < 75$
B-	2.75	$65 \leq B- < 70$
C+	2.50	$60 \leq C+ < 65$
C	2.00	$55 \leq C < 60$

	D	1.00	$40 \leq D < 55$
	E	0.00	$0 \leq E < 40$

Forms of Media	Slides, LCD projector, whiteboard, UNESA Learning Management System (LMS), MATLAB or Python (NetworkX, Google Colab), GeoGebra
Literature	1. Wilson, R. J., & Watkins, J. J. (1990). Graphs: An introductory approach. John Wiley & Sons. 2. Fournier, J.-C. (2009). Graph theory and applications. John Wiley & Sons. 3. Mardiyono, S. (2010). Teori graf. Universitas Terbuka. 4. Liu, C. L. (1985). Elements of discrete mathematics (2nd ed.). McGraw-Hill. 5. Chartrand, G., & Zhang, P. (2012). A first course in graph theory. Dover Publications. 6. West, D. B. (2001). Introduction to graph theory (2nd ed.). Prentice Hall. 7. Bondy, J. A., & Murty, U. S. R. (2008). Graph theory. Springer. 8. Rosen, K. H. (2019). Discrete mathematics and its applications (8th ed.). McGraw-Hill Education.
Note	*Based on the Regulation of the Minister of Education, Culture, Research, and Technology of the Republic of Indonesia Number 53 of 2023 on Quality Assurance in Higher Education, 1 credit unit (CU) corresponds to 45 hours of learning per semester. UNESA implements this as 170 minutes per week over 16 weeks, including the midterm and final examinations: 1 CU = 170 x 16 = 2,720 minutes or 45.3 hours. The total workload of 144 CU is therefore 144 x 45.3 = 6,523.2 hours. UNESA sets this workload as equivalent to 229 ECTS, so that 1 ECTS = 6,523.2 / 229 = 28.48 hours and 1 CU = 1.59 ECTS.