Module designation	**Graph Theory** **Indonesian title:** *Teori Graf* **Course code:** 8420203224
Semester(s) in which the module is taught	Semester 7 (Fourth year)
Person responsible for the module	**Coordinator:** Dr. Budi Rahadjeng, M.Si. **Teaching staff:** Dr. Budi Rahadjeng, M.Si.
Language	Indonesian
Relation to curriculum	Elective
Teaching methods	Expository lectures, discussion, inquiry, student presentations, demonstration with software, and quizzes **Media and tools:** Slides, LCD projector, whiteboard, UNESA Learning Management System (LMS), MATLAB or Python (NetworkX, Google Colab), GeoGebra
Workload (incl. contact hours, self-study hours)	**(Estimated) total workload:** 2 CU × 170 minutes × 16 weeks = 5,440 minutes = 90.67 hours (≈ 3.18 ECTS) **Contact hours:** lectures, 2 × 50 minutes per week × 16 weeks = 26.67 hours (class hours per week: 340 minutes = 5.67 hours, including structured activities) **Private study including examination preparation:** structured assignments, 2 × 60 minutes per week × 16 weeks = 32.00 hours; independent study, 2 × 60 minutes per week × 16 weeks = 32.00 hours (total 64.00 hours)
Credit points	2 CU (3.18 ECTS) *1 CU = 170 minutes per week × 16 weeks = 45.3 hours; 1 ECTS = 28.48 hours (144 CU = 229 ECTS), so 1 CU = 1.59 ECTS (UNESA Rector's Decree No. 736/HK/KM/2023).*
Required and recommended prerequisites for joining the module	Discrete Mathematics
Module objectives/intended learning outcomes	**Programme learning outcomes (PLO) addressed:** • PLO-5: Apply the basic principles of mathematics to solve simple mathematical problems. • PLO-6: Demonstrate mathematical knowledge and insight. **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 6) • 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 6) • CLO-4: Solve problems of vertex colouring, edge colouring, and graph decomposition, including the scheduling of a tournament with

<table>
<tr><td></td><td>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 6)</td></tr>
<tr><td>Content</td><td>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.</td></tr>
<tr><td>Examination forms</td><td>Final score is calculated from the weekly assessment scheme below (CLO/PLO addressed and weight of each assessment):
<table>
<tr><th>Week</th><th>CLO</th><th>PLO</th><th>Weight (%)</th></tr>
<tr><td>1</td><td>CLO-1</td><td>PLO-6</td><td>3</td></tr>
<tr><td>2</td><td>CLO-1</td><td>PLO-6</td><td>4</td></tr>
<tr><td>3</td><td>CLO-1</td><td>PLO-6</td><td>4</td></tr>
<tr><td>4</td><td>CLO-2</td><td>PLO-5</td><td>4</td></tr>
<tr><td>5</td><td>CLO-2</td><td>PLO-5</td><td>4</td></tr>
<tr><td>6</td><td>CLO-2</td><td>PLO-5</td><td>4</td></tr>
<tr><td>7</td><td>CLO-2</td><td>PLO-5</td><td>4</td></tr>
<tr><td>8</td><td>CLO-2</td><td>PLO-5</td><td>20</td></tr>
<tr><td>9</td><td>CLO-3</td><td>PLO-6</td><td>4</td></tr>
<tr><td>10</td><td>CLO-3</td><td>PLO-6</td><td>4</td></tr>
<tr><td>11</td><td>CLO-3</td><td>PLO-6</td><td>4</td></tr>
<tr><td>12</td><td>CLO-4</td><td>PLO-5</td><td>4</td></tr>
<tr><td>13</td><td>CLO-4</td><td>PLO-5</td><td>4</td></tr>
<tr><td>14</td><td>CLO-4</td><td>PLO-5</td><td>4</td></tr>
<tr><td>15</td><td>CLO-5</td><td>PLO-5, PLO-6</td><td>4</td></tr>
<tr><td>16</td><td>CLO-4</td><td>PLO-5</td><td>25</td></tr>
</table></td></tr>
<tr><td>Study and examination requirements</td><td>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 index (grade conversion):
<table>
<tr><th>Index</th><th>Converted score</th><th>Score range (A = final score)</th></tr>
<tr><td>A</td><td>4.00</td><td>85 ≤ A ≤ 100</td></tr>
<tr><td>A-</td><td>3.75</td><td>80 ≤ A < 85</td></tr>
<tr><td>B+</td><td>3.50</td><td>75 ≤ A < 80</td></tr>
<tr><td>B</td><td>3.00</td><td>70 ≤ A < 75</td></tr>
</table></td></tr>
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	B- | 2.75 | 65 ≤ A < 70 C+ | 2.50 | 60 ≤ A < 65 C | 2.00 | 55 ≤ A < 60 D | 1.00 | 40 ≤ A < 55 E | 0.00 | 0 ≤ A < 40
Reading list	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.