The Hong Kong Polytechnic University

Subject Description Form

Subject Code	AMA3250
Subject Title	Introduction to Graph Theory and Networks
Credit Value	3
Level	3
Pre-requisite	Discrete Mathematics (AMA2200) or equivalent
Objectives	This subject aims to prepare students to model real-life problems using discrete mathematical models, such as graphs and networks, and to solve these problems using techniques from finite mathematics.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) apply core concepts and results in graph theory to analyze graphs, digraphs, and network structures; (b) construct and communicate mathematical proofs of intermediate results in graph theory using appropriate proof techniques; (c) analyze and solve problems involving connectivity, trees, Eulerian graphs, Hamiltonian graphs, and planar graphs; (d) apply the theory of matchings in bipartite graphs, including Hall's Marriage Theorem, to relevant mathematical models; (e) formulate and investigate network models arising from practical situations using suitable graph-theoretic tools.
Subject Synopsis/ Indicative Syllabus	<u>Graphs and Digraphs</u> Review of basic graph concepts and terminology. Isomorphism. Degree sequences and graphic sequences. Subgraphs, bipartite graphs, and directed graphs. <u>Connectivity and Trees</u> Connected graphs and components. Cut-vertices, bridges, blocks, vertex-connectivity, and edge-connectivity. Review of trees and their basic properties, including rooted trees and tree characterizations. <u>Traversability</u> Eulerian trails and circuits. Hamiltonian paths and cycles. Sufficient conditions for Hamiltonicity. <u>Matchings in Graphs</u> Matchings and perfect matchings. Bipartite matchings. Hall’s Marriage Theorem and applications. Introduction to vertex covers and independent sets in bipartite graphs. <u>Planar Graphs and Colourings</u> Plane and planar graphs. Euler’s formula and consequences. Basic colouring concepts and chromatic number. Selected results and examples on planar graph colouring.

<table>
<tr><td></td><td>Directed Graphs and Applications
Basic properties of digraphs, tournaments, and acyclic digraphs. Simple graph-theoretic modelling of networks and real-life systems.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>Concepts, theorems, examples and techniques of graph theory and networks will be taught in lectures and students will learn the skills of problem solving in the tutorials.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="5">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>1. Assignments/Quizzes</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>2. Tests</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Examination</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="5"></td></tr>
</table>
Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
The subject focuses on knowledge, skills and understanding of Graphs and Networks, thus, Exam-based assessment is the most appropriate assessment method, including 60% examination. Continuous Assessment methods comprising tests and assignments (40%) are included to keep the students in progress. A written examination is held at the end of the semester.
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>26 Hrs.</td></tr>
<tr><td>▪ Tutorials</td><td>13 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Assignments</td><td>26 Hrs.</td></tr>
<tr><td>▪ Self-study</td><td>52 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>117 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>Textbook:
D.B. West Introduction to Graph Theory, 2nd edition Prentice Hall, 2001
References:
J.A. Bondy and U.S.R. Murty Graph Theory Springer, 2008
R. Diestel Graph Theory, 6th edition Springer, 2024
R.J. Wilson Introduction to Graph Theory, 5th edition Pearson, 2010</td></tr>
</table>

	G. Chartrand, L. Lesniak and P. Zhang *Graphs & Digraphs, 6th edition* CRC Press, 2016 D.L. Kreher and D.R. Stinson *Combinatorial Algorithms: Generation, Enumeration, and Search* CRC Press, 1998 D. Easley and J. Kleinberg *Networks, Crowds, and Markets: Reasoning About a Highly Connected World* Cambridge University Press, 2010 M.E.J. Newman *Networks, 2nd edition* Oxford University Press, 2018