

School of Computer Science & Applied Mathematics

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG



**DISCRETE OPTIMIZATION & OPTIMIZATION IN BIG DATA:
COMS4050**

TEST-I

Time:14H00-16H00

Answer all questions

QUESTION 1

[10 marks]

- (a) Consider the max-flow problem of a directed network with a source node s and the sink node t . Let x_{ij} (respectively, x_{ji}) denote the amount of positive flow from node i to node j (respectively, from node j to node i). Write the node balanced equations of a nodes i and j where $i, j \neq s$ and $i, j \neq t$. [2 Marks]
- (b) Answer the following questions
 - (i) An Augmenting Path in the Ford Fulkerson algorithm. [2 Marks]
 - (ii) Explain what do you mean by the residual network in the Ford-Fulkerson algorithm. [2 Marks]
- (c) Establish the connection between the minimum cost network flow problem and the shortest path problem. [2 Marks]

- (d) Construct a directed graph with s and t as the source and terminal node, respectively, and define an $(s - t)$ cut- (A,B) . [2 Marks]
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QUESTION 2 ON PAGE 2

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QUESTION 2 **[10 marks]**

- (a) Which constraint in the mathematical model of the minimum spanning tree problem ensures that the graph is a tree graph. [2 Marks]
- (b) Describe the difference between the Hamiltonian and the Eulerian cycle in graph theory. Use an example graph for each concept. [3 Marks]
- (c) Give an example of a sub-tour that can occur for the 7-city asymmetric TSP? How does the sub-tour elimination constraint of ATSP differ from the same constraint of the symmetric travelling salesman problem (STSP)? Why? [2 + 1 + 2 Marks]