

Student Number: _____

Last (Family) Name(s): _____

First (Given) Name(s): _____

Write the following statement on the first page of the exam:

“In submitting this exam, I confirm that my conduct during this exam adheres to the Code of Behaviour on Academic Matters. I confirm that I did NOT act in such a way that would constitute cheating, misrepresentation, or unfairness, including but not limited to, using unauthorized aids and assistance, personating another person, and committing plagiarism.”

On the first page of your answer sheet, please write down your full name and student number. Also write down the above Academic Integrity Statement.

This term test consists of 2 questions

In your answers, you may use without proof any result or theorem covered in lectures, tutorials, homework, tests, or the textbook, as long as you give a clear statement of the result(s)/theorem(s) you are using. You must justify all other facts required for your solutions.

Write up your solutions carefully! In particular, use notation and terminology correctly and explain what you are trying to do — part marks *will* be given for showing that you know the general structure of an answer, even if your solution is incomplete.

If you are unable to answer a question (or part), you will get 10% of the marks for that question (or part) if you leave it blank, and 20% of the marks if you write “I don’t know” and nothing else — you will **not** get those marks if your answer contains contradictory statements (such as “I don’t know” followed or preceded by parts of a solution that have not been crossed off).

MARKING GUIDE

1: _____/20

2: _____/20

TOTAL: _____/40

Term Test # 2
(Duration: 50 minutes)

Question 1. [20 MARKS]

Part (a) [13 MARKS]

Explain how to modify Dijkstra's algorithm so that if there is more than one minimum path from s to v , a path with the fewest number of edges is chosen.

Part (b) [7 MARKS]

Company A produces and sells two products P and Q . They have sixty workers. They believe they can make a profit of \$3,000 per worker producing P and \$5,000 per worker producing Q . From past experience, they feel that they cannot take care of more than fifty workers producing P or forty workers producing Q . Write a linear program to show how many workers they should assign to the two products to maximize profit.

Question 2. [20 MARKS]

You are given a railway network in the form of a weighted graph where vertices are rail stations, edges are rail connections between stations, and each edge has a weight/capacity which limits the number of trains that can travel on that rail connection daily. After the COVID-19 pandemic outbreak, the authorities have decided to reduce the number of trains running on the network to limit the spread of the virus. To that end, they have imposed restrictions on the stations whereby they have limited the number of trains that can travel through a given station (the number varies by station). You may assume all the trains in the network start from one source station, end at one terminal station, and for all other stations, if a train arrives at that station it must leave the station. The goal is to find the maximum number of trains that can run through the network under these restrictions.

Part (a) [7 MARKS]

Model this problem mathematically as a network flow problem.

Part (b) [7 MARKS]

Design an algorithm to solve this problem.

Part (c) [4 MARKS]

Prove the correctness of your algorithm.

Part (d) [2 MARKS]

Compute the runtime of your algorithm.