

Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Computer Science and Technology
300 Level 2nd Semester Examination – Dec./Jan. 2018/19
IIT 312-2 Operational Research



Instructions to candidates

Duration: Two (02) hours

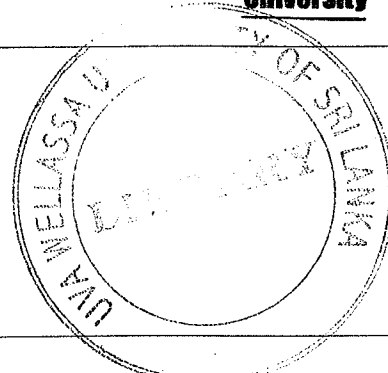
Number of questions: Four (04) Essay Questions

Mark allocation: 100 mark

Use standard symbols without definition.

Scientific calculators are allowed.

Answer all questions



1. Janith is a commercial farmer. He is going to plant corn and green gram. Each acre planted with corn yields Rs. 200,000 profit and each with green gram yields Rs. 300,000 profit. The labor and fertilizer used for each acre given in the following table. One hundred workers and 120 tons of fertilizer are available. His objective is to maximize the total profit of the session.

	Corn	Green gram
Labor (per acre)	3 workers	2 workers
Fertilizer (per acre)	2 tons	4 tons

- a. Formulate a mathematical model for this scenario. (07 mark)
- b. Use the **graphical method** or **simplex method** to solve the model formulated in part (a). (10 mark)
- c. How many acres of each crop should be cultivated to yield maximum profit? (03 mark)
2. A distribution Agency has three factories in the three cities viz. A, B, and C. These three factories supply consignments to three dealers viz. X, Y, and Z. Weekly factory capacities of A, B, and C factories, weekly dealer requirements and unit transportation costs (in Rupees) are given in following table.

To From	X	Y	Z	Supply
A	6	7	9	100
B	5	3	2	180
C	8	5	7	200
Demand	135	175	170	

The general administration manager wants to determine the best plan for how many shipments to send from each factory to the respective dealers in each week. The manager's objective is to minimize the total transportation cost.

- a. Formulate a mathematical model for this problem. (05 mark)
 - b. Use the **north-west corner rule** to obtain an initial basic feasible solution for the model formulated in part (a). (06 mark)
 - c. Discuss the degeneracy of the solution in part (b). (02 mark)
 - d. Starting with the initial basic feasible solution from part (b), find the optimal solution to this problem. (12 mark)
3. Human Resource Division of the Uva Wellassa University has four jobs to assign to four newly recruited workers. The estimated costs (in thousands of rupees) of assigning a particular worker to a particular job are shown in the table below.

Workers \ Jobs	Office assistant	Book keeper	Computer operator	Lab labor
A	5	7	11	6
B	8	5	9	6
C	4	7	10	7
D	10	4	8	3

The objective is to assign workers to jobs such that total assignment cost is a minimum. Only one worker can work on any one job.

- a. Formulate a mathematical model for this scenario. (05 mark)
 - b. Use the **Hungarian algorithm** to obtain an optimal assignment and the minimum total assignment cost. (20 mark)
4. *Kingswood Park* has recently been set aside for a limited amount of sightseeing and backpack hiking. Personal vehicles are not allowed into the park, but there is a narrow, winding road system for trams and for jeeps driven by the park rangers. This road system is shown (without the curves) below, where location "O" is the entrance into the park; other letters designate the locations of ranger stations (and other limited facilities). The numbers indicate the distances of these winding roads in miles. The park contains a scenic wonder at station "T". A small number of trams are used to transport sightseers from the park entrance "O" to station "T" and back. The park management currently faces four problems. Therefore, management has decided to recruit a BIIT

graduate from the Uva Wellassa University to solve the following problems. Imagine that you are selected to do this job.

- a. The first problem is to determine which route from the park entrance "O" to station "T" has the smallest total distance (shortest path) for the operation of the trams. Then, you should determine the *shortest path* from the park entrance "O" to station "T" using **Dijkstra's Algorithm** (Use figure 4.1). (10 mark)

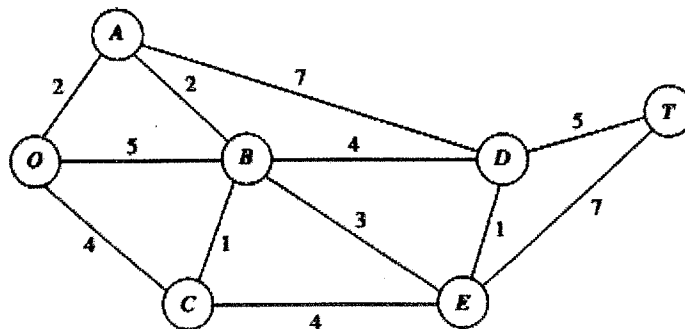


Figure 4.1

- b. The second problem is that telephone lines must be installed under the roads to establish telephone communication among all the stations (including the park entrance). Because the installation is both expensive and disruptive to the natural environment, lines will be installed under just enough roads to provide some connection between every pair of stations. The question is where the lines should be laid to accomplish this with a minimum total number of miles of line installed. Then, you should determine the *minimum spanning tree* of the given road network using **Kruskal's Algorithm** or **Prim's algorithm** (Use figure 4.1). (10 mark)
- c. The third problem is that more people want to take the tram ride from the park entrance "O" to station "T" that can be accommodated during the peak season. To avoid unduly disturbing the ecology and wildlife of the region, a strict ration has been placed on the number of tram trips that can be made on each of the roads per day. (These limits differ for the different roads) Therefore, during the peak season, various routes might be followed regardless of distance to increase the number of tram trips that can be made each day. The question pertains to how to route the various trips to maximize the number of trips that can be made per day without violating the limits on any individual road. Then, you should find the *maximum flow* from the park entrance "O" to station "T" using **Augment Path algorithm**. (Use figure 4.2) (06 mark)



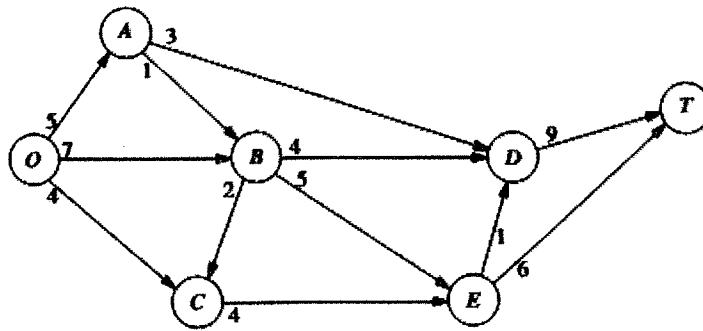


Figure 4.2

- d. The fourth problem is that the government wants to construct an alternative road from area X to area Y through the garden. However, the management has informed that the proposed road should be constructed as reducing the damage to the existing road network and natural beauty. Then, you should propose the optimal method to construct that new road to connect area X and area Y. (Hint: *minimum cut* – use figure 4.3) (04 mark)

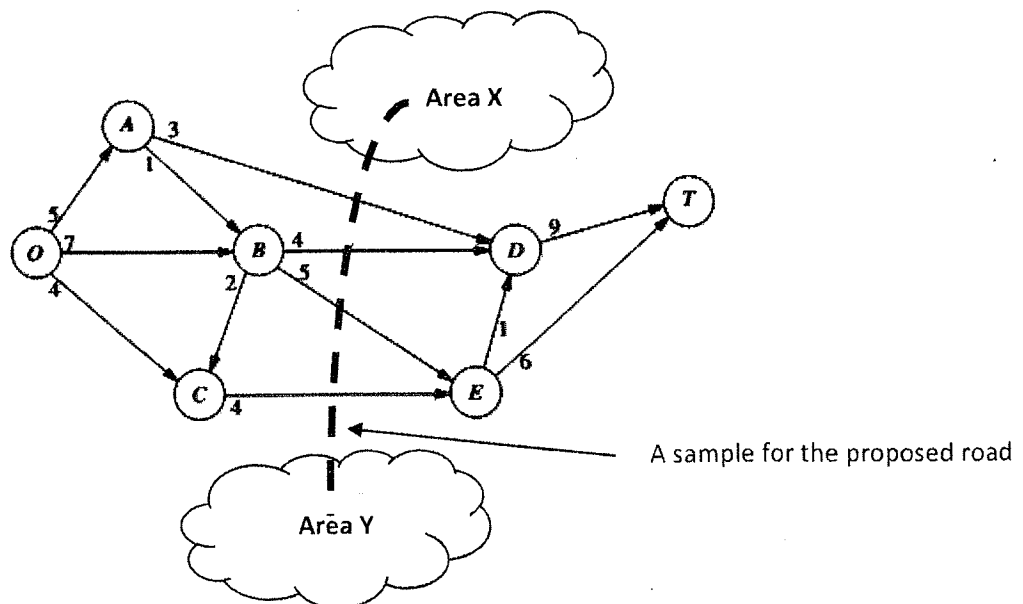


Figure 4.3