**SECI1013: DISCRETE STRUCTURE**
**SESSION 2024/2025 – SEMESTER 1**
**ASSIGNMENT 4**

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**INSTRUCTIONS:**

1. This assignment must be conducted in a group. Please clearly write the **group members name and matric number** in the front-page of the submission.
2. Solutions for each question must be readable and neatly written on plain A4 paper. Every step or calculation should be properly shown. Failure to do so will result in rejection of the submission of assignment.
3. This assignment consists of 7 questions (50 Marks), contributing 5% of overall course marks.

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1) A security guard in the area of Town Villa Gated Guarded Residency needs to make an exhaustive patrol the streets of the entire neighborhood as shown in Figure 1.

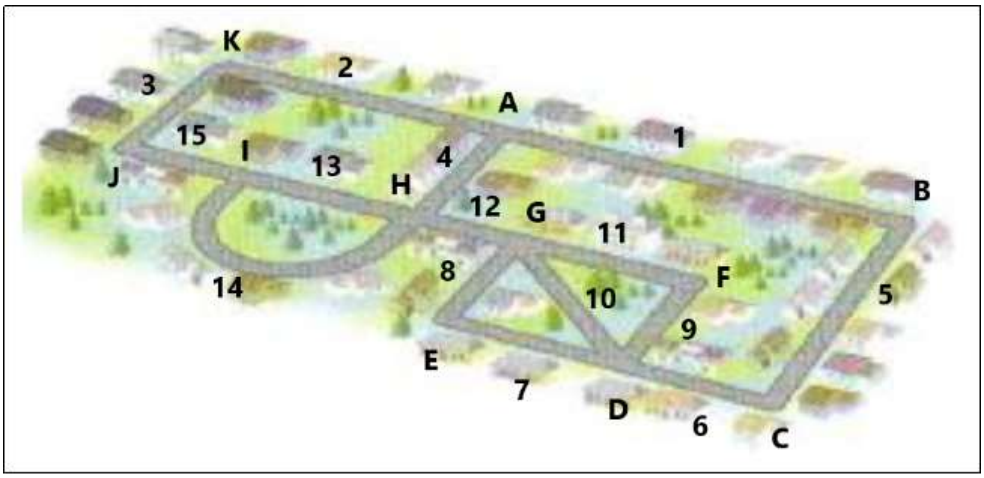



**Figure 1**: Neighborhood area at Town Villa Gated Guarded Residency

a) A security guard has the task of periodically checking each street in the neighborhood and it is desirable to minimize time and cost by not inspecting the same street more than once. Construct the route for the security guard to patrol the entire neighborhood starting from the guard house, labelled A. Will the guard be back at the guard house at the end of the inspection? (6 Marks)

b) Is it possible for the security guard to visit each street intersection for the neighborhood exactly once (but doesn't need to include all streets) to switch off the street lights located at each street intersection before they end the night shift beginning and ending at A? Justify your answer. (4 Marks)

2) Graph in **Figure 2** shows the flight path connections between 6 cities in India and the times, in hours, it takes to fly between each of the cities.

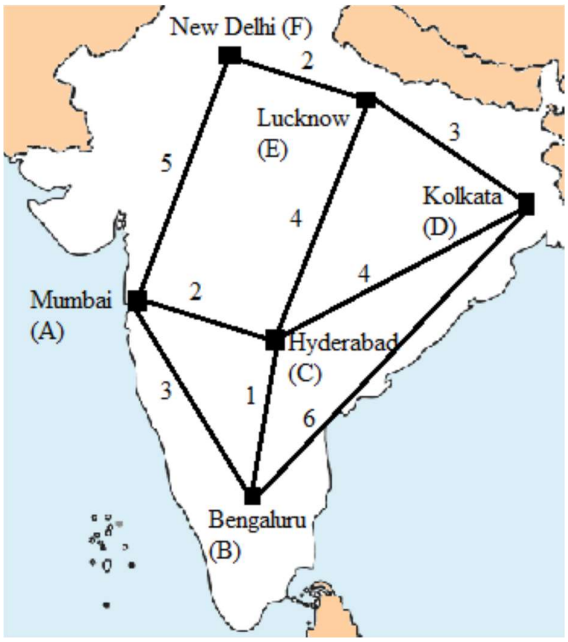



**Figure 2**

a) Determine the shortest path with minimum time required to travel from Bengaluru to New Delhi using Dijkstra's algorithm. Show all your work for each iteration in a table.

(8 marks)

b) State the shortest path and the minimum hours to travel from Bengaluru to New Delhi.

(2 marks)

3) Consider the rooted tree T shown in Figure 3

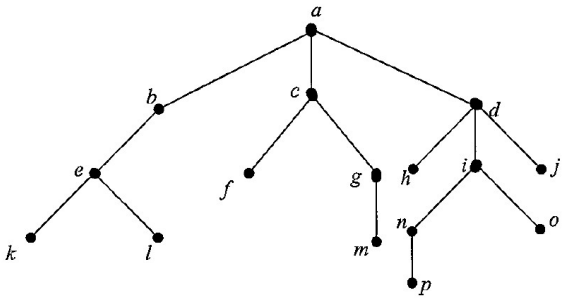



**Figure 3**: Rooted tree, *T*

a) What are the ancestors of p? (2 marks)

b) Perform inorder traversal. (3 marks)

4) Figure 4 represents a network of paths in a park. The number on each edge represents the length of the path in meters. The cost per meter is RM100. To gain as much profit, the contractor asked one of his staff to find the minimum network needed using Kruskal's algorithm.

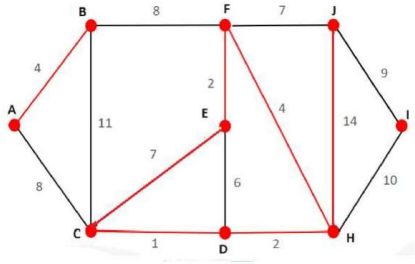



Figure 4

a) Explain why the staff's work which is highlighted in red is incorrect. (1 mark)

b) Help the staff to find the correct minimum network using Kruskal's algorithm and states its length and total cost. (7 marks)

c) Is there any possibiliy, more than one distint MST obtained for the Figure 4?. If yes, justify your answer and show the network. (2 marks)

5) Construct a state transition diagram of a DFA that accepts all strings over $\{a, b, c\}$ that begin with $a$, contain exactly two $b$'s, and end with $c$. (5 marks)

6) Let M ={S, I, $w$, $f_s$, F) be the DFA such that F = { $x$, $z$} and $f_s$ is defined as in **Table 1**.

**Table 1**

| State | $f_s$ | |
|---|---|---|
| | **0** | **1** |
| $v$ | $v$ | $y$ |
| $w$ | $v$ | $y$ |
| $x$ | $w$ | $x$ |
| $y$ | $z$ | $x$ |
| $z$ | $z$ | $w$ |

a) Write the set of states and the initial state for DFA machine M. (2 marks)

b) Determine an input string with length 4 and start with **0** that will be accepted by the machine. Show the sequence of transition of each state for the input string. (3 marks)

7) There is a 3-story elevator that can go to ground floor, floor 1 and floor 2; and there are buttons for each floor. The initial state is the ground floor. The inputs to the elevator are the buttons for the ground, first, and second floor. If the elevator is on floor 1 and the button for :

- Floor 1 is pressed, nothing happens, and the elevator remains on floor 1.
- Floor 2 is pressed; the elevator goes up until it has reached floor 2.
- Ground floor is pressed the elevator goes down until it has reached ground floor.

This situation also applies for elevator that is on floor 2 or ground floor. The FSM has three inputs which is for button ground floor is “0”, button first is “1”, and button second floor is “2”. Design the FSM which controls the operation of an elevator in a 3-story building using the transition table. (5 marks)

# Answer

1a. A $\xrightarrow{1}$ B $\xrightarrow{5}$ C $\xrightarrow{6}$ D $\xrightarrow{7}$ E $\xrightarrow{8}$ G $\xrightarrow{11}$ F $\xrightarrow{9}$ D $\xrightarrow{10}$ G $\xrightarrow{12}$ H $\xrightarrow{14}$ I $\xrightarrow{15}$ J $\xrightarrow{3}$ K $\xrightarrow{2}$ A $\xrightarrow{4}$ H $\xrightarrow{13}$ I

vertices are not even, not circuit, cannot go back

b. Not posible. It is not hamiltonian circuit, It have repeated at G and D.

2a.

| S | N | B | A | C | D | E | F |
|---|---|---|---|---|---|---|---|
| {0} | {BACDEF} | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| {B} | {ACDEF} | 0 | 3 | 1 | 6 | ∞ | ∞ |
| {BA} | {CDEF} | 0 | 3 | 1 | 6 | ∞ | 8 |
| {BAC} | {DEF} | 0 | 3 | 1 | 5 | 5 | ∞ |
| {BACD} | {EF} | 0 | 3 | 1 | 5 | 8 | 8 |
| {BACDE} | {F} | 0 | 3 | 1 | 5 | 5 | 7 |

b. Shortest path

B → C → E → F

Minimum hours

1 + 4 + 2 = 7 hours.

3a. a, d, i, n

b. k, e, l, b, a, f, c, m, g, h, d, p, n, i, o, j

4a. The highlighted in red included (A, B) and (J, H). It should included the path in the circuit form which is (C, D) → (D, H) → (H, F) → (F, E) → (E, C).

b. (C, D) → (D, H) → (F, H)

(B, F) → (A, B) → (F, J)

(J, I) → (E, F)

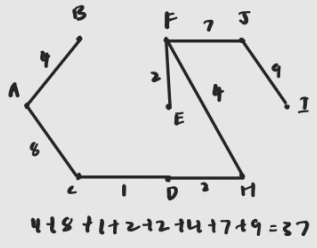
Length = 1 + 2 + 4 + 8 + 4 + 7 + 9 + 2

= 37m

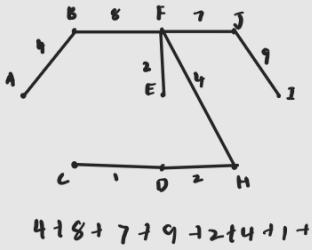
Cost = 37 × 100

= RM3700

c. Yes.

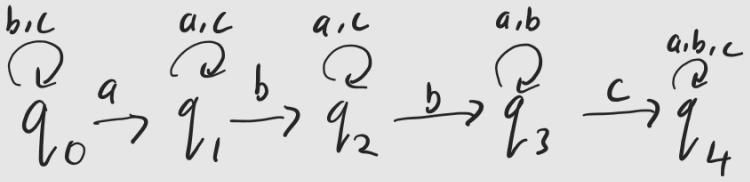



4 + 8 + 1 + 2 + 2 + 4 + 7 + 9 = 37



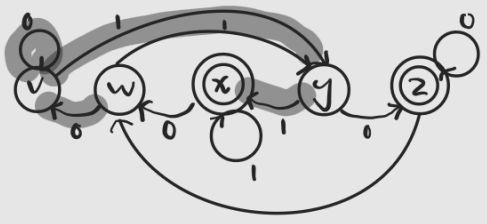

4 + 8 + 7 + 9 + 2 + 4 + 1 + 2 = 37

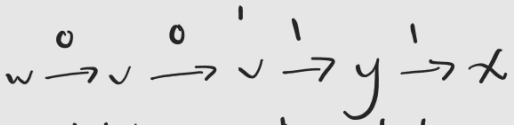
5.




6. a. $S = \{v, w, x, y, z\}$ initial state = w

b.




Final state : accepting state

7.

| | $f_s$ | | | $S_0$ | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 0 | 1 | 2 |
| L0 | L0 | L1 | L2 | 0 | 1 | 1 |
| L1 | L0 | L1 | L2 | 1 | 0 | 1 |
| L2 | L0 | L1 | L2 | 1 | 1 | 0 |