A

BRAC UNIVERSITY
Department of Computer Science and Engineering

Examination: Final Exam | Semester: Summer 2024
Duration: 1 Hour 50 Minutes | Full Marks: 40

CSE 221: Algorithms

Answer the following questions.
Figures in the right margin indicate marks.

Name:	ID:	Section:

1

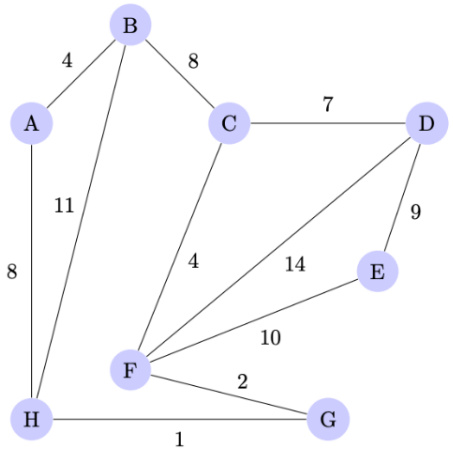

Figure 1: A Transportation Network

CO2 a. For the given transportation network, find a configuration connecting all regions with minimal cost. **Demonstrate** the steps and the algorithm you used to select connections. **05**

CO1 b. Based on the result from part (a), **calculate** the total cost of your configuration and explain in short, why it represents the minimum cost required to connect all regions. **02**

CO3 c. Now, imagine the road between Region C and Region F became ***unavailable*** due to maintenance. How would this impact overall connectivity? Propose an alternative solution to maintain network connectivity with minimal disruption, and explain your reasoning. **03**

2 You and your friend learned about single-source shortest path algorithms and are now given a directed weighted graph (*figure 2.*) to implement your algorithm. However, **the edge (2,4)** has an undefined weight **(Weight: X)**.

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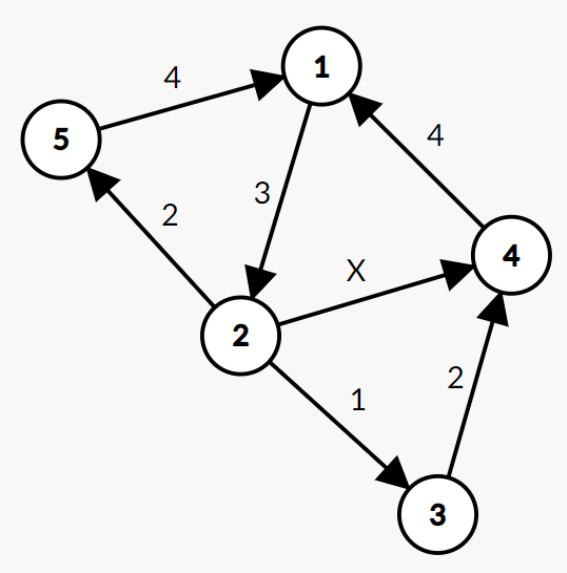

Figure 2: A Directed Weighted Graph for Question 2

a. **CO2** If the edge weight **X = 1**, then simulate the Dijkstra Algorithm with the necessary calculation needed to find the shortest path from **Source Node 1** to every node in the graph. Mention the minimum distances you could find. **03**

b. **CO1** Now, with the weight of edge (2,4) set to **X = -9**, prove or disprove the statement: '*This graph's single-source shortest path is unsolvable from source 1, and only Bellman-Ford can identify this issue.*' Simulate/Give logical reasoning to support your answer. **04**

c. **CO1** If all roads have the same travel time, can an algorithm with time complexity O(V+E) be used to find the best route? Explain your idea in brief statements/pseudocode/flow-chart/step-by-step instructions. **03**

3 You are given two strings, **'cbabdcb'** and **'badcbc'**, and tasked with finding a common sequence with the longest length. Initially, you considered a recursive solution, but person 'X' suggested using a dynamic programming approach instead.

CO3 a. Find the longest common sequence using the approach proposed by person 'X'. **Show** the necessary **simulation** to find the answer. **05**

CO3 b. Additionally, you want to send these strings as an encoded message. After merging them into one string, **'cbabdcbbadcbc'**, now you need an efficient text-encoding algorithm with minimal space requirement. **05**

i. Simulate the encoding process,
ii. construct any needed tables or trees,
iii. generate the codeword for each character,
iv. show the encoded message and
v. the total number of bits required to store it.

4 You are now attending the CSE221 final exam and there is a limited time to solve the questions. Each question requires a different amount of time and offers varying marks. After answering some questions, you suddenly realized that only 6 minutes remained. You aim to maximize the total marks you can score, given the constraints on time.

Questions and their properties:

- Question 4: Time = 4 minutes, Marks = 7
- Question 5: Time = 2 minutes, Marks = 9
- Question 6: Time = 3 minutes, Marks = 10
- Question 7: Time = 5 minutes, Marks = 8
- Question 8: Time = 6 minutes, Marks = 12
- Question 9: Time = 1 minute, Marks = 3

a. CO3 If your faculty doesn't give partial marks for incomplete answers, which combination of questions maximizes your total marks without exceeding the time limit? Hurry up, you need a quick, efficient approach—no time for brute force. **Show** a full detailed calculation. **04**

b. CO3 Fortunately, your faculty enters the hall and announces a new rule: partial marks will be given for partially completed answers. If you can solve part of a question, you'll get marks proportional to the time you spend on it. For example, solving half of a 4-minute question gives you half the marks. **04**

Now, with this new opportunity, how does your strategy shift? How will you maximize your score within the time limit, factoring in that you can now earn something even if you don't fully complete a question? **Calculate** the maximum marks you can score with this fortunate announcement. Did you score more than the previous scenario?

c. CO2 How does Dynamic Programming have a lower time complexity than brute force or recursive solutions? Explain briefly. **02**

B

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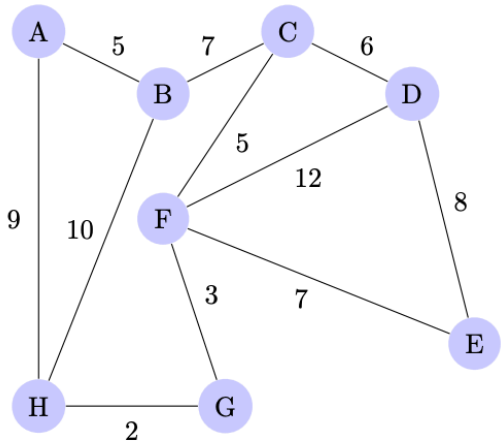

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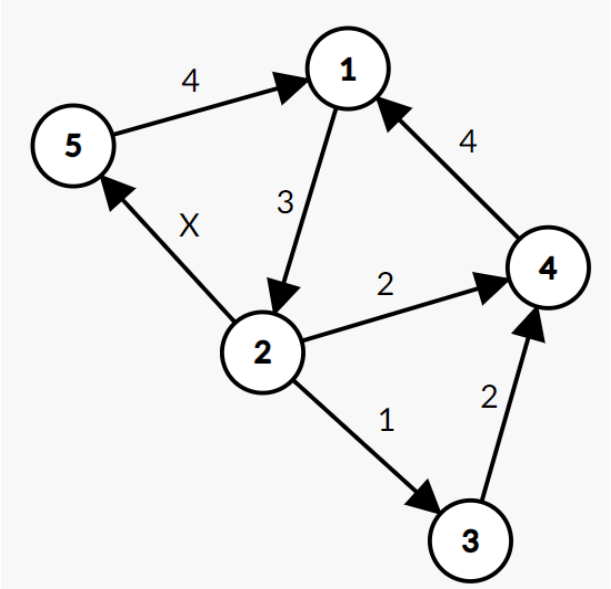

Figure 4: A Directed Weighted Graph for Question 2

a. **CO2** If the edge weight **X = 2**, then simulate the Dijkstra Algorithm with the necessary calculation needed to find the shortest path from **Source Node 1** to every node in the graph. Mention the minimum distances you could find. **03**

b. **CO1** Now, with the weight of edge (2,5) set to **X = -11**, prove or disprove the statement: '*This graph's single-source shortest path is unsolvable from source 1, and only Bellman-Ford can identify this issue.*' Simulate/Give logical reasoning to support your answer. **04**

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