A

BRAC UNIVERSITY
Department of Computer Science and Engineering

Examination: Final Exam

Semester: Spring 2024

Duration: 1 Hour 15 Minutes
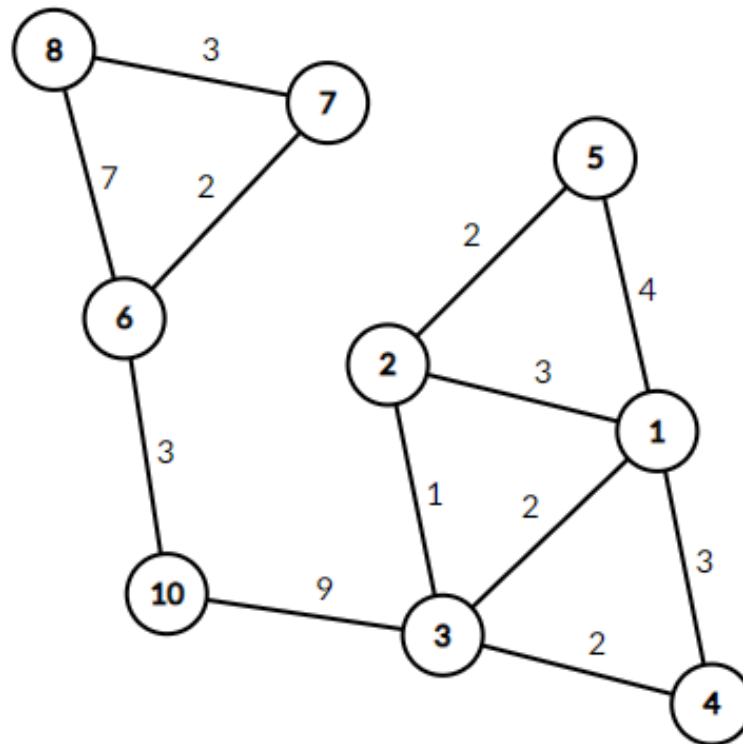
Full Marks: 30

<u>CSE 221: Algorithms</u>

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

Name:	ID:	Section:

1   Professor Bumstead needs to figure out a proper order of clothing when getting dressed. He notes down some of the dependencies which describe which garments he needs to put on before others. For example, Prof Bumstead needs to put on his shirt before he puts on his tie or his belt. He wrote down the following:
1. undershorts, watch and socks are independent
2. pants need to be put on after undershorts
3. shoes need to be put on after pants, undershorts and socks
4. belt needs to be put on after pants and shirt
5. tie needs to be put on after shirt
6. jacket needs to be put on after tie and belt

CO1   a.   **Write** down the name of an appropriate algorithm to find the proper order of clothing items.   **01**

CO1   b.   **Simulate** the algorithm by drawing a proper graph and determining the correct order of clothing items. If you can choose among multiple items, choose the alphabetically smallest one. For example, between "shirt" and "shoes", i comes before o, so choose "shirt".   **05**

CO1   c.   Based on the clothing dependencies provided by Professor Bumstead, **identify** if there are any strongly connected components in the graph representation using an algorithm.
Demonstrate the steps of the algorithm you are applying or justify your answer in brief.   **04**

2 a.
CO2   You have this graph where there is a negative weight on one edge. **Explain** why Dijkstra's shortest path algorithm will find correct answers on this graph given node A as the source. Then **propose** a change in the graph to make the result incorrect.   **02**
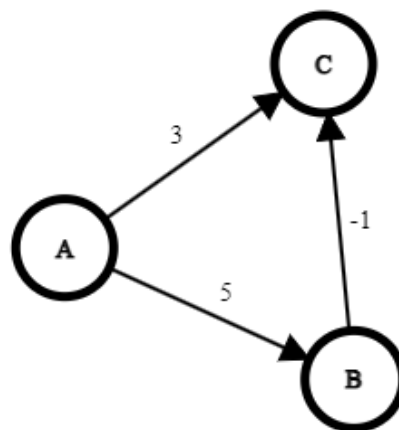
b. **03**
CO2 Someone mistakenly used Max-heap data structure instead of Min-heap to create a priority queue. So a pop/remove operation on the queue brings out the highest value element instead of the lowest one. Then this priority queue was used to implement Dijkstra's algorithm.
Should it still work on any input graph? **Explain** your answer with proper reasoning and/or example. Assume that there will be no negative edges in the input.

c. **05**
CO1 Construct the minimum spanning tree from the graph below. Present your work with proper details/data structures. Finally, **draw** the MST and **write** the total cost of that tree.

3 Wye is a CSE BracU Student. The pre-advising week is approaching, and he is trying to find the most suitable course combination for next semester. As per his previous academic results, his credit limit **has been set to 9**. Different courses have different credits. He came up with values for these courses by consulting with students who have already taken them. He wants to select the most valued courses. Courses, credits and values are provided below:

Course	PHY112	CSE330	CSE331	CSE370	CSE499
Credit	1	2	3	4	5
Value	9	7	15	12	16

CO1 a. Wye wants to try all possible combinations to find the best one. Help him by simulating a suitable dynamic programming approach. **Show** your work in detail, then **write** down the selected courses. **04**

CO1 b. Zed, a friend of Wye, adopted a slightly different approach and considered the courses based on their per-credit value. **Determine** whether Zed could select more valued courses than Wye. **02**

CO1 Note that, selecting a course still means taking the whole, with full credits.
c. If Zed is successful, he will send a message **Successful**; otherwise, **Unsuccessful**. Instead of fixed-length coding, he is willing to send the message using Huffman Coding. **Show** simulation of Huffman coding to encode his message. **04**

B

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CSE 221: Algorithms

Answer the following questions.
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Name:	ID:	Section:

1   Mr. Smith, a carpenter, needs to figure out a proper order of assembling items when making a bookshelf. He notes down some of the dependencies which describe which task he needs to complete before others. For example, he needs to create the frame before attaching the shelves. He wrote down the following:
1. Frame, Paint and Shelf-stand are independent
2. Back-panel needs to be installed after Frame
3. Drawer needs to be installed after Paint, Back-Panel and Shelves
4. Shelves need to be installed after Back-panel
5. Screws need to be installed after Shelves and Back-panel
6. Books need to be installed after Drawers
7. Knobs need to be installed after Drawers

CO1 a. **Write** down the name of an appropriate algorithm to find the proper order of tasks.   **01**
CO1 b. **Simulate** the algorithm by drawing a proper graph and determining the correct order of tasks. If you can choose among multiple items, choose the alphabetically smallest one. For example, between "screws" and "shelves", c comes before h, so choose "screws".   **05**
CO1 c. Based on the dependencies provided by Mr. Smith, **identify** if there are any strongly connected components in the graph representation using an algorithm.   **04**
        Demonstrate the steps of the algorithm you are applying or justify your answer in brief.

2 a.   You have this graph where there is a negative weight on one edge. **Explain** why Dijkstra's shortest   **02**
CO2 path algorithm will find correct answers on this graph given node A as the source. Then **propose** a change in the graph to make the result incorrect.
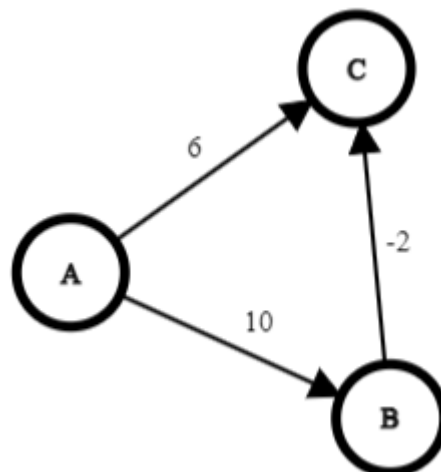
b.
CO2 Dijkstra's algorithm inserts all vertices in a priority queue/Min-heap at the beginning and then repeatedly extracts the vertex with minimum distance. However, someone proposed the following changes:
> 1. At the beginning, it inserts only the source vertex in the priority queue.
> 2. Whenever the distance of a vertex is updated, it then inserts that vertex into the queue.

Should the time complexity of the algorithm be same as before? **Explain** your answer with proper reasoning and/or example. Assume that there will be no negative edges in the input.

03

c.
CO1 Construct the minimum spanning tree from the graph below. Present your work with proper details/data structures. Finally, **draw** the MST and **write** the total cost of that tree.

05
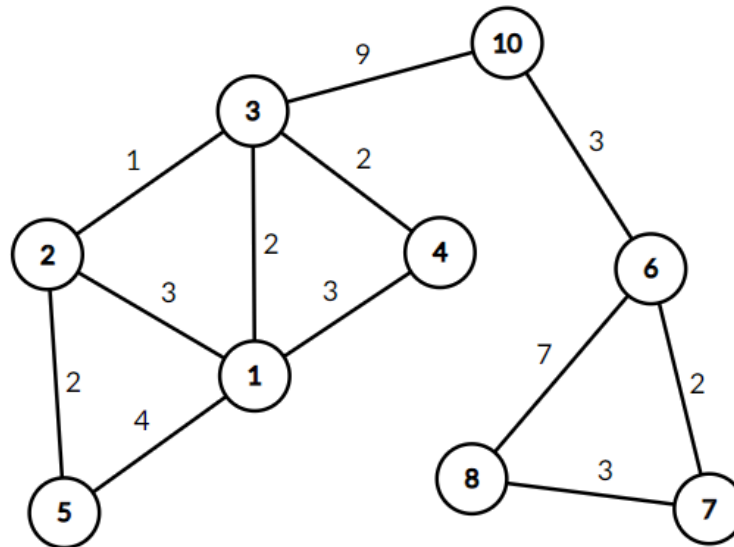
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CO1 **b.** Zed, a friend of Wye, adopted a slightly different approach and considered the courses based on their per-credit value. **Determine** whether Zed could select more valued courses than Wye. Note that, selecting a course still means taking the whole, with full credits.

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