Answer all 3 questions from Part A and any 2 questions from Part B

Department of Computer Science and Engineering
FINAL EXAMINATION, Summer' 19
CSE 221: Algorithms
Total Marks: 50 Time Allowed: 2 Hours 15 Minutes
Student I[redacted] Section [redacted] N[redacted]

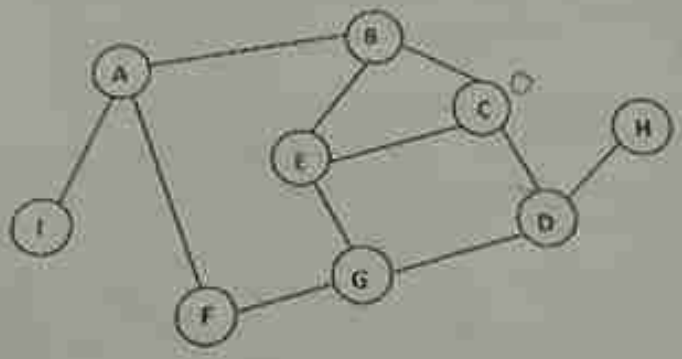
PART A (ANSWER ALL)

Question 1:

a) **[CO1]** A complete graph is a simple undirected graph in which every pair of distinct vertices are connected by an edge. **Visualize** a complete graph of 5 vertices. **[2]**

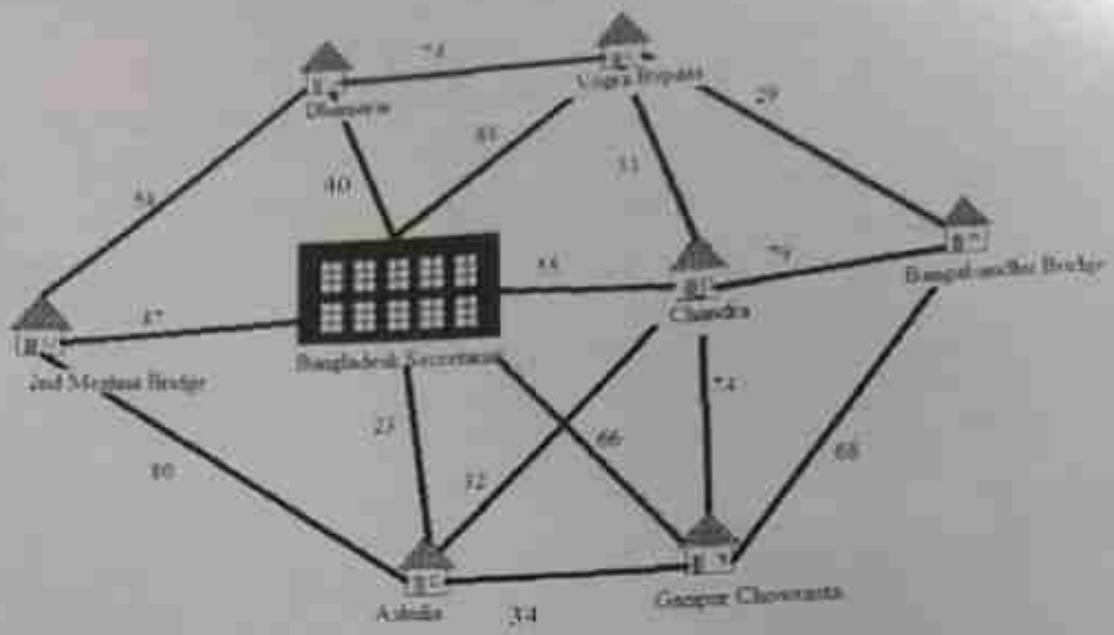
b) **[CO3] Analyze** the time complexity of the algorithm for finding the connected components in a directed graph. Write the pseudocode and analyze step by step. **[4]**

c) **[CO2]** Chris Pine has recently become very popular. One day, Chris Pine goes to a party and everyone present there wants to shake hands with him. However, he cannot shake hands with all of them. Now if a person gets to shake hands with Chris Pine directly, s/he considers herself/himself to be "1-Lucky ". A person that shakes hands with someone who has shook hands with Chris Pine considers themselves " 2-Lucky ", and so on. The Luckiness is defined on the basis of the above mentioned rule: (1-Lucky -> Luckiness = 1). Luckiness of Chris Pine is 0. In the graph given below, node C denotes Chris Pine. The nodes connected to Chris Pine are people who have shook hands with him. Based on your understanding, **demonstrate** a suitable algorithm to calculate the Luckiness of person I in the graph. **[4]**



Question 2:

Mr. Obaidul Quader, Cabinet Minister of Road Transport and Bridges of Bangladesh has planned to visit different vital road junctions from his office at Bangladesh Secretariat before Eid-Ul-Azha to ensure smooth commute of people who are willing to leave Dhaka before eid. Mr. Quader asks his personal secretary(PS) to find the optimal route to cover all these places in the shortest time possible. According to Mr. Quader's plan, his PS draws the following graph (Weight of the edges represents distance in km):



The PS has asked for your help in the following matters:

a) **[CO2] Demonstrate** a suitable algorithm to find the shortest route to each location from Mr. Quader's office. What is the least no. of kms Mr. Quader needs to travel to cover all places? **[4+2=6]**

b) **[CO1] State** the time complexity of your chosen algorithm. **[1]**

c) **[CO6]** BFS, Dijkstra and Bellman-Ford algorithms all give the shortest path starting from a single source. **Compare** all three algorithms based on their similarities and differences. **[3]**

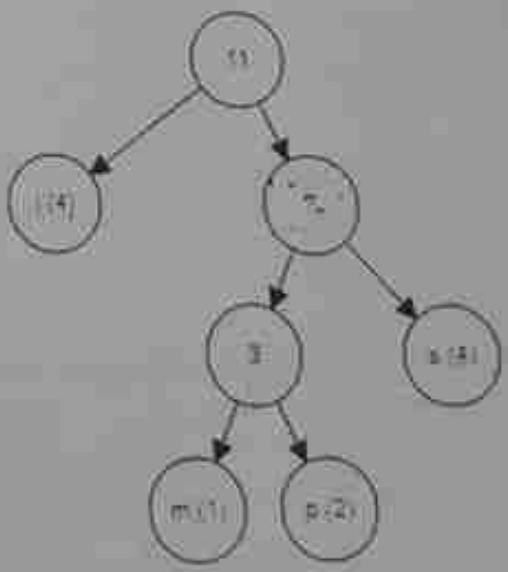
Question 3:

GO_GO_GOPHERS

a) **[CO2] Demonstrate** the Huffman Coding Algorithm to construct the Huffman tree, write the codes for each letter and encode the above text. **[4]**

b) **[CO1]** **100011110111101011010**

The above binary text is encoded using the Huffman tree shown on the right. **What is** the original (decoded) text? (*Use 1 = right and 0 = left*) **[3]**



c) **[CO6] Evaluate** the merit/demerit of the above algorithm with respect to the "Compression Ratio (CR)" for question **3(b)**. Note that

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$CR = \frac{\text{Length of the original text in bits}}{\text{Length of the encoded text in bits}}$. Also, note that each character is 8 bits in length in the original text. [3]

PART B (ANSWER ANY TWO)

Question 4:

You are very well prepared for your Bus101 (Business) exam and your teacher has promised you very easy questions with several options. On top of the question paper the following instruction is written: "The total points is 12. There are 6 questions and the points for each are written in brackets. For each question, there will not be any partial marking. You may answer any number of questions. However, when grading the script, I will check from the start, the moment you reach 12 points, I will stop checking any further. If you obtain less than 12 points, but your next answer makes your points more than 12, then it will not be considered. The marks for answering each question is calculated according to the following formula: marks = points * difficulty_factor. Please note, that your task is not to maximize the points, your task is to maximize your marks. Best of luck."

Since you are a CSE student and you have already completed your algorithms course, you know exactly which questions you should answer. The points and difficulty level of each question is given below.

Questions	Points	Difficulty_Factor
Q1	4	50
Q2	3	50
Q3	2	60
Q4	2	100
Q5	5	40
Q6	3	10

a) **[CO5] Develop** an algorithm so that you can choose which questions to answer and also calculate the maximum marks you can obtain within 12 points (show simulation). **[8]**

b) **[CO1] What** is the recurrence formula for solving the above problem? **[2]**

Question 5:

Your uncle Rahim is a construction builder, who loves building houses. Rahim has several bricks of different lengths. He believes that by using a lesser number of bricks, to build each wall, the building will be more robust. However, he does not know which brick to use in which scenario. One day, you overheard him discussing this issue during a family gathering. You realized that you can solve the problem using a dynamic programming technique given you know the length of the wall. So you asked Rahim to tell you the dimensions of the wall he is going to build next and the length of bricks he has.

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Rahim informed that the length of the wall is 11 meters and the width is 5 meters and the length of available bricks are 1 meter, 3 meters, and 4 meters. The width of each brick is 1 meter. So you applied your algorithm, found out the bricks used in each layer of the wall and solved the problem for your uncle Rahim.

a) **[CO1] State** the recurrence equation for solving the above problem? **[2]**
b) **[CO5] Simulate** the algorithm for finding out how many of which bricks were used for each layer. Also, calculate the total number of each brick needed for the 12 m X 5 m wall. **[7+1=8]**

Question 6:

Esfar & Moin both study at BRAC University. Each of them lost their only sibling at a huge fanfare during their childhood. Due to their mutual resemblance, Moin sequenced both of their DNA. He knew, if any two person's DNAs match for about 80%, then it somewhat proves that they are very closely related. Moin shared his idea with Esfar, and Esfar agreed to provide Moin his DNA sample.

Let DNA samples of Esfar & Moin be **TCGTGA & ATCTGA** respectively. After running a simple algorithm learned from Summer'19 *Algorithms* course, Moin found out the longest common DNA sequence between the two samples. Then he used the following formula to find out the percentage-similarity: similarity = (LCS/Length of the sample) * 100

a) **[CO5] Develop** an algorithm so that Moin can find the LCS and also calculate the percentage similarity between Esfar and Moin (show simulation and final calculation). **[8]**
b) **[CO1] What** properties must be satisfied to successfully apply the above algorithm technique? **[2]**