A

BRAC UNIVERSITY
Department of Computer Science and Engineering

CSE 221: Algorithms

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

Name:	ID:	Section:

1 a.
CO3
As we all know, the Spanish National Football Team is notorious for their passing football, especially their back passes. After their disastrous 2022 World Cup campaign, The King of Spain made you the coach and declared that no back passes are allowed on the field from now on till Spain scores 2 goals, that is, Simon the goalkeeper can only pass to the defenders Rodri and Cesar, but Rodri and Cesar cannot pass the ball back to Simon. Also, every pass now comes with a cost– and the more cost players accumulate, the angrier the King gets. These are the costs of the passes:

06

Passes	Cost
Simon → Rodri	2
Simon → Cesar	4
Rodri → Cesar	1
Rodri → Pedri	7
Cesar → Gavi	3
Gavi → Pedri	2
Pedri → Morata	1
Gavi → Morata	5

Find the lowest cost for the ball to reach every player starting from Simon, using any algorithm you find useful. The King will need to see every single step of the algorithm, or he will not believe you and fire you on the spot.

b.
CO3
After scoring 2 goals, Spain changed their strategy and started to back pass again incorporating 2 more players, the master of dark arts Busquets and the young sensation Ansu Fati. Now they are no longer concerned with the cost of the pass as well. These are the passes for the new strategy:

04

Passes
Simon → Rodri
Simon → Cesar
Rodri → Busquets
Rodri → Pedri
Cesar → Rodri
Busquets → Gavi
Busquets → Pedri
Gavi → Cesar
Gavi → Pedri
Gavi → Fati
Fati → Morata
Pedri → Fati
Morata → Pedri

Now using a suitable algorithm, **find** out the largest group of players who can pass the ball among themselves. For example, one such group can be (Fati, Morata, Pedri) where Morata can pass to Pedri, Pedri can pass to Fati and Fati can pass to Morata. It is important to keep in mind that the king will be observing every step of the algorithm. Any discrepancies can lead you to lose your job.

2 a.
CO2

You are given the following table containing symbols and their frequencies:

Symbol	A	B	C	D	+
Frequency	40	10	20	15	15

i) **Build** the Huffman code tree and find the codewords for each character.   **04**
ii) **Decode** 100010111001010 using the Huffman code that you generated.   **01**

b.
CO4

You are given the arrival and departure times of eight trains for a railway platform, each in the following format: $[arrival\,time,\,departure\,time)$. Only one train can use the platform at a time.

Suppose, you have got the following train-use requests for the next day.

{ [8, 13), [6, 9), [11, 14), [2, 7), [1, 7), [12, 20), [7, 13) , [13, 20) }

i) **Find** the maximum number of trains that can use the platform without any collision.   **03**
ii) **Determine** the minimum number of platforms that needs to be there to ensure the arrival and departure of all these trains without collision.   **02**

3 Suppose you went to Miniso to buy a Teddy Bear Plushie (a soft toy or doll) as a gift for your younger sister's birthday. The plushie is 700 BDT. At Miniso, all items are subject to a 6% additional VAT charge.

You bought one plushie and gave the cashier 750 BDT. The cashier has a huge supply of 1 taka, 2 taka, and 5 taka coins in the cashbox. You don't want to carry many coins, so you asked her to return the change using a minimum number of coins.

CO4	i)	Using the Dynamic Programming approach, **determine** how many coins she should return in this scenario.	**06**
CO4	ii)	Which coins did you get from the cashier? **Show** how your table was used to pick up these coins. You may use arrows and circles to point to the chosen cells.	**02**
CO7	iii)	Suppose you did not apply memoization to find the answer for question (i). What will be the time complexity of that brute force approach? **Explain** with proper reasoning.	**02**

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Examination: Semester Final Exam   Semester: Fall 2022
Duration: 1 Hour 40 Minutes   Full Marks: 30

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defenders Rodri and Cesar, but Rodri and Cesar cannot pass the ball back to Simon.
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angrier the King gets. These are the costs of the passes:

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Pedri → Morata
Fati → Pedri
Morata → Fati
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2 **a.**
CO2 You are given the following table containing symbols and their frequencies:

Symbol	A	B	C	D	#
Frequency	35	15	25	10	20

i) **Build** the Huffman code tree and find the codewords for each character. **04**
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b.
CO4 You are given the arrival and departure times of eight trains for a railway platform, each in the following format: $[arrival\ time,\ departure\ time)$. Only one train can use the platform at a time.

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$$\{ [8, 12), [6, 9), [11, 14), [2, 7), [1, 7), [12, 20), [7, 12), [13, 19) \}$$

i) **Find** the maximum number of trains that can use the platform without any collision. **03**
ii) **Determine** the minimum number of platforms that needs to be there to ensure the arrival and departure of all these trains without collision. **02**

3   A team of two infamous thieves, Denver and Nairobi, planned to rob the famous Louvre Museum. Before the scene, they both agreed on the fact that none of them will break any item as all the items in the Louvre are too precious, and taking a fraction of any item won't sell in the black market. If it fits in the bag as a whole, they will take it, otherwise, leave it as it is.

Both of them arrived at the Louvre with an empty knapsack weighing a total of 8 kg. Despite the fact that both thieves are experts in their fields, they take slightly different approaches. Denver believes he will use a Dynamic Programming Approach to rob the items in the most efficient manner possible. Nairobi, on the other hand, believes that if she chooses a Greedy Approach, she will make the most money.

The objects in the Louvre Museum are listed below.

Objects	Jewelry	Sculpture	Painting	Book	Mummy
Profit ($)	5	9	5	4	6
Weight (Kg)	3	5	4	1	12

CO4   i)   **Calculate** the maximum profit Denver can make using his strategy. What items did he pick up? **Show** how Denver used the DP table to select these objects. You may use arrows and circles to point to the chosen cells.   **08**

CO4   ii)   Does Nairobi's belief remain valid after the robbery? **Prove** it.   **02**