

## CSE221 Final Examinations

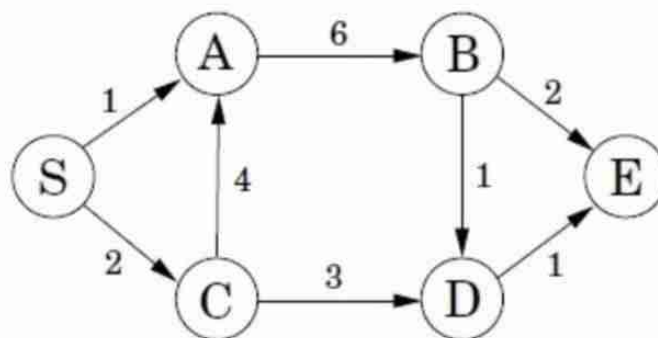
Fall 2020

Answer all four questions below on paper, take picture and submit a single pdf

**Question 1:**

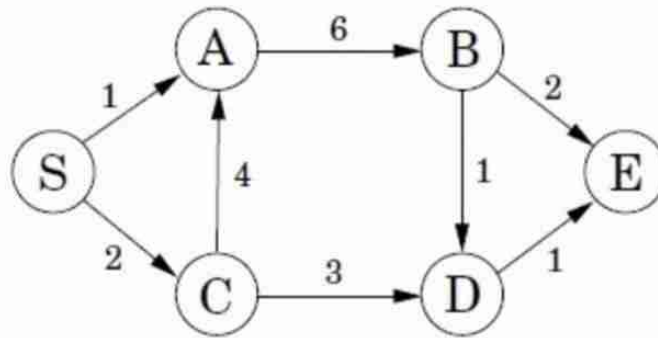
Rifat loves to travel. She travels around the world taking photos and souvenirs. This week she went to Buganda. Common Tourists would surely travel around the main city and some other nearby cities, but Rifat has a different idea. She wants to measure the distances of all the cities from her source and then decide the route.

Problem is that Buganda is very large so she has no idea how to figure this out. Luckily, you are around so she asked you for help. If the nodes of the graph represent cities and edge path costs represent driving distances, Can you tell her, from "node A" what will be the shortest path to go to other cities with minimum cost?



a.

Which algorithm will you suggest to Rifat? Does this algorithm always work on a negative



a.

Which algorithm will you suggest to Rifat? Does this algorithm always work on a negative weighted edge? Explain with an example. (3)

b.

Show the simulation of your suggested algorithm to solve Rifat's problem. Mention the total driving distance of all the paths found in the simulation above and also mention the whole shortest path for each destination. (6)

c.

What is the time complexity of your algorithm? (1)

## Question 2

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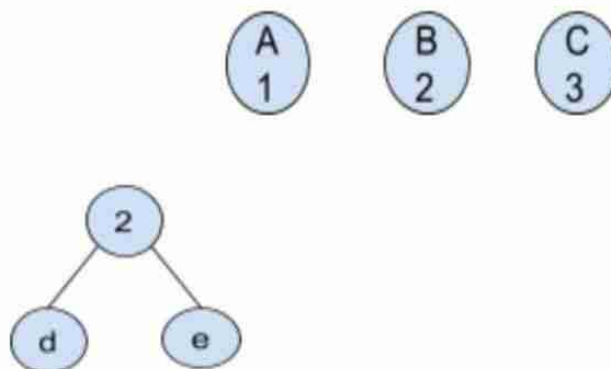
Your uncle James Bond went missing 3 years ago when he went on an office trip. You miss him a lot. He said he worked in a bank, but he always had so many office trips, you always found that strange. Anyways, 3 years after his disappearance, you got a letter with only one message "I open at the close". You immediately knew it was from James, as it is your favourite quote from your favourite book "Harry Potter" and he is the only one who knows it. You got the last Harry Potter book and opened the page with the quote, and at the bottom in your uncle's handwriting the following note was written:

1.  
rrr6oottdaaaafy
2.  
taught in summer
3.  
1011001101011111100001001001110

You immediately understood what you had to do. James taught you a variable length encoding algorithm in the last summer vacation you had with him. You have to find the code of each character in the first line using the encoding algorithm and then use the code of each character to decode the third line. James also gave you some special instructions in case you had to use that algorithm, so that you can decode the code correctly. The instructions are:

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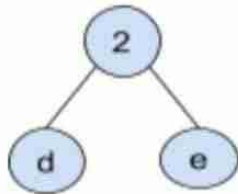
- If any characters have same frequency, then the character that appears first has higher priority (e.g, in above example r and t have same frequency, since r appears before t, it will also appear before t in the queue when generating the tree)
- A new node will always be placed immediately before the next higher frequency node in the queue. E.g,



this new node should be inserted just before C and after B.

Now that you have read all instructions clearly,





this new node should be inserted just before C and after B.

Now that you have read all instructions clearly,  
complete the tasks below:

a.

Use the appropriate encoding algorithm to find the code of each character in line 1 of your uncle's note. Generate the tree, show step by step process. [7]

b.

Use the character codes found in (a) to decode the code in line 3 of your uncle's note.[3]

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### Question 3

Suppose, you have \$10 to buy food for a day. You have several options, but you need to maximize total calories from the food items for longer survival. Apply dynamic programming technique to choose the items so that you can have maximum calories from the given amount of money. You are not allowed to waste any food, so if you choose an item, you will eat it completely.

## Question 3

Suppose, you have \$10 to buy food for a day. You have several options, but you need to maximize total calories from the food items for longer survival. Apply dynamic programming technique to choose the items so that you can have maximum calories from the given amount of money. You are not allowed to waste any food, so if you choose an item, you will eat it completely.

<u>Item</u>	<u>Price</u>
<u>Calories</u>	
Cheese Burger	\$3
250 cal	
Pizza	\$4
295 cal	
Chicken fry	\$3
225 cal	
Fried rice	\$2
290 cal	
Salad	\$1
180 cal	

(i) Apply dynamic programming technique to find the maximum calorie you can eat. [4]

(ii) Write and simulate the algorithm to find the selected items for optimal calorie intake within \$10. [4]

(iii) Analyze the time complexity of your algorithm in (ii). [2]

## Question 4:

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Humans(*Homo sapiens*) have very close cousins in apes. In fact chimpanzees (*Pan troglodytes*), bonobos (*Pan paniscus*), orangutan(*Pongo abelii*) and gorilla(*Gorilla gorilla*) has

Genetic similarity from 96% to as high as 99.4%. Some scientists even believe that they are so similar to humans that some of them should be reclassified into the genus *Homo*. Below is given some genetic sequence of these apes along with humans. You can run a dynamic programming algorithm to find out which species has the most genetic similarity with humans.

*Homo sapiens* AAATTCGTA

*Pongo abelii* ATGTAGCAT

*Pan troglodytes* TGCGCGTAG

*Gorilla gorilla* TACGATCGA

a.

Find out the genetic similarity between humans and each of the other species and state which one(s) are the most similar to humans. Show all steps clearly. [8]

b.

Tell us what is the matching string that helped you to come to this conclusion. Show how you found this string. [2]

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