CS218/201 Data Structures

Tuesday, June 23, 2020 (10:00 a.m. – 01-00 p.m.)

Course Instructor

Dr. Usman Habib.

Serial No:

Final Term Exam
Spring Semester 2020
Max Time:3 Hour
Max Marks: 100
Exam Weight (Out of 100). 50

_____   _____
          Roll No   Section

Guidelines for Submission:

1. You should submit only one PDF document and **all text should be typed**. Equations, figures can be taken as pictures (all figures/equations can be pasted as images inside that document).
2. You must submit your solution before due time via **Google Classroom**. Submissions submitted after the due time shall not be considered.
3. If you don't finish every part of a question, don't worry! You can still submit what you've done to get marks based on your efforts.
4. In case of copied or plagiarized solutions in exam Or If a student provided help to another student during exam both will be awarded "F" grade and it will affect the student CGPA.
5. Viva of any student can be conducted by the instructor after conducting an online exam in case of any doubt.
6. This document should be submitted through LMS (**Google Classroom**). But in worst case, you can email it within the deadline.

**Arrange the images or papers in order starting from Q1 to Q7.
Secondly save the file as Solution_RollNo_YourSection**

National University of Computer and Emerging Sciences

Department of Computer Science   Chiniot-Faisalabad Campus

<u>**Question No. 1**</u>   **[Total= 10 marks]**

    a. You have the following postfix equation and you have to evaluate it using stack. Use the table and show the output after each iteration [5 marks]

2 3 ^ 4 2 * / 10 5 / 9 <u>??</u> - * +   (<u>??</u> = it is the last digit of your roll no)

S.No	Symbol	Operand 1	Operand 2	Value	Operand Stack
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

    b. Use Algorithm to convert the following infix to postfix. Use the table given below and show after each iteration the status of variables. [5 marks]

((A - B ^ C) * D / E + F ^ <u>??</u>)

[<u>??</u> = it is the first letter of your name, if its already in the string then take the next letter of your name that is unique]

S.No	Symbol	Postfix String	Operator Stack
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

<u>**Question No. 2**</u>   **[Total= 17 marks]**

You are to implement a caller-id system which supports the operations such as insertion, searching and deletion. Each item consists of **Phone No**, **Address** and **Name**.

    a. Pick a data structure that is best suited for the problem (i.e. the required operation will run as efficiently as possible). You should very clearly describe how the data structure is to be applied (e.g. what is used as the key, what the associated data is). (**2 marks**)

    b. Write a pseudocode/steps for insertion operation of your choice of data structure. Compare it with data structures studied in class and show why your choice is better in insertion than other methods. (**5 marks**)

    c. Pseudocode and analysis as in part (b) for search operation. (**5 marks**)

    d. Pseudocode and analysis as in part (b) for deletion operation.   (**5 marks**)

Question No. 3:   **[Total= 20 marks]**

Use the following graph for this problem. Where needed and not determined by the algorithm, assume that any algorithm begins at node A.
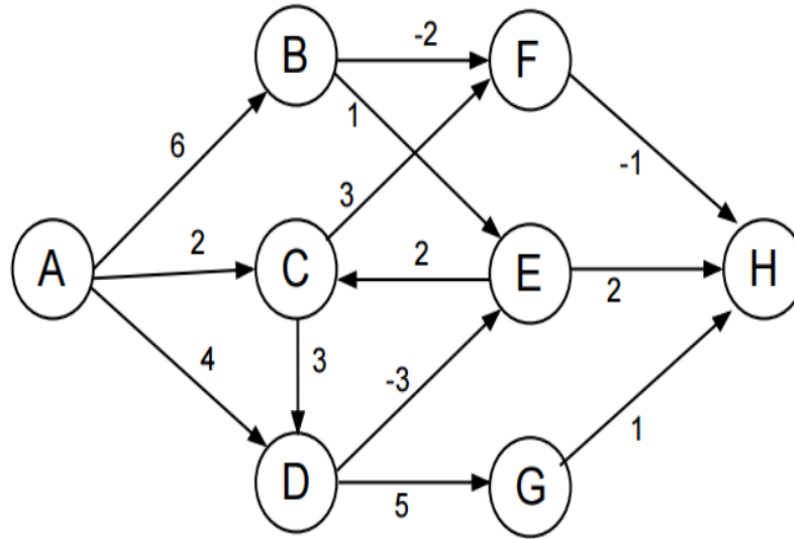
a. Draw both the adjacency matrix and adjacency list representations of this graph. Be sure to specify each thing. [**5 marks**]

b. Give two valid topological orderings of the nodes in the graph. [**2 marks**]

c. Step through Dijkstra's Algorithm to calculate the single source shortest path from A to every other vertex. You only need to show your final table, but you should show your steps in the table below. Show your steps by crossing through values that are replaced by a new value. [**7 marks**]

Vertex	Distance/Cost	Path
A		
B		
C		
D		
E		
F		
G		
H		

d. In what order would Dijkstra's algorithm mark each node. Write the order? [**3 marks**]

e. Imagine that the graph is undirected. Highlight the MST(minimum Spanning Tree) on the graph above or redraw it here [**3 marks**]

Question No. 4:   **[Total= 8 marks]**
Below are four graph-based computational tasks. For each one, you must answer two things:
- specify the type of graph most appropriate for the data in question in terms of **undirected or directed, and unweighted or weighted**.

- You must choose the graph algorithm from the following list best suited to computing a solution: **Breadth-First Search, Minimum Spanning Tree (e.g. Prim's or Kruskal's), Dijkstra's Algorithm, Topological Sort, Depth-First Search.**

(a) You have data for the rail transport (i.e. train track) network in Pakistan, including the length of each section of track. You need to compute the shortest (in terms of distance) route for a train traveling from Faisalabad City to Karachi. [**2 marks**]

(b) You need to lay water lines for a new housing development (i.e. pipes to carry water to and from each house). You have data on all the places it's possible to build pipes, and how much pipe would be required in each case. From the many potential pipeline options, you must compute which pipes to build such that you use the least amount of pipe overall. [**2 marks**]

(c) You are compiling a program from source code and you know the dependencies between source files (i.e. for each file F, you know which other files, if any, can't be compiled until F is compiled). You need to compute a valid compilation order such that each file is compiled after all its dependencies are compiled. [**2 marks**]

(d) You have data about friend relationships from a social network, and you want to model the spread of a rumor based on these relationships. Your model is that a rumor starts with a single person, who then tells all of their friends. Then at each subsequent step, everyone who knows about the rumor spreads it to all of their friends who don't know it. You want to compute how many people know about the rumor after k steps. [**2 marks**]

Question No. 5:   **[Total= 10 marks]**

a. Draw the binary min heap that results from inserting: 77, 22, 9, 68, 16, 34, 13, 8 in that order into an initially empty binary min heap. You do not need to show the array representation of the heap. You must draw intermediate heaps, and at the end circle your final result. [**5 marks**]

b. Draw the binary min heap that results from doing 2 delete mins on the heap you created in part a). You must draw intermediate heaps and please circle your final result. [**3 marks**]

c. What is the null path length of the root node in the last heap you drew in part b) above? [**2 marks**]

Question No. 6:   **[Total= 25 marks]**

Given a weighted, undirected graph with |V| nodes, answer the following as best as possible, with a brief explanation. Assume all weights are non-negative.

a. If each edge has weight $\leq w$, what can you say about the cost of an MST? [3 marks]

b. If the cost of an MST is c, what can you say about the shortest distances returned by Dijkstra's algorithm when run with an arbitrary vertex s as the source? [3 marks]

c. Draw the contents of the hash table in the boxes below given the following conditions: [7 marks]

- The size of the hash table is 11. Open addressing and double hashing is used to resolve collisions.

- The hash function used is $H(k) = k \bmod 11$

- The second hash function is $H2(k) = 5 - (k \bmod \underline{\textbf{??}})$

  [**??= last digit of your roll no. If it is 0 then take ??=5**]

- What values will be in the hash table after the following sequence of insertions? Draw the values in the boxes below.

16, 23 9, 34, 12, 56,112,131,200,32

0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

d. Consider the hash function $h(x) = x \bmod \underline{\textbf{??}}$

  [**??= last digit of your roll no. If it is less than 5 then take ??=10**]

  Insert the keys {**16, 23 9, 34, 12, 56, 112, 131 , 200, 32** } into the table with **??** number of slots. Use linear probing for collision resolution. Show the result in the table as given above. [6 marks]

e. Consider the hash function $h(x) = x \bmod \underline{\textbf{??}}$

  [**??= last digit of your roll no. If it is less than 5 then take ??=10**]

  Insert the keys {**16, 23 9, 34, 12, 56, 112, 131 , 200, 32** } into the table with **??** number of slots. Use quadratic probing for collision resolution. Show the result in the table as given above. [6 marks]

Question No. 7:   **[Total= 10 marks]**

a. You could use an AVL tree to do a sort. Describe how you would do this. [3 marks]

b. Consider the binary tree shown below. For each of the traversals listed, give the order in which the nodes are visited. [4 marks]
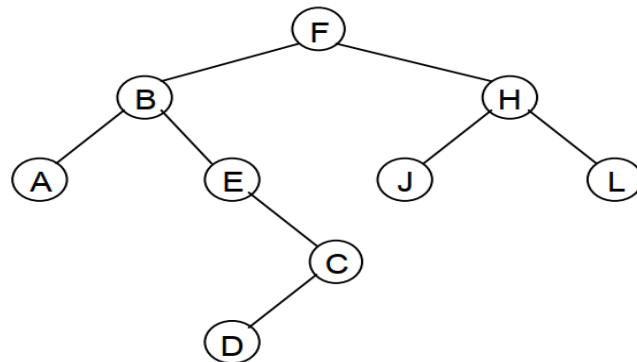
Preorder											
Inorder												
Postorder												
Breadth-first												

c. For each node shown in the binary tree below, show its depth, height, and AVL balance factor. Write your answers in the following table. [3 marks]
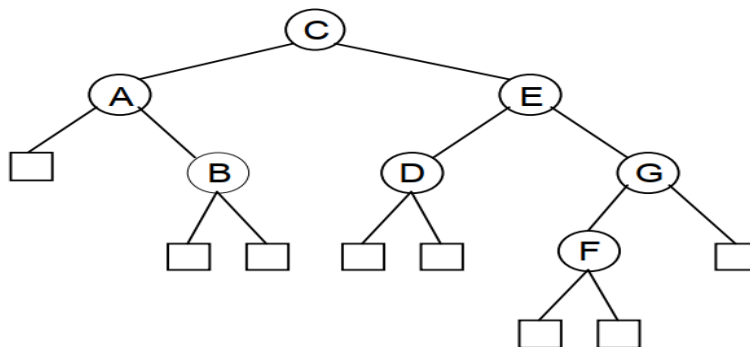
Node	Depth	Height	Balance Factor
A			
B			
C			
D			
E			
F			
G			

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