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Final Assessment Test – June 2023

Course: **BCSE202L - Data Structures and Algorithms**

Class NBR(s):**5829/5831/5834/5836/5857/5859/ 5861/5953/5956/6218/ 6305/6315/7612**

Slot: **C1+TC1**

Time: **Three Hours**

Max. Marks: **100**

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Solve the following recurrence relation using recursion tree method. $T(n) = 2T(n/2) + n$ Show that the obtained solution is correct by using substitution method.

2. Convert the infix expression (a * (b + c)) + (b / d) *a to prefix expression using stack with an algorithm. Write all steps used in conversion.

3. Write an algorithm with an example for switch pairs that switches the order of each pair of elements. For example, if an element called in linked list stores this sequences of values: [a, d, f, y, h, l]. The linked list should now store [d, a, y, f, l, h].
Note: if there are an odd number of values, the final element is not moved.

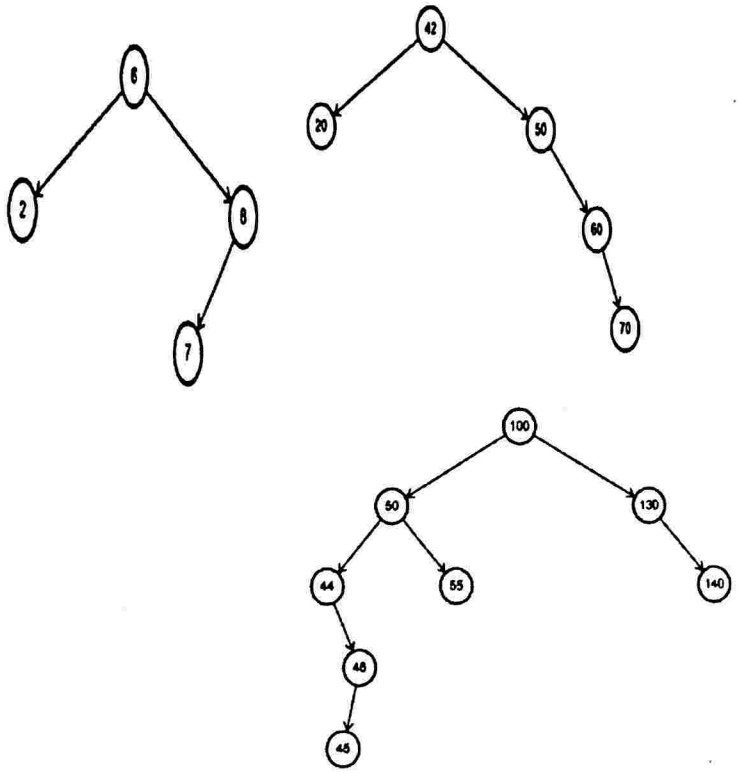
4. The column on the left is the original input of strings to be sorted or shuffled: the other columns are the contents at some intermediate step during one of the 2 algorithms listed below. Match up each algorithm by writing its number under the corresponding column. Use each number exactly once. Write pseudocode for the following sorting techniques.

1. Insertion sort
2. Selection sort

push	axis	axis
poll	bank	bank
iran	fdic	bear
iraq	iran	bull
bank	Iraq	duck
fdic	poll	evil
axis	push	fdic
evil	evil	hall
lame	lame	iran
duck	duck	Iraq
town	town	town
hall	hall	push
bull	bull	poll
bear	bear	lame
veto	veto	veto

5. a) Suppose that we start with an empty map, represented by a BST. Then we add ("Homer", 20000), then add ("Monty", 500000), then add ("Carl", 100000), then add ("Lenny", 25000), then remove "Homer". Show the contents of the BST after each operation. [5]

b) Three Binary Search Trees are given to you below, but they are not necessarily AVL trees. Determine if the BSTs are also valid AVL trees. If not, point out all nodes that are unbalanced as per the definition of an AVL tree. [5]



6. Represent the expressions (x + x * y) + (x/y) and x + ((x * y + x)/y) using binary tree. Convert the expression into prefix and postfix.

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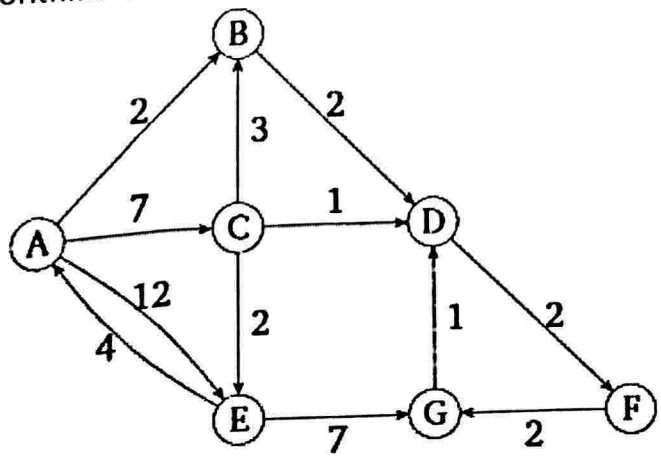
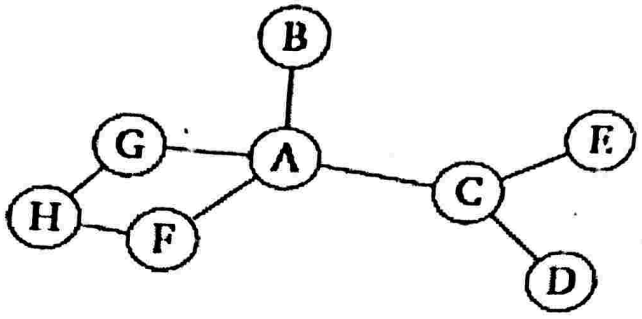
7. What are the final costs and shortest paths if we run Dijkstra's starting on node 'A' with algorithm? Provide the details of constructing shortest paths.



8. Consider the following graph. Suppose that we want to traverse it, starting at node A.Come up with pseudocode to implement breadth-first search on a given graph, given a starting node and find an adjacency matrix representation of the graph. What data structure do you use?



9. Demonstrate a pseudocode to Max Heapify on the array A= < K, B, X, Y, Z, C, D >. Provide what the array A becomes after the execution of Max Heapify and draw the resulting heap. You must provide the representation as an array and a Heap.

10. Consider a hashing mechanism (type A) which accepts integer keys, k, of maximum five digits, calculates the hash table size, p, as the minimum prime number which is larger than the number of keys entered (for eg., if the number of entries are 5, the hash table size p is 7). The hashing function takes the sum of the squares of the first, third and fifth digits as sum1 applies modular p operation on sum 1, resulting in the value x. Thus the key k gets stored in x location of the hash table. If x, the mapped location, is occupied then the key k is rotated right by one digit. Then sum1' is calculated by again taking the sum of the squares of first, third and fifth digits, and applying modular p operation, resulting in value y. Now the key is placed y locations away from its original intended location, x. If collision occurs for the second time, rotate right the original key by two digits and repeat the process to get one more value of y, and the key is placed (new) y locations away from x, and so on.

If the key has less than five digits, then appropriate zero padding is required (in the most significant digits) to compute x and y. Compare the performance (in terms of no. of collisions) of this technique with general modular function and linear probing (type B). Show the content of the resultant hash table for each of the hashing approaches A and B.

The numbers are 12345, 25378, 2543, 71356, 99919, 23151, 131 and 4217.

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