8903

CSE 202

B. TECH. III[rd] SEMESTER EXAMINATION, 2025-26

BACHELOR OF TECHNOLOGY

(CSE)

Data Structure

Time : Three Hours] [Maximum Marks : 75

Note: There are **three** sections (A, B and C) and candidate has to attempt questions from all sections. Marks are indicated against each section.

Section-A

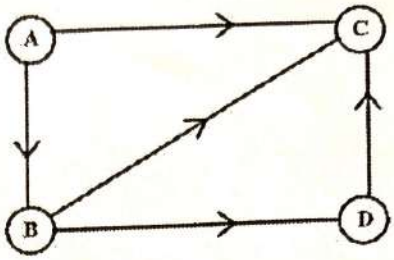
1. Attempt all parts of the following : 5×3=15

(a) A binary search tree is generated by inserting in order the following integers :
50, 15, 62, 5, 20, 58, 91, 3, 8, 37, 60, 24
the number of nodes in the left subtree and right subtree of the root respectively will be.

(b) Prove that -
$3n^2 + 4n + 2 = \theta(n^2)$

(c) There are 4 different algorithms A_1, A_2, A_3 and A_4 to solve a given problem with the order $\log_2 n, log_2(log_2 n), n\, log_2 n,$ and $\frac{n}{\log_2 n}$ respectively. Which is the best algorithm ? Justify your answer by taking suitable numerical values.

(d) Consider the graph in the figure, given below :



Write all possible topological sorting orders.

(e) The following sequence of operations is performed on a stack, PUSH (10), PUSH (20), POP, PUSH (10), PUSH (20), POP, POP, POP, PUSH (20), POP. After performing the above sequence of operations, multi POP is called on that stack. Write the sequence of values popped out, step by step.

Section-B

Note: Attempt **all** questions : 4×5=20

2. (a) Prove by mathematical induction that Tower of Hanoi requires 2^n-1 moves for n discs to complete.

Or

(b) Given input {4371, 1323, 6173, 4199, 4344, 9679, 1989} and a hash function n (x) = x (mod 10), show the resulting :

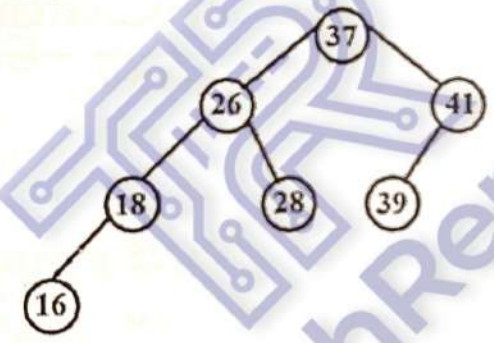
(i) Separate chaining hash table.

(ii) Open addressing hash table using linear probing.

(iii) Open addressing hash table using quadratic probing.

(vi) Open addressing hash table with second hash function $h_2(x) = 7 - (x \bmod 7)$.

3. (a) Show LR Rotation using suitable diagram. Consider the AVL tree given below as :



Now delete the key 39 with suitable rotation.

Or

(b) Consider the following parenthesis-free arithmetic expression :

E : $6 + 2 \uparrow 3 \uparrow 2 - 4 * 5$

Evaluate the expression E

(i) Assuming that exponentiation is performed from left to right.

(ii) Assuming that exponentiation is performed from right to left.

4. (a) Suppose that T_1 (n) and T_2 (n) are the time complexities of two program fragments P_1 and P_2 where $T_1(n) = 0(f(n) and\ T_2(n) = 0(f(n))$. What is the time complexity of the program fragment P_1 followed by P_2 ?

Or

(b) Let n data items are uniformly distributed in an array, AAA. Analyse the linear searching technique when it is executed on the AAA.

5. (a) Consider the following table where symbols and its frequency of occurrence are given as :

Symbol	Frequency
A	19
B	10
C	25
D	36
E	40
F	3
G	21

These symbols are to be stored in memory by using ASC II 8.0 standard. Compute the efficiency when static and dynamic coding schemes are used to store these symbols.

Or

(b) Consider the following arithmetic expression Q : A + (B * C - (D/E ↑ F) * G) * H using stack.

Postfix

Section-C

Note: Answer any **two** questions : 2×20=40

6. (a) Briefly describe the significance of transitive closure.

(b) Construct a 3-way search tree for the list of keys in the order shown below. What are your observations ?

List A : 10, 15, 20, 25, 30, 35, 40, 45

List B : 20, 35, 40, 10, 15, 25, 30, 45

What are the properties of a B-tree ? Construct a B-Tree of order 5 using the keys : 17, 35, 49, 36, 42, 67, 100, 90, 54, 45, 31, 98, 75, 43, 67, 97, 27.

7. (a) Suppose n data items A_1, A_2, ----------, A_N are already sorted ie. $A_1 < A_2 <$ -------- $< A_n$

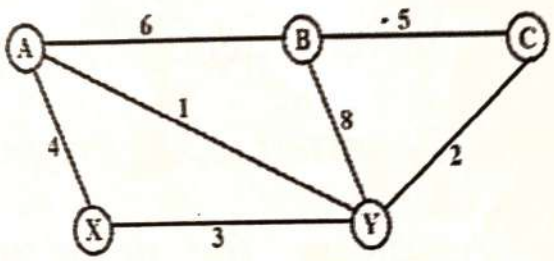
(i) Assuming the items are inserted in order into an empty binary search tree, describe the final tree T.

(ii) What is the depth D of the tree T.

(iii) Compare D with the average depth AD of a binary search tree with n nodes for n = 50, n = 100 and n = 500.

(b) Prove that in a binary tree no = n_2 + 1 holds where no is total number of terminal nodes and n_2 is the total number of nodes having degree, 2. Consider the all possible permutations of the keys 1, 2, and 3. Construct the BSTs (Binary Search Trees) and compute the average height of all the trees assuming that root is located at height 1.

8. (a) Consider the undirected graph G :



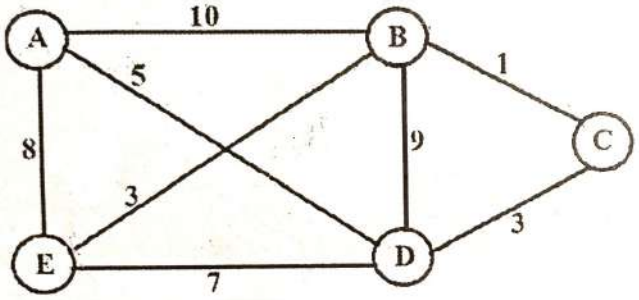
Suppose the nodes are stored in the memory in an array DATA as follows :

Data : A, B, C, X, Y

(i) Find the weight matrix W of the graph G.

(ii) Apply Kruskal and Prim algorithm to compute the minimum spanning tree of G.

(b) Let us consider a graph, G as :



Assume node A as source node and apply Dijkastra algorithm to compute single source shortest path.

9. (a) Consider the keys as : 10, 25, 13, 11, 17, 19, 26, 90, 31 and 40. Sort these keys using Quick sort. Derive the expressions for the performance of Quick sort .

(b) A complete n-any tree is a tree in which each node has n children or no children. Let I be the number of internal nodes and L be the number of leaves in a complete n- any tree. If L = 41 and I = 10, what is the value of n ?

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