DATA STRUCTURES & ALGORITHMS
(CSEN 2101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) We measure best case time complexity of any algorithm by using
(a) Θ(n) (b) θ(n) (c) O(n) (d) Ω(n)
where n is the number of inputs.

(ii) A graph and its inverse have exactly the same set of Strongly Connected Components. This is
(a) always true (b) always false
(c) true for some graphs (d) true for bipartite graphs.

(iii) In which format(s) can we represent a sparse matrix
(a) triplet format (b) CSR/YALE format
(c) both (a) and (b) (d) none of these.

(iv) What does the following function do for a given Linked List with first node as head?

```
void fun1(struct node* head)
{
 if(head == NULL)
   return;
 fun1(head->next);
 printf("%d  ", head->data);
}
```

(a) Print all nodes of linked lists
(b) Print all nodes of linked list in reverse order
(c) Print alternate nodes of Linked List
(d) Print alternate nodes in reverse order.

(v) Which of the following is true about the single linked list implementation of stack?
(a) In push operation, if new nodes are pushed at the beginning of linked list, then in pop operation, nodes must be removed from end.

(b) In push operation, if new nodes are pushed at the end, then in pop operation, nodes must be removed from the beginning.
(c) Both of the above
(d) None of the above.

(vi) The following postfix expression with single digit operands is evaluated using a stack:
8 2 3 ^ /
Note that ^ is the exponentiation operator. The top two elements of the stack after ^ is evaluated are:
(a) 6, 1 (b) 5, 7 (c) 3, 2 (d) 8, 8.

(vii) Reverse Polish notation is preferred over infix notation because
(a) The knowledge of precedence is not needed
(b) Brackets will not be needed
(c) Both of the above
(d) None of the above.

(viii) Run time of Heap Sort is tightly bounded by which of the following:
(a) O(n) (b) O(n log n) (c) O(1) (d) None of these

(ix) Tower of Hanoi problem can be solved in
(a) O(n) (b) O(n^2) (c) O(nlogn) (d) O(2^n)
time, when n= Number of disks

(x) What will be the time complexity to find the middle element among n elements, using binary search?
(a) O(1) (b) O(log n) (c) O(n) (d) $O(n^2)$.

Group – B

2. Give an example of linear data structure.
State if the following statement is correct and also explain your answer.
$2n^3+100=O(n^2)$
Which one is asymptotically bigger, n or log n? Draw the graphs required and prove.
Draw and explain the asymptotic curves for Θ, Ω and O.

(1 + 2 + (1 + 2) + 6) = 12

3. (a) Why do we need sparse representation of matrices? State the name of the two representations.
Write the pseudocode to reverse a single linked list . Remember, you need to change the order in the linked list itself, **not** just print the elements in reverse order.

(b) Explain your answer for each of the following questions:
(i) You are given pointers to the first and last nodes of a singly linked list, which of the following operations are dependent on the length of the linked list?
(A) Delete the first element
(B) Insert a new element as a first element
(C) Delete the last element of the list

(D) Add a new element at the end of the list

(ii) Considered that a pointer to a node X in a single linked list is given and the pointer to the head of the list is ***not*** given, can we delete the node X from given linked list?
(A) Possible if X is not the last node using the following two steps (a) Copy the data of next of X to X. (b) Delete next of X.
(B) Possible if size of linked list is even.
(C) Possible if size of linked list is odd
(D) Possible if X is not first node using the following two steps (a) Copy the data of next of X to X. (b) Delete next of X.

((2 + 2) + 4) + (2 × 2) = 12

Group – C

4. (a) Explain step by step how the following infix expression will be changed to postfix expression using stack:
7-(2^3+5)*8
Show the status of Remaining Infix String, Stack, Postfix String and Rule used in each step.

(b) Write an application of queue. What is a circular queue? State the advantage of a circular queue over a normal queue.

7 + (1 + (2 + 2)) = 12

5. (a) Write the pseudo code to solve Tower of Hanoi problem. What is the time complexity of your code? How many steps will be required to solve the problem for 5 disks?

(b) Which data structure do we use for recursive algorithm implementation? What is difference between recursion and iteration? What is tail recursion?

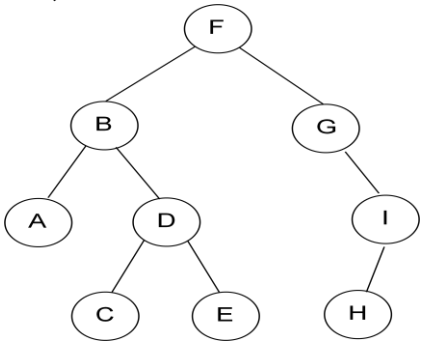
(3 + 1 + 2) + (1 + 3 + 2) = 12

Group – D

6. (a) How does a balanced binary tree differ from a degenerate binary tree?

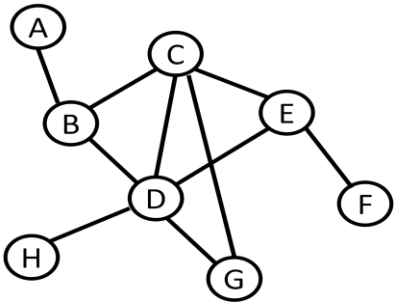
(b) Prove the following statement:
In a complete binary tree with height h>=0, minimum number of nodes are 2^h.

(c) Write the output of pre, post, in and level order traversal of the following binary tree:



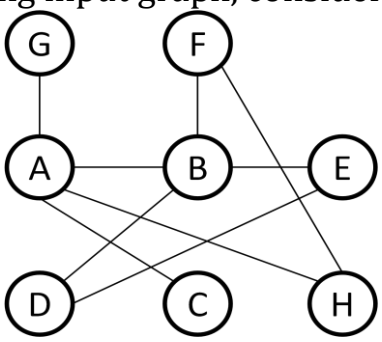
1 + 3 + (4 × 2) = 12

7. (a) List the cut vertices in the following graph.



What is adjacency matrix and adjaceny list?

(b) Write the pseudo code for BFS traversal and show step wise how you will run your code on the following input graph, considering G as the source node.



(2 + (2 + 2)) + 6 = 12

Group – E

8. (a) Write the pseudo code for randomized quick sort. Explain the time complexity.

(b) Write the pseudo-code for insertion sort. State its best-case, worst-case and average-case asymptotic complexity.

(4 + 2) + (3 + 3) = 12

9. (a) What is hashing? How many types of hashing are there? Write one merit and one demerit of each type.

(b) Write the pseudo-code of binary search and state the time complexity.

(2 + 2 + 2 + 2) + 4 = 12

Department & Section	Submission Link
CSE	https://classroom.google.com/c/NTUzMTY5NjAzNDVa/a/Mjg4MDQ1NDU2ODA5/details