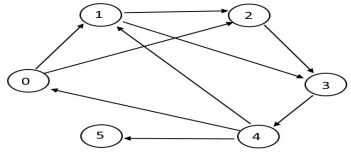
(b) The inorder and preorder traversals of a binary tree T yield the following sequence of nodes:
Inorder : U K M E A L F J Z G
Preorder : A K U E M Z F L J G
Draw the tree T. State briefly the logic used to construct the tree.

6 + 6 = 12

7. (a) Consider the following graph for DFS traversal. Starting from node 0, what will be DFS traversal? Show every step .



(b) What is Adjacency matrix and Adjacency list of the above graph?

(c) What is the critical node in AVL tree? Explain with example.

5 + (2 + 2) + 3 = 12

Group – E

8. (a) Transform the array 2, 8, 10, 6, 15, 12, 11 into a heap using any suitable method and use the heap to sort the array. Show all intermediate steps.

(b) Using divide-and-conquer approach, write the quick sort algorithm and derive its complexity.

6 + 6 = 12

9. (a) Write a function to implement Binary search algorithm. Assume the user is going to enter the list of integers in either ascending or descending order.

(b) A hash function f defined as f(key) = key mod 7, with linear probing, is used to insert the keys 37, 38, 72, 48, 98, 11, 56 into a table indexed from 0 to 6. What will be the location of key 11? Show your work. What is quadratic probing?

(c) (i) In insertion sort algorithm, how many times the outer for loop will iterate when n = 100?
(ii) In insertion sort, at some point you are trying to insert k^{th} element where $0 < k < n$. Assume also you started with a file which was sorted in reverse order. What will be the exact number of key comparisons?

6 + 3 + (1 + 2) = 12

B.TECH/IT/3RD SEM/INFO 2101/2019

FUNDAMENTALS OF DATA STRUCTURE & ALGORITHMS
(INFO 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) The time complexity of 4 algorithms that solves the same task is given below. Which algorithm will execute the slowest for large values of n
(a) $O(n^2)$ (b) $O(n)$
(c) $O(2^n)$ (d) $O(n\log n)$.

(ii) In a modified Towers of Hanoi problem, you have to move 5 disks from peg 1 to peg 3. To do that first you need to move 4 disks from peg 1 to peg 2. How many legitimate moves will it take to move 4 disks from peg 1 to peg 2?
(a) 31 (b) 16
(c) 32 (d) 15.

(iii) The prefix expression of the infix expression a * (b +c) / e - f
(a) /*a+bc-ef (b) -/*a+bcef
(c) -/*+abcef (d) none.

(iv) A circular queue is empty if
(a) front=rear-1 (b) rear=front-1
(c) front=rear+1 (d) none.

(v) The following sequence of operations is performed on stack. push(1), push(2), pop(), push(1), push(2), pop(), pop(), pop(), push(2), pop(). The sequence of popped out values are
(a) 2,2,1,1,2 (b) 2,2,1,2,2
(c) 2,1,2,2,1 (d) 2,1,2,2,2.

(vi) Using Bubble sort, to sort 100 names, the maximum number of comparisons will be
(a) 4950 (b) 5050
(c) 10000 (d) 100.

(vii) The inorder and postorder traversal of a binary tree are DBEAFC and DEBFCA. What will be the total number of nodes in the left subtree of the given tree?
(a) 1 (b) 4 (c) 5 (d) none.

(viii) What data structure is used for breadth first traversal of a graph?
(a) queue (b) stack
(c) linked list (d) none of the mentioned.

(ix) If a node having two children is deleted from a binary tree, it is replaced by its
(a) inorder predecessor (b) inorder successor
(c) preorder predecessor (d) none of the above.

(x) Let G be a graph with n vertices and m edges. What is the complexity of Depth First Search of G. Assume that the graph is represented using adjacency matrix.
(a) O(n) (b) O(m+n) (c) $O(n^2)$ (d) O(mn).

Group – B

2. (a) Algorithm RSum(a,n)
{ if (n <= 0) then
return 0;
else
return RSum(a, n-1) + a[n];
}
Deduce the time complexity of the above algorithm.

(b) Consider an array of 40 x 4 called Score to store the numerical grades of 40 students in four different subjects. Suppose base address of Score is 1000 and w = 2 bytes. What will be the address of Score[25,3], i.e. the score of 3rd subject of 25th student in Row-Major order? What will be the address of the same in Column-Major order?

(c) Prove that running time $T(n) = n^3 + 20n + 1$ is $O(n^3)$. What do you understand by O(1)?

5 + 4 + 3 = 12

3. (a) Write down (draw the nodes) the linked list expression of polynomial : $9x^3 - 7x^2 + 9$.

(b) What are the advantages of linked lists over an array. Write an algorithm to insert an element X after a given element Y, in a singly linked list.

(c) Explain with diagram, how the push operation takes place in case of a linked list implementation of Stack. Write down the algorithm for push operation in linked Stack.

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

Group – C

4. (a) Consider the following queue of characters, where QUEUE is a circular queue with a size of 6. At some point, FRONT=2, REAR=4 and QUEUE: _ , A,C,D, _ , _
Here "_" denotes an empty cell in the array. What will be the value of FRONT and REAR, also describe the QUEUE as the following operations takes place.
(a) F is added to the queue (b) Two letters are deleted
(c) K,L and M are added to the queue (d) Two letters are deleted
(e) R is added to the queue (f) Two letters are deleted.

(b) Let a and b denote positive integers. Suppose a function Q is defined recursively as follows:-

$$Q(a,b) = \begin{cases} 0 & \text{if } a < b \\ Q(a-b, b) + 1 & \text{if } b <= a \end{cases}$$

Find the value of Q(2,3), Q(14,3) and Q(586,7).

6 + (1 + 2 + 3) = 12

5. (a) Suppose STACK is an array of size 6 and initially STACK is empty, i.e., TOP = 0. A, B and ITEM are integer variables, and STACK operates on LIFO principle. Find the output of the following:
Set A: = 2 and B: = 5;
PUSH (STACK, A);
PUSH (STACK, 4);
PUSH (STACK, B+2);
PUSH (STACK, 9);
PUSH (STACK, A+B);
Repeat while (TOP is not equal to zero)
{ POP (STACK, ITEM)
PRINT : ITEM;
}[End of loop]
Return;

(b) Write an algorithm to convert an infix expression to its corresponding postfix expression using stack. Using the above algorithm, convert the following infix expression into postfix expression using stack. Show all the intermediate steps with a diagram.

A + B * C + (D / E – F) * G

5 + (4 + 3) = 12

Group – D

6. (a) Insert the following keys in the order given below to build them into an AVL tree 3, 2, 1, 4, 5, 6, 7, 16, 15, 14. Clearly mention different rotations used and balance factor of each node.