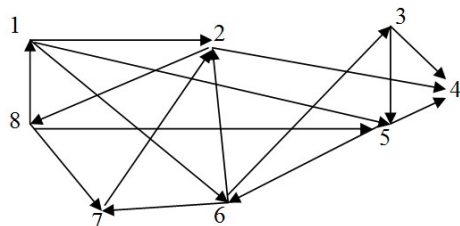


- (b) The inorder and preorder traversal of a binary tree are given below:  
Inorder: d b e a f c g  
Preorder: a b d e c f g  
Find the postorder traversal of the binary tree.
- (c) How does the height of a binary search tree affect its performance like insertion, deletion, and searching?

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

7. (a) What is complete binary tree and full binary tree? Give example.  
(b) How are graphs represented inside computer's memory? Discuss with example.  
(c) "Graphs have a purely parent-to-child relationship among their nodes" – comment on the statement (whether true or false). Give explanation of your comment.  
(d) Write the result of running BFS and DFS on the directed graph given below using vertex 1 as the source. Show the status of the data structure used at each stage. Write down the in-degree of the vertices.



$$3 + 3 + 2 + 4 = 12$$

### Group - E

8. (a) Suppose we are sorting an array of eight integers using heapsort, and we have just finished some heapify (either maxheapify() or minheapify()) operations. The array now looks like this: 16 14 15 10 12 27 28. How many heapify operations have been performed on root of heap? Explain.  
(b) Write a program for implementing quick sort algorithm using recursion.  
(c) Write an algorithm to implement binary search on an array of integers.
9. (a) Compare the best case, worst case, and average case running time complexities of insertion sort, bubble sort, selection sort, and quick sort.  
(b) Discuss various collision resolution techniques in hashing. Consider a hash table of size 10. Using linear probing, insert keys 72, 27, 36, 24, 63, 81, 92, and 101 into the table.

$$5 + (2 + 5) = 12$$

## DATA STRUCTURES AND 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) Level of a node is distance from root to that node. For example, level of root is 1 and level of left or right children of root is 2. The maximum number of nodes on level i of a binary tree is  
(a)  $2^{i-1}$  (b)  $2^i$  (c)  $2^{(i+1)}$  (d)  $2^{\lfloor (i+1)/2 \rfloor}$ .
- (ii) Consider the following recursive function fun(x, y). What is the value of fun(4, 3)  
int fun(int p, int q)  
{  
    if (p == 0)  
        return q;  
    return fun(p - 1, p + q);  
}  
(a) 13 (b) 12 (c) 9 (d) 10.
- (iii) In the worst case, the number of comparisons needed to search a singly linked list of length n for a given element is  
(a)  $\log_2 n$  (b)  $n/2$  (c)  $\log_2 n - 1$  (d) n.
- (iv) Maximum number of edges in an n-node undirected graph without any self loop is  
(a)  $n^2$  (b)  $n-2$  (c)  $n(n-1)/2$  (d)  $n(n+1)/2$ .
- (v) What is the worst case time complexity for search, insert and delete operations in a general Binary Search Tree?  
(a)  $O(n)$  for all  
(b)  $O(\log n)$  for all  
(c)  $O(\log n)$  for search and insert, and  $O(n)$  for delete  
(d)  $O(\log n)$  for search, and  $O(n)$  for insert and delete.
- (vi) Which of the following is CORRECT with respect to a stack?  
(a) push(pop()) (b) pop(pop())  
(c) push(push(x)) (d) pop(push(x)).

- (vii) The array representation of a complete binary tree contains the data in sorted order. Which traversal of the tree will produce the data in sorted form?  
 (a) Preorder (b) Inorder  
 (c) Postorder (d) Level order.
- (viii) The average number of key comparisons required for a successful search for sequential search on items is  
 (a)  $n/2$  (b)  $(n-1)/2$   
 (c)  $(n+1)/2$  (d) none of these.
- (ix) Suppose we are sorting an array of eight integers using quicksort, and we have just finished the first partitioning with the array looking like this:  
 2 5 1 7 9 12 11 10. Which statement is correct?  
 (a) The pivot could be either the 7 or the 9  
 (b) The pivot could be the 7, but it is not the 9  
 (c) The pivot is not the 7, but it could be the 9  
 (d) Neither the 7 nor the 9 is the pivot.
- (x) Which of the following is true about linked list implementation of queue?  
 (a) In push operation, if new nodes are inserted at the beginning of linked list, then in pop operation, nodes must be removed from end  
 (b) In push operation, if new nodes are inserted at the end, then in pop operation, nodes must be removed from the beginning  
 (c) Both of the above  
 (d) None of the above.

**Group – B**

2. (a) What is the output of following function for start pointing to first node of following linked list? 1->2->3->4->5->6. Give an explanation.  

```
void fun(struct node* start)
{
    if(start == NULL)
        return;
    printf("%d ", start->data);

    if(start->next != NULL )
        fun(start->next->next);
    printf("%d ", start->data);
}
```

 (b) Write a program that creates a singly linked list. Use a function IsSort() that returns 1 if the list is sorted and 0 otherwise.  
 (c) Show that  $10n^3 + 20n \neq O(n^2)$ .  
 (d) The running time complexity of a constant time algorithm is \_\_\_\_.

$$3 + 5 + 3 + 1 = 12$$

3. (a) Write a program that reads a square matrix (A) of size  $n \times n$ . Write a function int isLowerTriangular(int a[ ][ ], int n) that returns 1 if the matrix is lower triangular. (Note that a matrix is lower triangular if  $A_{ij} = 0$  when  $i < j$ ). The matrix has to be allocated using dynamic memory allocation.  
 (b) Give the linked representation of the following polynomial:  
 $7x^3y^2 - 8x^2y + 3xy + 11x - 4$ .  
 (c) Give the advantages and uses of circular linked list. Write the difference between linear array and linked list.

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

**Group – C**

4. (a) Predict output of following program and explain.  

```
#include <stdio.h>
int fun(int n)
{
    if (n == 4)
        return n;
    else return 2*fun(n+1);
}
int main()
{
    printf("%d ", fun(2));
    return 0;
}
```

 (b) What is tail recursion? Explain with example.  
 (c) Write an algorithm to convert an infix expression to postfix. Convert the expression given below into its corresponding postfix expression. Show each step of the conversion.  
 $10 + ((7-5) + 10)/2$ .

$$3 + 3 + (3 + 3) = 12$$

5. (a) Write a program to implement insertion and deletion of elements in a circular queue (using array). Also, incorporate the checking for underflow and overflow.  
 (b) Write a program to print the first n numbers of Fibonacci series using recursion.  
 (c) Give the infix expression for the following prefix expression:  $* - + A B C D$

$$6 + 5 + 1 = 12$$

**Group – D**

6. (a) Consider the AVL tree given below and insert 18, 81, 29, 15, 19, 25, 26, and 1 in it. Then delete nodes 39, 63, 15, and 1 from the AVL tree.