Ref. No.: Ex/IT/T/121/2017

Bachelor of Information Technology

1st Year 2nd Semester Examination 2017

Sub: Data Structures and Algorithms

Time: 3 Hours | Full Marks: 100

Answer any five Questions

1. (3 + 5 + 6 + 2 + 4)

a. What is the time complexity of the following code in big-Oh notation?

```
int fun (int n)
{
    int count = 0;
    for (int i = n; i > 0; i /= 2)
        for (int j = 0; j < i; j++)
        count += 1;
    return count;
}
```

b. Assuming array implementation of list, write a recursive function to find the biggest number from a list of numbers.

c. Write an algorithm to print all the LEADERS in a list of numbers. An element is leader if it is greater than all the elements to its right side. And the rightmost element is always a leader. For example in the array {16, 17, 4, 3, 5, 2}, leaders are 17, 5 and 2.

d. What condition must be satisfied for the list representation of sparse matrix to be advantageous over general 2-D representation of the same sparse matrix?

e. Let A be a six dimensional array declared as follows:

A: array [1...10][1...10][1...10][1...20] [1...20] [1...20] of integers;

Assuming that each integer takes one memory location, array is stored in row-major order, and the first element of the array is stored at location 1000, what is the address of the element A[3][4][3][4][3][4]?

2. (4+6+10)

a. The following C function takes a singly connected linked list as input argument. It modifies the list by moving the last element to the front of the list and returns the modified list. Some part of the code is left blank. Write the correct code to replace the blank line.

```
Node *move_to_front(Node *head)
{
 Node *p, *q;
 if ((head == NULL: || (head->next == NULL))
  return head;
 q = NULL; p = head;
 while (p-> next !=NULL)
 {
  q = p;
  p = p->next;
 }
 _____
 return head;
}
```

b. A circularly linked list is used to represent a Queue. A single pointer variable p is used to access the Queue. To w node should p point such that both the operations EnQueue and DeQueue can be performed in constant time? \ down the EnQueue and DeQueue functions.

5.

c. Suppose n petrol pumps are connected in a circular linked list. Each node contains two sets of data: The amou petrol that the petrol pump has and distance from that petrol pump to the next petrol pump. Write an algorith calculate the first point from where a truck will be able to complete the circle (The truck will stop at each petrol p and it has infinite capacity). Assume for 1 liter petrol, the truck can go 1 unit of distance. For example, let there petrol pumps with amount of petrol and distance to next petrol pump value pairs as {4, 6}, {6, 5}, {7, 3} and {4 The first point from where truck can make a circular tour is 2nd petrol pump.

3. (8+4+3+5)

a. Let S be a stack of size $N \geq 1$. Starting with the empty stack, suppose we push the first n natural numbers in seque and then perform n pop operations. Assume that Push and Pop operation take X seconds each, and Y seconds el between the end of one such stack operation and the start of the next operation. For $M \geq 1$, define the stack-life o as the time elapsed from the end of Push(M) to the start of the pop operation that removes M from S. Show that average stack-life of an element of this stack is $N * (X + Y) - X$.

b. Suppose a circular queue of capacity (n – 1) elements is implemented with an array of n elements. Assume that enqueue and dequeue operations are carried out using REAR and FRONT as array index variables, respectiv Initially, REAR = FRONT = 0. What are the conditions to detect queue full and queue empty?

c. Consider the following operation along with standard Enqueue and Dequeue operations queues, where k is a global parameter.

```
MultiDequeue (Q)
{
        m=k;
        while (Q is not empty and m>0)
        {
                Dequeue (Q);
                m=m-1;
        }
}
```

What is the worst case time complexity of a sequence of n MultiQequeue () operations on an initially empty queue.

d. The following postfix expression with single digit operands is evaluated using a stack:

8 2 3 ^ / 2 3 * + 5 1 * -

Note that ^ is the exponentiation operator. What are the top two elements of the stack after the first * is evaluated?

4. (7 + 3 + 4 + 6)

a. Insert the following keys in an AVL tree:

1, 10, 2, 9, 3, 8, 4, 7, 5, 6

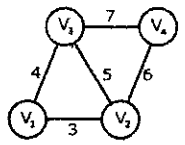
b. A scheme for storing binary trees in an array X is as follows. Indexing of X starts at 1 instead of 0. The root is sto at X[1]. For a node stored at X[i], the left child, if any, is stored in X[2i] and the right child, if any, in X[2i+1]. To able to store any binary tree of n vertices, what should be the minimum size of X? Illustrate with an example.

c. Consider two binary operators '↑' and '↓' with the precedence of operator ↓ being lower than that of the ↑ operator. ↑ Operator is right associative while operator ↓ is left associative. Draw the expression tree for the expression (7↓3↑4↑3↓2)?

d. Write an algorithm to convert a binary search tree into a sorted singly connected linked list.

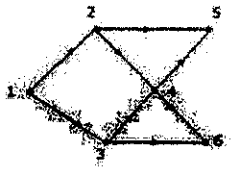
5. (5 + 5 + 10)

a. An undirected graph G(V, E) contains n (n > 2) nodes named v_1 , v_2 ,....v_n. Two nodes v_i , v_j are connected if and only if $0 < |i - j| \leq 2$. Each edge (v_i, v_j) is assigned a weight i + j. A sample graph with n = 4 is shown below.

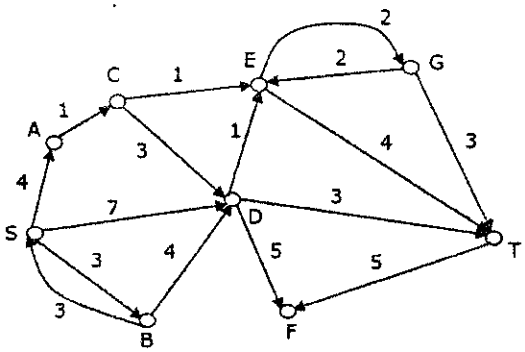


What will be the cost of the minimum spanning tree (MST) of such a graph with n nodes?

b. Consider the following directed graph. Find the spanning tree generated by DFS search.



c. Consider the directed graph shown in the figure below. There are multiple shortest paths between vertices S and T. Which one will be reported by Dijstra's shortest path algorithm? Assume that, in any iteration, the shortest path to a vertex v is updated only when a strictly shorter path to v is discovered.



6. (8 + 8 + 4)

a. Insert the following elements on-by-one into an initially empty Max-Heap.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10

b. 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. Complete the sorting using Quicksort algorithm.

c. Consider a hash table with 100 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the first 3 slots are unfilled after the first 3 insertions?