CS5343 Algorithms and Data Structures 6

Exam – May 11, 2021

PLEASE WRITE USING BLUE/BLACK PEN

First Name:_____ Last Name:_____

Student #:_____

PS: In each question show the steps as appropriate.

1. You are given a single linked list. The list has at least 3 nodes. The list is messed up so that one of the node pointer points back to a previous node rather than the next node. So as you traverse the list, you will never reach the end of the list. Write a recursive algorithm to find if the list is messed up. It would return true if it is messed up or false if it is ok. Your function can have up to 2 arguments (not more). You cannot use global variables or static variables. Also do not modify the list structure. **You must write the main function start the recursive function**. Then write the recursive function. The list is defined as follows: (10 points)

```
  Node {
        Int val;
        Node *next;
   }
Main() {
    Bool ret;
    Ret = Bad(
}

Bool Bad(Node n1, Node n2 ) {
}
```

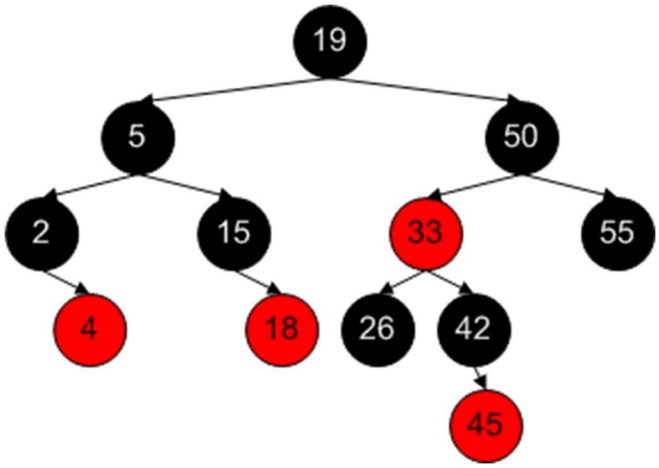
2. The node of a binary tree is defined as follows:

```
Node {
        Int val;
        Node *lchild;
        Node *rchild;
};
```

Write a recursive algorithm to check if the tree meets the value property of a min heap. The argument to the function is the root of the tree. Do not add any other arguments to the function. No Global variables. (10 points)

```
Bool heap(Node *root1) {
```

3. The following is a red-black tree. (10 points)
    a. Delete the node 55. Show each step and the final tree after deletion.
    b. In the original tree below, as shown, insert 40 and then 44. Show each step and the final tree after insert

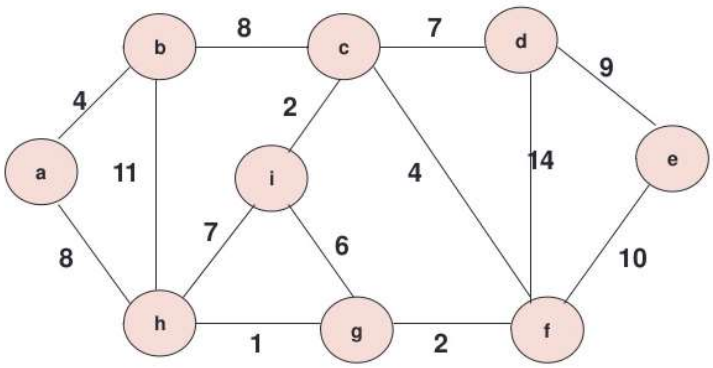


4. (10 points)The following sets are represented in an array. Show the result of the following operations of union by rank. Break tie by joining the second argument to first. Show each step and the final array.
   Sets s =1,2,3,4,5,6,7,8,9, 10,11,12
   Union(4,5); Union(10,12); Union(1, 7); Union(12,5); Union(6,3); Union(3, 11); Union(7, 11); Union(8,2); Union(12,2); Union(7,12);

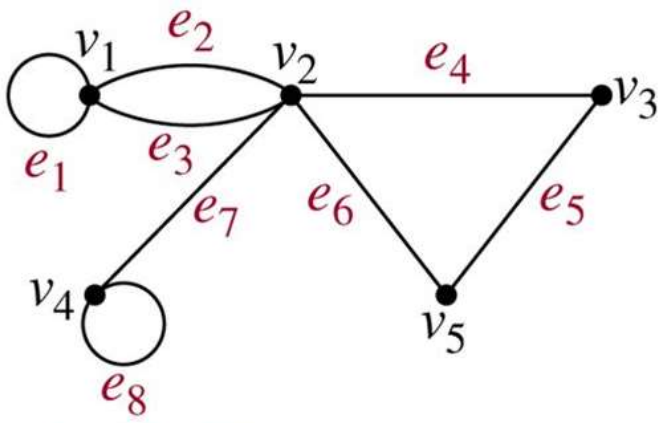
5. Sort the following, using LSD radix sort. Show each step. (10 points)
   3776, 1248, 159, 378, 127, 47, 4495, 77, 3218, 119, 61, 1416, 3225

6. Insert the following keys into a hash table. The given size of the hash table is 7. The hash function is sum of each digit. Handle collisions using linear probing.Show each step (10 points)
   164, 378, 289, 94, 821, 632, 200, 120

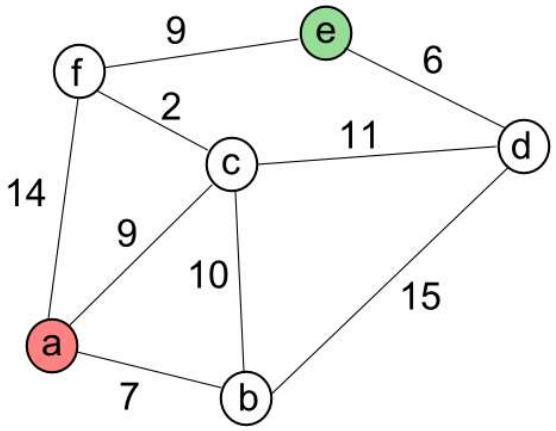
7. Find the Minimum spanning tree from A, using Kruskal's Algorithm for the following graph. Show each step.(10 points)



8. What is the incident matrix representation for the following graph. (10 points)



9. (10 points)Given the following graph, use the Dijkstra's algorithm to find the shortest path tree. Use the node **a** as the start node. Show Steps.



10. Define the terms degree, in-degree and out-degree of a graph. Show by an example of each. (6 points)

11. Write is the algorithm to prove if a directed graph is strongly connected or not. The big O must be (n+m) (4 points)