

Exam information:	Midterm exam
Version:	II
Date:	Friday Nov. 4, 2022
Time:	2:30 pm to 3:30 pm
Duration:	1 hours

Part 1: Multi choice questions:

1. An algorithm takes as input an $n \times n$ Boolean matrix A. If the running time of the algorithm is $T(n) = O(n \log n)$ when n is used as the input size parameter, then which of the following expressions describes the big-O growth of $T(m)$, the running time of the algorithm when $m = n^2$ is used as the size parameter? (5 points)
 - a. $O(\sqrt{m} \log m)$
 - b. $O(m^2 \log m)$
 - c. $O(m \log m)$
 - d. $O(m^2 \log m^2)$

Ans: a
2. Quicksort is guaranteed to run in time $O(n \log n)$ so long as the pivot is: (5 points)
 - a. randomly selected.
 - b. set to the median of the first, middle, and last array element.
 - c. set to the median of the array.
 - d. none of the above

Ans: c
3. In a double hashing solution to cope with a collision, what is not correct? (5 points)
 - a. There are two hash functions; first hash function: $h(k) = k \bmod N$ and second hash function: $d(k) = q - (k \bmod q)$
 - b. Second hash function cannot have a zero value
 - c. There is no condition for table size to allow probing to all cells
 - d. For these hash functions: $q < N$ and q and N are prime

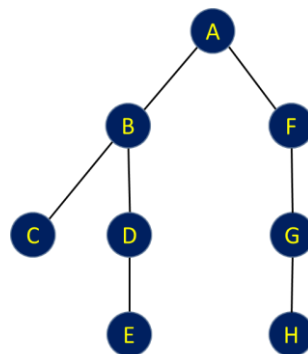
Ans: c
4. Let k denote the degree of polynomial $p(n)$, and l the degree of polynomial $q(n)$. If $p(n) = O(q(n))$, then necessarily (5 points)
 - a. $k = l$
 - b. $k < l$
 - c. $k > l$
 - d. Not possible to find

Ans: b

5. When following Kruskal's algorithm, the greedy choice is to (5 points)
- remove the edge of greatest cost from the graph so long as its removal does not disconnect the graph.
 - add the edge of least cost to the forest so long as its addition does not create a cycle.
 - add the vertex having least connection cost to the current tree.
 - remove the vertex having greatest connection cost from the tree.
- Ans: b
6. Let $G = (V; E)$ be the undirected graph whose edges are $\{(a; b); (b; c); (c; d); (a; d)\}$. If T is the depth-first spanning tree of G rooted at vertex a , how many branch(es) does T have? (5 points)
- 4
 - 3
 - 2
 - 1
- Ans: d

7. Which of the following algorithms does not require a heap for its efficient implementation? (5 points)
- Human's algorithm
 - Dijkstra's algorithm
 - Kruskal's algorithm
 - Prim's algorithm
- Ans: c

8. What is the output sequence of a Breath-first search (BFS) traversing over the following graph? (5 points)



- A B F C D G E H
- A B C D E F G H
- A B C F D G E H
- A F G H B C D E

Ans: a

Part 2: Essay questions:

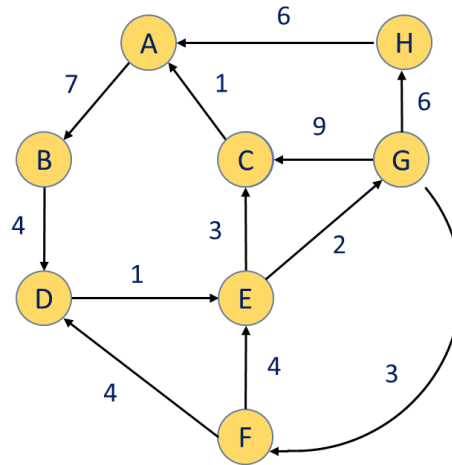
9. Consider an open addressing hash table with 18 slots. Find proper hash function to insert the keys {33, 15, 69, 74, 68, 109, 50, 96} (in the order given) into the table.
- Use linear probing for collision resolution. (5 points)
 - Use quadratic probing for collision resolution. (5 points)

10. Consider the following algorithm:

```
Algorithm Alg (n)
if (n ≤ 1)
    return false
if (n == 2)
    return true;
if (n%2 == 0)
    return false;
for (int i = 3; i2 ≤ n; i += 2)
    if (n%i == 0)
        return false ;
return true;
```

- What does Alg compute? (5 points)
 - What is O() complexity? (5 points)
11. a: Make an AVL tree of a list of [129,56,7,32,95,46,54,80] (10 points)
- b: What is the Insertion complexity of this AVL tree? (5 points)

12. Use Dijkstra algorithm and find the shortest path to all nodes from the starting point node E . (10 points)



13. For a given integer array $a[]$ with n integers,
- Write an algorithm to find if there are three indices i, j , and k (not necessarily distinct) such that $a[i] + a[j] + a[k] == 0$. (10 points)
 - What is time complexity of your algorithm? (5 points)

Good luck,
Mahdi Firoozjaei
November 2022