Ahmedabad University

School of Arts and Sciences

CSC210 Introduction to Data structures and Algorithms

BS(Hons) in CS
Mid Term Examination 2022-23 (Monsoon Semester)

Total Marks = 100 **Time – 2 hours**

Enrolment Number:.....
Date: 18-09-2022
No. of printed pages: 2

Instructions:

- Glance through all the questions before you begin. If you are stuck at any problem, try the others first, and then come back to it.
- You can write algorithms either in the form of a pseudocode or as a program in an imperative language of your choice (C, Java, Python etc.).
- Your pseudocode may contain plain English statements, but they should only use standard well-defined operations. Examples of acceptable statements are as follows –
  1. For each element x in the array, push x into the stack.
  2. Create a pointer (temp) pointing to the head of the linked list.

  Examples of unacceptable (non-standard or vague) statements are as follows -
  1. Count the number of items in the tree.
  2. Pop all items from the queue into a stack.
- When asked for complexities, you do not need to derive them but you must provide a brief explanation (just a couple of sentences).

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1. marks: 10

Order the following functions by growth rate:
N, $\sqrt{N}$, $N^{1.5}$, N^2, $N \log N$,$N \log \log N$, $N \log^2 N$, $N \log(N^2)$, $2/N$, 2^N, $2^{N/2}$, 37, N^2, N^3.
Indicate which functions grow at the same rate.

2. marks: 10

For the following program, give an analysis (big-oh) of the running time.

```
sum = 0;
for( i = 1; i < n; ++i )
  for( j = 1; j < i * i; ++j )
      if( j % i == 0 )
          for( k = 0; k < j; ++k ) ++sum;
```

3. marks: 12

Give an efficient algorithm to determine if there exists an integer i such that $A_i = i$ in an array of integers $A_1 < A_2 < A_3 < \cdots < A_N$. What is the running time of your algorithm?

4. marks: 12

A common problem for compilers and text editors is determining whether the parentheses in a string are balanced and properly nested. For example, the string (((())())() contains properly nested pairs of parentheses, while the strings)()(and ()) do not. Give an algorithm that returns true if a string contains properly nested and balanced parentheses, and false if otherwise.

5. marks: 12

Given two sorted singly-linked lists, L1 and L2, write a procedure to compute L1 $\bigcap$ L2 using only the basic list operations.

6. marks: 15

Write a function to determine whether two binary trees are identical. Identical trees have the same key value at each position and the same structure.

7. marks: 14

A *deque* is a data structure consisting of a list of items on which the following operations are possible:
- push(x): Insert item x on the front end of the deque.
- pop(): Remove the front item from the deque and return it.
- inject(x): Insert item x on the rear end of the deque.
- eject(): Remove the rear item from the deque and return it.

Write routines to support the deque that take O(1) time per operation.

8. marks: 15

You are given a complete binary tree of 10 integers. How can you efficiently store the tree using an array such that you only use 40 bytes of memory (i.e. an integer array of size 10) and and avoid any space for pointers that you would normally require in the implementation discussed in class. Explain why the efficiency is reduced if the binary tree is not complete.