International Islamic University Chittagong

Department of Computer Science and Engineering

B. Sc. in CSE Midterm Examination, Autumn 2023

Course Code: CSE 2421 Course Title: Computer Algorithms

*Total marks: **30*** *Time: **90** minutes*

[Answer all the questions; in some questions, there might be options;
Figures in the right hand margin indicate full marks.]

1.

1.a) Find the time complexity of the following function? 4

```
Fib (n)
  if (n = 0 or n = 1)     return 1
  return Fib(n-1) + Fib(n-2)
```

How will it be changed if the function is written as follows?

```
Fib_tail(n, a=0, b=1)
     if (n == 0)     return a
     if (n == 1)     return b
     return Fib_tail(n-1, b, a+b)
```

Here, a=0, b=1 are default arguments.

1.b) Find the time complexity of the following function. 3

```
void Tweety (int n)
{
  for (int i = 1; i <= n; i++)
    for (int j = 1; j <= i*i; j++)
      k = k + 1;
}
```

How the time complexity will be changed if **i*i** is replaced with **i**?

1.c) Find the asymptotic bound of the following recurrence by using master method: 3

$$T(n) = 4T(n/k) + n^2$$

where **(i)** $k = 4$ and **(ii)** $k = 2$.

2.a) Show that the lower bound of any comparison based sort in $\Omega(n \lg n)$. 4

OR

Show that a heap can be constructed from an array in $O(n)$ time.

2.b) Show the operation of the Radix-sort on the following array. 3

$A = \langle 673, 424, 527, 639, 247, 826, 974, 428, 356, 652, 713 \rangle$

2.c) Show the steps of sorting the following list of numbers using Quicksort. Show steps of each partition operation. 3

$A = \langle 15, 9, 5, 2, 3, 6 \rangle$

OR

Show how you can sort the numbers of the following min-heap **A**. Illustrate each step.

$A = \langle 1, 2, 3, 6, 8, 11, 13, 15, 17, 21, 23 \rangle$.

3.a) Find an optimal parenthesization of a matrix-chain product whose sequence of dimensions is $\langle 3, 7, 9, 5, 8 \rangle$. 4

3.b) What is optimal substructure? Show that the longest common subsequence problem has this property. 3

OR

What is overlapping subproblems? Show that the matrix-chain-multiplication problem has this property.

3.c) How many ways you can parenthesize a chain of 7 matrices? Show the steps of calculation. Also, find how many distinct subproblems you will encounter if you want to parenthesize a chain of 7 matrices optimally for multiplication. 3