



## COMSATS University Islamabad, Lahore Campus

### Midterm Examination – SPRING 2024

Course Title:	Design and Analysis of Algorithms				Course Code:	CSC301	Credit Hours:	3(3,0)
Course Instructor:	Dr. Hasan Jamal, Dr. Atif Saeed				Programme Name:	BS Computer Science		
Semester:	5 <sup>th</sup>	Batch:	FA22-BCS	Section:	A, B, C (D)	Date:	27/04/2024	
Time Allowed:	90 Minutes				Maximum Marks:		50	
Student's Name:	[REDACTED]				Reg. No.	[REDACTED]		
<b>Important Instructions / Guidelines:</b>								
<ul style="list-style-type: none"><li>• Be precise and to the point while answering any question.</li><li>• Show all your work, as partial credits will be given. You will be graded not only on the correctness of your answer, but also on the clarity with which you express it. Please be neat.</li><li>• Good luck!</li></ul>								

**Question 1:** CLO: <1>; Bloom Taxonomy Level: <Applying> [Marks: 02 + 02 + 01 = 05]

- List down two reasons on why do we need to analyze algorithms?
- List down two limitations of empirical analysis.
- In Hashing,  $\lambda$  is the load factor which is calculated as  $N/M$ , where  $N$  is the number of elements and  $M$  is the table size. Why can  $\lambda$  be more than 1 while using separate chaining and not while using open addressing?

**Question 2:** CLO: <2>; Bloom Taxonomy Level: <Analyzing> [Marks: 10]

Prove or disprove:  $\sqrt{n} + \frac{1}{n} \in \Theta(1)$

**Question 3:** CLO: <2>; Bloom Taxonomy Level: <Analyzing> [Marks: 10]

For the following code snippet, provide a line-by-line analysis and construct function  $T(n)$  that give the runtime of this code snippet as a function of " $n$ ". Also determine the Big-Oh of this code snippet. Assume ' $x$ ' to be an integer value which is provided as input by the user.

```
for (int i = 0; i < n; ++i)
    if (n < x)
        sum = foobar(i);
    else
        sum = foo(i) * bar(i + 1)
```

```
bar(a)
for (int i = 0; i < n * n; ++i)
    sum += i * a;
return sum;
```

```
foo(a)
return a * bar(a);
```

```
foobar(a)
for (int i = 0; i < n; ++i)
    sum = foo(a) * i;
return sum;
```



**Question 4:**

**CLO: <2>; Bloom Taxonomy Level: <Analyzing>**

**[Marks: 3 + 3 + 2 + 2 = 10]**

In not more than five lines each, provide the answers to the following questions. Be reasonable in your assumptions. Your answer must appear in the first few words, followed by strong justification to support your answer.

- a) You are given an unsorted list of readings of Systolic (upper number) blood pressure of 10,000 patients. To find the critical readings, the data must be sorted. Which sorting algorithm will you choose to sort the given data? Justify your answer.
- b) A credit card company is maintaining a sorted list of credit card transactions according to the timestamp of the transaction. At any given time, many clients make transactions simultaneously. These transactions need to be recorded on the sorted list. Which algorithm will you choose to sort this list? Justify your answer.
- c) Explain briefly, when using Bucket Sort, why we assume the data to be uniformly distributed.
- d) List down the two assumptions made for count sort.

**Question 5:**

**CLO: <2>; Bloom Taxonomy Level: <Analyzing>**

**[Marks: 10]**

Solve the following recurrence using the "Recursion Tree Method".

$$T(n) = 3T\left(\frac{n}{4}\right) + T\left(\frac{3n}{4}\right) + n$$

**Question 6:**

**CLO: <2>; Bloom Taxonomy Level: <Analyzing>**

**[Marks: 5]**

Solve the following recurrence using the "Master Theorem Method".

$$T(n) = T\left(\frac{n}{2}\right) + \frac{1}{n}$$