	COLLEGE OF COMPUTING AND INFORMATION SCIENCES		
	MIDTERM Assessment Spring 2021 Semester		
Class Id	106397/106398/ 106399 / 106600	**Course Title**	Design and Analysis of Algorithms
Program	BSCS / MCS	**Campus / Shift**	North Campus / Morning
Date	11th March 2021	**Total Points**	30
Duration	02 + 01 hours	**Faculty Name**	Dr. Salman Khan & Shah Emaduddin
Student Id	62952	**Student Name**	SYED RAZA AHMED

INSTRUCTIONS:

- Students are expected to complete the exam within **02 hours**.
- To accommodate electricity or internet failures, students will be given **01 extra hour** for uploading and downloading.
- The exam will be from **6:30 PM to 8:30 PM**. Submission will be due by **9:30 PM**.
- Answers submitted after 9:30 pm may be penalized or even rejected.
- **Similar copies or material taken from the internet will be marked zero and plagiarism policy will be applied in accordance with the institutional regulations.**
- Students are advised to upload their answer scripts **as PDF file only** on **LMS** as soon as they finish the exam. A copy of the answer script should also be submitted to **Google classroom**.
- The answer script should be named in the following format: **ID_FirstName_CourseID.pdf**
- E.g. 12345_FirstName_105123.pdf, where 12345 is std id, and 105123 is replaced with your course id.
- Answers should be solved on this given question paper. No change should be made to the cover page of this exam paper.
- A recorded viva session may be conducted with students to ascertain the quality of answer scripts where deemed necessary.
- **The answer should preferably be typed**. Hand written answers should bear the name and ID number of the student on the page, and clear image of the page should be pasted in this exam sheet just below the concerned question.
- Any non-compliance with the given instructions may result in deduction of marks as penalty.

UNDERTAKING:

By attempting this exam, I declare that all answers in this examination have been given solely by me while using books, notes, internet and other sources of information, and I have not taken any help from any person or student in solving any part of this examination.

Question	Q1	Q2	Q3	Q4	Q5	Q6	Total
Max. marks	5	5	5	5	5	5	30
Marks obtained							

Q1: WARM UP [5 MARKS]

For each of the following questions, provide your answer in a SINGLE word. Answers longer than one word will be considered invalid.

a. Which approach for algorithm description is not concerned with software engineering issues?

Ans: Formal Description.

b. This term defines the number of primitive operations

Ans: Asymptotic Notation

c. The time requirements of an algorithm depend on two things. One of them is the nature of the problem being studied, while the other one is concerned with _____

Ans: Input Size

d. Insertion sort uses this approach in sorting a given array

Ans: Incremental Approach

e. This notation gives the upper bound on the growth rate of a function

Ans: Big-O

Q2: ASYMPTOTIC ANALYSIS [5 MARKS]

An algorithm A_1 has a runtime $T_1(n)$ defined (in seconds) by the following function:-

$$\mathbf{T_1(n) = n^2 + n + 50}$$

For $n = 9$, the runtime of algorithm A_1 is **140** seconds.

Runtime of another algorithm A_2 is represented by the following equation:-

$$\mathbf{T_2(n) = 2n^3 + 14n + 230}$$

For $n = 2$, the runtime of algorithm A_2 is **274** seconds.

Algorithm A_3 with runtime represented by the following equation.

$$\mathbf{T_3(n) = 3n^2 + 33n + 333}$$

Identify all values of n (if such values exist) for which the runtime of A_3 exceeds the given runtime of 140 sec of A_1 but is less than the runtime of 274 seconds of A_2.

J. Raza (62952) Date

Q#2

Solution:

Algorithm A_1 is $T_1(n) = n^2 + n + 50$, $n = 9$, run time = 140s
Algorithm A_2 is $T_2(n) = 2n^3 + 14n + 230$, $n = 2$, run time = 274s

for Algorithm A_3 is $T_3(n) = 3n^2 + 33n + 333$

let, $n = -3$, $T_3(-3) = 3(-3)^2 + 33(-3) + 333 = 27 - 99 + 333$
$\Rightarrow \boxed{T_3(-3) = 261}$

let, $n = -4$, $T_3(-4) = 3(-4)^2 + 33(-4) + 333 = 48 - 132 + 333$
$\Rightarrow \boxed{T_3(-4) = 249}$

let, $n = -5$, $T_3(-5) = 3(-5)^2 + 33(-5) + 333 = 75 - 165 + 333$
$\Rightarrow \boxed{T_3(-5) = 243}$

let, $n = -6$, $T_3(-6) = 3(-6)^2 + 33(-6) + 333 = 108 - 198 + 333$
$\Rightarrow \boxed{T_3(-6) = 243}$

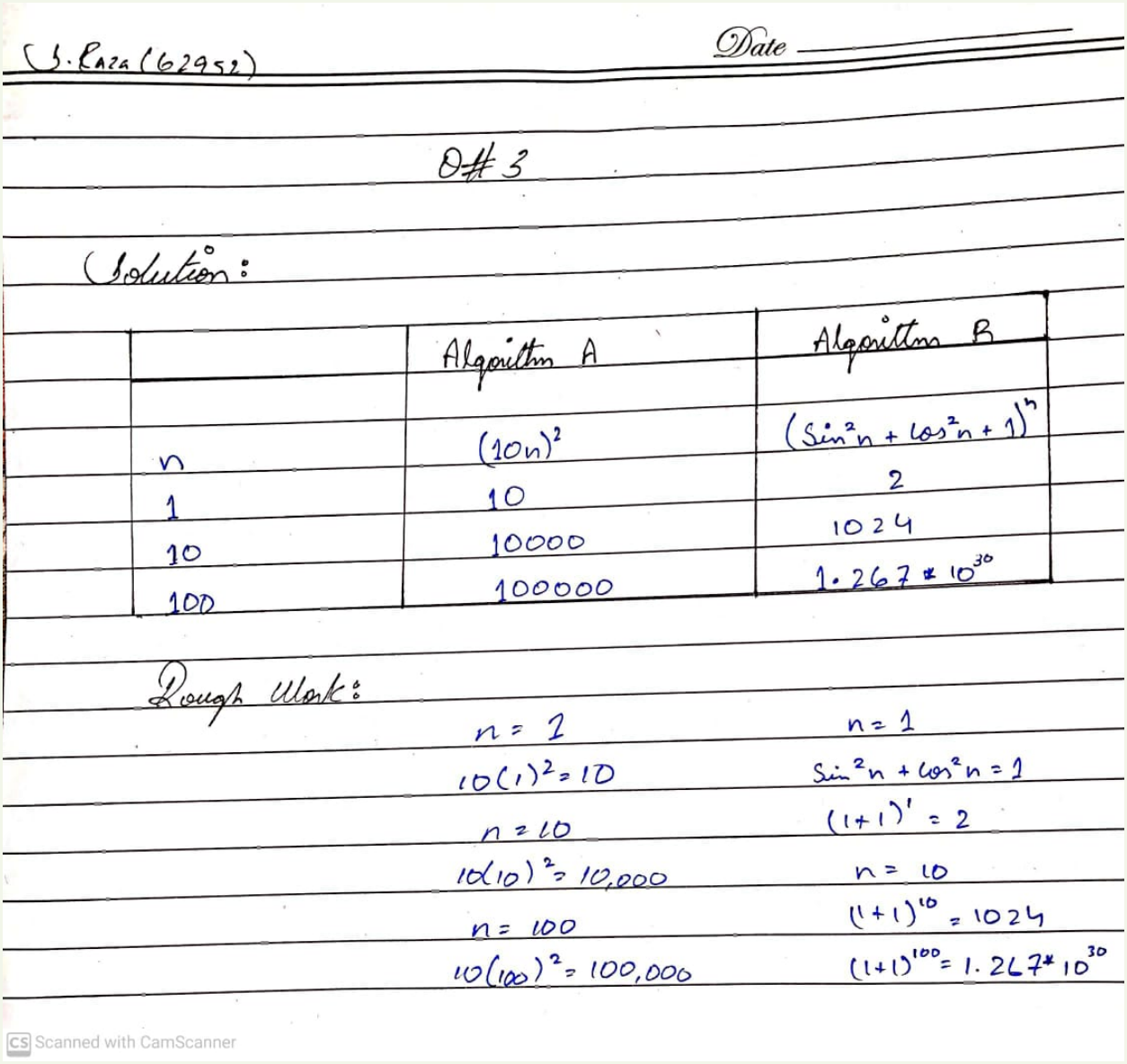
$\Rightarrow$ let, $n = -7$, $T_3(-7) = 3(-7)^2 + 33(-7) + 333 = 147 - 231 + 333$
$\Rightarrow \boxed{T_3(-7) = 249}$

$\Rightarrow$ let, $n = -8$, $T_3(-8) = 3(-8)^2 + 33(-8) + 333 = 192 - 264 + 333$
$\Rightarrow \boxed{T_3(-8) = 261}$

The value of n will lies from -3 to -8 so the run time of A_3 algorithm will be greater then 140s & less then 274s

Q3: ASYMPTOTIC ANALYSIS [5 MARKS]

Let us assume that we have two algorithms A and B. Algorithm A has run time given by $(10n)^2$ and algorithm B has run time given by $(\text{Sin}^2 n + \text{Cos}^2 n + 1)^n$ where n is the input size. Also assume that both algorithms are run on the same computer. Find the smallest value of n for which the runtime of algorithm A is less than the run time of algorithm B.



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Q#3

Solution:

	Algorithm A	Algorithm B
n	$(10n)^2$	$(\text{Sin}^2 n + \text{Cos}^2 n + 1)^n$
1	10	2
10	10000	1024
100	100000	$1.267 * 10^{30}$

Rough Work:

$n = 1$
$10(1)^2 = 10$
$n = 10$
$10(10)^2 = 10,000$
$n = 100$
$10(100)^2 = 100,000$

$n = 1$
$\text{Sin}^2 n + \text{Cos}^2 n = 1$
$(1+1)^1 = 2$
$n = 10$
$(1+1)^{10} = 1024$
$(1+1)^{100} = 1.267 * 10^{30}$

Q4: ALGORITHM EFFICIENCY [5 MARKS]

Consider the pseudo-code below:

```
01 F(n)
02 int sum = 0
03 for (int i = 0; i < n; i++)
04     sum++
05 return n
```

a. Is the time efficiency of the code greater than, equal to, or less than O(n)? **Explain your answer**.

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Q#4(a)

Solution:

```
f(n)
int sum = 0
for (int i=0; i<n; i++)
    sum ++
return n
```

run time 1 + n + 1 + n + 1 = 2n + 3

runtime of this pseudo code = 2n + 3

n = 0 then its efficiency will be lower than O(n), O(1) and if n is greater than 0 then efficiency is greater than O(n) & loop will run infinity.

b. What is the expected runtime of the code (in Big-O notation?) **Explain your answer**.

Ans: The algorithm run infinite time not more than 1 time and then terminate the program considering on the value of n.

Q5: Dynamic Programming [5 marks]

Wireless sensor networks (WSNs) refer to a domain of communication networks. In a WSN, small devices called *sensor nodes* are used for data transfer among each other and a base station. One limitation of a sensor node is that it has a very limited processing capability and very small memory. Consider a scenario in which you have an algorithm that can be subdivided into smaller problems. If you have to run these sub-problems in different sensor nodes, would you prefer to use divide & conquer approach or dynamic programming approach? Write briefly and precisely.

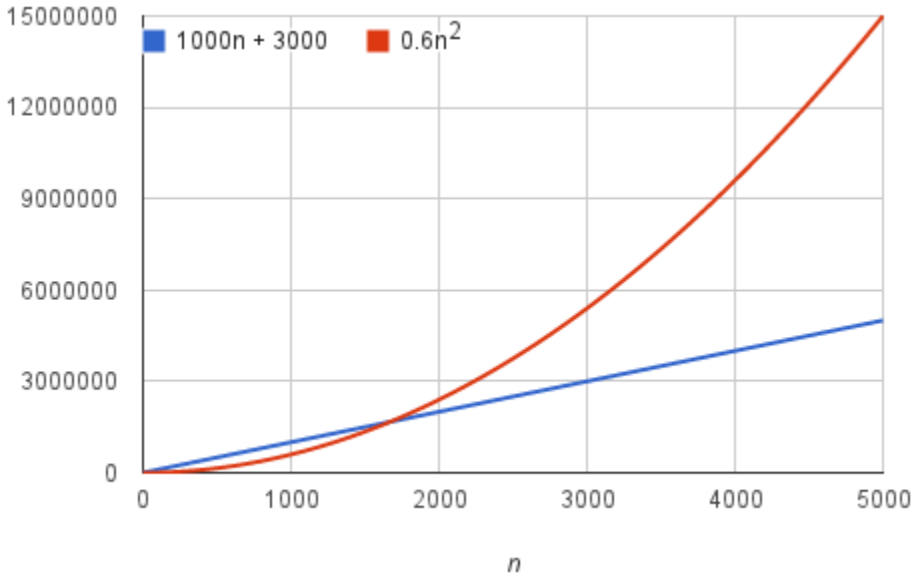
Ans: I will go for dynamic programming for this scenario because it will not recheck the nodes instead it will solve it in a bottom-up fashion although in divide and conquer it will recheck the already checked nodes and it will cause time efficiency.

Q6: Growth Of Functions [5 marks]

The following figure shows the plots of runtime versus input size for two algorithms. Asymptotic efficiency of algorithm RED is defined by $0.6n^2$ while of algorithm BLUE is defined by $1000n + 3000$. The x-axis represents the input size (shown from 0 to 5000) while the y-axis shows the runtime in seconds.

(a) Find the value of input size n at which the two plots intersect each other.

(b) What is the importance of this intersection point?



U. Raza (62952) Date

Q# 6(a)

Solution:

By using Quadratic equation, $\frac{-b \pm \sqrt{b^2-4ac}}{2a}$

(i) $0.6n^2$ — (i) $0.6n^2 = 1000n + 3000$

(ii) $1000n + 3000$ — (ii) $0.6n^2 - 1000n - 3000$

$$\Rightarrow \frac{+1000 \pm \sqrt{(-1000)^2 - 4(0.6)(-3000)}}{2(0.6)}$$

$$\Rightarrow \frac{1000 \pm \sqrt{1000000 + 7200}}{1.2}$$

Or

$$\Rightarrow \frac{1000 + \sqrt{1000000 + 7200}}{1.2}, \quad \frac{1000 - \sqrt{1000000 + 7200}}{1.2}$$

$$\Rightarrow n_1 = 1669.66, \quad n_2 = -2.994$$

$$\Rightarrow \boxed{n = 1669.66}$$

6(b) Ans: The intersection point of both curves are same in this scenario and considering this value the behavior of both algorithms is similar, the running time is increasing when 0.6n^2 is taken as compare to 1000n + 3000.