

CS210 - MidSem Exam

- All the questions are compulsory.
- Errors in questions are unavoidable; students are expected to distribute time across all the questions.
- If you're having trouble remembering any of the material, try taking a power nap under your desk. It might help refresh your memory.
- Whatever you do, don't even think about asking your friend for help because we are diving headfirst into the epic adventure known as the **VIVA**.
- Do not panic.

1. Let A be an $n \times n$ matrix of integers such that each row and each column is arranged in ascending order. We want to check whether a number k appears in A . If k is present, we should report its position—that is, the row i and column j such that $A(i, j) = k$. Otherwise, we should declare that k is not present in A . Describe an algorithm that solves this problem in $O(n)$ time. **[30 marks]**

Example :

$$A = \begin{bmatrix} 1 & 4 & 7 & 11 & 15 \\ 2 & 5 & 8 & 12 & 19 \\ 3 & 6 & 9 & 16 & 22 \\ 10 & 13 & 14 & 17 & 24 \\ 18 & 21 & 23 & 26 & 30 \end{bmatrix}$$

For $k=5$, Output: 1st row and 2nd column.

For $k= 22$, Output: 22 is not present in A .

For students who were unable to solve the problem in linear time, there is an alternative opportunity. If you can successfully solve it in a time complexity of $O(n \log n)$, you will be awarded 15 marks.

2. Given an integer d and an array A of n numbers, find the longest increasing subsequence of A such that the difference between any two consecutive numbers in the subsequence is at least d . The desired time complexity to solve the problem is $O(n^2)$.

Example : $A = \{-9, -5, 1, 3, 4, 6, -2\}$

For $d= 2$, output is $\{-9, -5, 1, 3, 6\}$

For $d= 3$, output is $\{-9, -5, 1, 4\}$

For $d= 4$, output is $\{-9, -5, 1, 6\}$

[30 marks]