


National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	Design and Analysis of Algorithms	Course Code:	CS2009
	Degree Program:	BSCS	Semester:	Spring 2023
	Due Date:	20 - 02 - 2023	Total Marks:	70
	Section:	G, H, J	Page(s):	3
	Exam Type:	Assignment 1		

Student : Name: _____ Roll No. _____ Section: _____
Instruction/Notes: _____

Loop invariants

Use loop invariants to prove the correctness of the following algorithms

Note: Use the code given in this assignment.

Question 1:

Find Min

MINIMUM(*A*)

```
1  min = A[1]
2  for i = 2 to A.length
3      if min > A[i]
4          min = A[i]
5  return min
```

Question 2:

Bubble Sort

BUBBLESORT(*A*)

```
1  for i = 1 to A.length - 1
2      for j = A.length downto i + 1
3          if A[j] < A[j - 1]
4              exchange A[j] with A[j - 1]
```

Question 3:

Selection Sort

SELECTIONSORT(A)

```
1  for  $j = 1$  to  $A.length - 1$ 
2       $smallest\_index = j$ 
3      for  $i = j + 1$  to  $A.length$ 
4          if  $A[i] < A[smallest\_index]$ 
5               $smallest\_index = i$ 
6      exchange  $A[j]$  with  $A[smallest\_index]$ 
```

Designing Algorithms

Question 1:

Given an array of integers, replace each element of the array with product of every other element in the array without using / operator.

Question 2:

You are given an array of n elements, and you notice that some of the elements are duplicates; that is, they appear more than once in the array. Show how to remove all duplicates from the array in time $O(n \log n)$.

Question 3:

Given a sorted array of distinct integers $A[1; : : ; n]$, you want to find out whether there is an index i for which $A[i] = i$. Give a divide-and-conquer algorithm that runs in time $O(\log n)$.

Question 4:

You are given two sorted lists of size m and n . Give an $O(\log m + \log n)$ time algorithm for computing the k th smallest element in the union of the two lists.
