Due Date: 31th Oct 2021
20% penalty for 1 day late
40% penalty for 2 days late
Submission not allowed afterwards

CS2009: Design and Analysis of Algorithms (Fall 2021)
Assignment 2
Total Marks: 100

1. You are given an unsorted array of 100 elements. All elements are between 1-100 in value and all are distinct except one element that repeats two times.

   Design $O(n^2)$ time algorithm to find the duplicate element in the array.

   Design $O(n)$ time algorithm to find duplicate element in array. [5+10 = 15 points]

2. You are given an array of positive integers in unsorted arrangement. You need to arrange the array in a zig-zag value of magnitudes such that $a[1] > a[2] < a[3] > a[4] < a[5] > a[6]$ and so on.

   Design a $O(nlogn)$ algorithm for this problem where n is the length of array.

   Design $O(n)$ time algorithm or better for this problem. [5+10 = 15 points]

3. Suppose you want to calculate square of a given number x with out using multiplication *, division / and pow() function.

   Design algorithm for this problem in $O(n)$ time

   Design algorithm for this in $O(logn)$ time [5+10 = 15 points]

4. You know that divide and conquer algorithm exists to find maximum subarray sum of any given array in $O(nlogn)$ time. Design algorithm for this problem that takes no longer than $O(n)$ time. [15 points]

5. (a) You have studied binary search algorithm to search any number in an array. There is another technique of searching known as Jump Search. Learn about Jump search algorithm from this link https://www.geeksforgeeks.org/jump-search/. Take any input sorted array (atleast of size 8) and search a number present at the end of array using both binary search and Jump search. Show each iteration of both algorithms. Discuss pros and cons of both techniques in different circumstances.

   (b) Learn about how interpolation and exponential search works from this link $https://www.geeksforgeeks.org/searching-algorithms/$

   Write working of both searching algorithms (interpolation and exponential) in your own words. [15+5 = 20 points]

6. HeapSort is a sorting technique that takes $O(nlogn)$ time. You may watch this video to understand working of heap sort. $https://www.youtube.com/watch?v=MtQL_ll5KhQ$

   Suppose array A contains 4,1,3,2,16,9,10,14,8,7. Sort it using heap sort along with showing each iteration. [20 points]