ITER, SOA (Deemed to be) University, Bhubaneswar

MCA I^{st} Semester
Assignment 3, November 2025
Subject: Discrete Mathematics (MA 3001)
Sections: 25C2A1, 25C2A2, 25C2B1, & 25C2B2

Answer all questions

3.1 Algorithm

1. List all the steps of the algorithm to find the maximum of the list $1, 8, 12, 9, 11, 2, 14, 5, 10, 4$.
2. Devise an algorithm that finds the sum of all the integers in a list.
3. A palindrome is a string that reads the same forward and backward. Describe an algorithm for determining whether a string of n characters is a palindrome.
4. Describe an algorithm that takes as input a list of n distinct integers and finds the location of the largest even integer in the list or return 0 if there is no even integers in the list.
5. List all the steps used to search for 9 in the sequence $1, 3, 4, 5, 6, 8, 9, 11$ using
   (a) a linear search
   (b) a binary search
6. Use (a) bubble sort and (b) insertion sort to sort d, f, k, m, a, b, showing the lists obtained at each step.

3.2 The Growth of functions

7. Use the definition of "$f(x)$ *is* $O(g(x))$" to show that $x^4 + 9x^3 + 4x + 7$ is $O(x^4)$.
8. Find the least integer n such that $f(x)$ is $O(x^n)$ for $f(x) = 3x^3 + (log\ x)^4$.
9. Show that x^3 is $O(x^4)$ but that x^4 is not $O(x^3)$.
10. Arrange the functions $\sqrt{x}$, $1000\ log\ n$, $n\ log\ n$, $2n!$, 2^n, 3^n, and $n^2/1000000$ in a list so that each function is big-O of the next function.
11. For each of the following functions, determine whether that function is $\Omega(x^2)$ and whether it is $\Theta(x^2)$
    (a) $f(x) = x^2 + 1000$
    (b) $f(x) = x^4/2$
    (c) $f(x) = 17x + 11$

3.2 Complexity of Algorithms

12. Describe the time complexity of Algorithm for finding the maximum element in a finite set of integers.

13. Describe the time complexity of the linear search algorithm.

14. Describe the time complexity of the binary search algorithm in terms of the number of comparisons used and ignoring the time required to compute $m = \lfloor (i + j)/2 \rfloor$ in each iteration of the loop in the algorithm.

15. Describe the average case performance of the linear search algorithm in terms of the average number of comparisons used, assuming that the integer x is in the list and it is equally likely that x is in any position.

16. What is the worst case complexity of the bubble sort in terms of the number of comparisons made?

17. What is the worst case complexity of the insertion sort in terms of the number of comparisons made?