Lab Sheet 2

Sorting and Recursion

Implement the following sorting algorithms and answer the associated questions.

1. Bubble sort
    a. What is the time complexity of a simple bubble sort algorithm? Is there any difference between the best case and the worst case?
    b. How can we change the best-case complexity to $\Omega(n)$? Modify your algorithm accordingly. What is the worst-case complexity of the improved algorithm?
    c. Give examples for best-case and worst-case inputs.

2. Selection sort
    a. What is the time complexity of a simple selection sort algorithm? Is there any difference between the best case and the worst case?
    b. How can we change the best-case complexity to $\Omega(n)$? Modify your algorithm accordingly. What is the worst-case complexity of the improved algorithm?
    c. Give examples for best-case and worst-case inputs.

3. Insertion sort
    a. What is the time complexity of a simple selection sort algorithm? Is there any difference between the best case and the worst case?
    b. How can we change the best-case complexity to $\Omega(n)$? Modify your algorithm accordingly. What is the worst-case complexity of the improved algorithm?
    c. Give examples for best-case and worst-case inputs.

4. Merge sort
5. Quick sort
6. Sort a set of strings using Radix sort

Write Recursive algorithms for the following problems. Implement your algorithm, write the recurrence relation, solve it, and find the asymptotic time complexity

7. Print the sum of the first N natural numbers.
8. Print the product of the first N natural numbers.
9. Print the N^{th} Fibonacci number.
10. Calculate x^y.
11. Print the first N natural numbers.
12. Print the first N natural numbers in reverse order.
13. Find the GCD(HCF) of two numbers.
14. Print the elements of an array.
15. Print the elements of an array in reverse order.
16. Reverse a given number.
17. Check if an array is sorted or not.
18. Write a recursive algorithm to find the median of median in O(n) time.
19. Write a recursive algorithm to find the k^{th} largest element.