Program Name: B.Sc.(H) Computer Science

Semester: 4th

Title of the Paper: Design and Analysis of Algorithms

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Q1: Write a code for heap sort with following details.

- Create a random input of different sizes (100, 200, 300, 400, 500, 700, 800, 1000, 2000, 3000, 4000, 5000, 7000, 8000, 10000, 15000, 20000)

- For every input and every situation, count the number of comparisons made in the insertion sort.

- Create an excel with input size and number of comparisons made for each of the situations. (paste the screenshot of excel file in pdf).

CODE

```
/* Given a set of positive integers and a sum value S, find out if there exists a su
bset in array whose sum is equal to given sum S using Dynamic Programming

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*/


#include <bits/stdc++.h>

using namespace std;


int count=0;


void generateRandomArray(int *array, int size)

{

    srand(time(nullptr));


    for(int index = 0; index < size; ++index)
```

```
        array[index] = (rand() % size) + 1;
}

void generateArrayAscendingOrder(int *array, int size)
{
    for(int index = 0; index < size; ++index)
        array[index] = index;
}

void generateArrayDescendingOrder(int *array, int size)
{
    int element = size;
    for(int index = 0; index < size; ++index)
        array[index] = element--;
}

void showArray(int *array, int size) {
    for(int index = 0; index < size; ++index)
        cout << array[index] << " ";

    cout << endl;
}

void maxHeapify(int *array, int n, int index) {
    int largest = index;
    int left = 2 * index + 1;
    int right= 2 * index + 2;

    if(left < n && array[left] > array[largest]) {
        ::count++;
        largest=left;
    }

    if(right < n && array[right] > array[largest]) {
        largest = right;
        ::count++;
    }
    if(largest != index) {
        swap(array[largest],array[index]);
        maxHeapify(array, n, largest);
    }
}

void heapsort(int *array, int n)
{
    for(int i = n / 2 - 1; i >= 0; i--)
        maxHeapify(array,n,i);

    for(int i = n - 1; i >= 0; i--) {
        swap(array[0],array[i]);
        maxHeapify(array,i,0);
    }
}

int main()
{
    char first_choice, second_choice;
    int size, *array;

    cout << "**** Case Scenario ****\n";
    cout << "1. Random Case\n";
    cout << "2. Best Case\n";
    cout << "3. Worst Case\n";
    cout << "Enter your choice: ";
    cin >> first_choice;

    do{

        cout << "Enter the size of array: ";
        cin >> size;

        array = new int[size];

        switch(first_choice)
        {
            case '1':
                generateRandomArray(array, size);
                heapsort(array, size);
                break;

            case '2':
                generateArrayAscendingOrder(array, size);
                heapsort(array, size);
                break;

            case '3':
                generateArrayDescendingOrder(array, size);
                heapsort(array, size);
                break;

            default:
                cout << "Wrong choice of option!!!\n";
        }

        cout << "\nNumber of comparisons: " << ::count;
        ::count = 0;

        cout << "\nDo you wish to continue? (Y/N): ";
        cin >> second_choice;

    } while(second_choice == 'y'|| second_choice == 'Y');

    delete[] array;

    return 0;
}
```

EXCEL SHEET

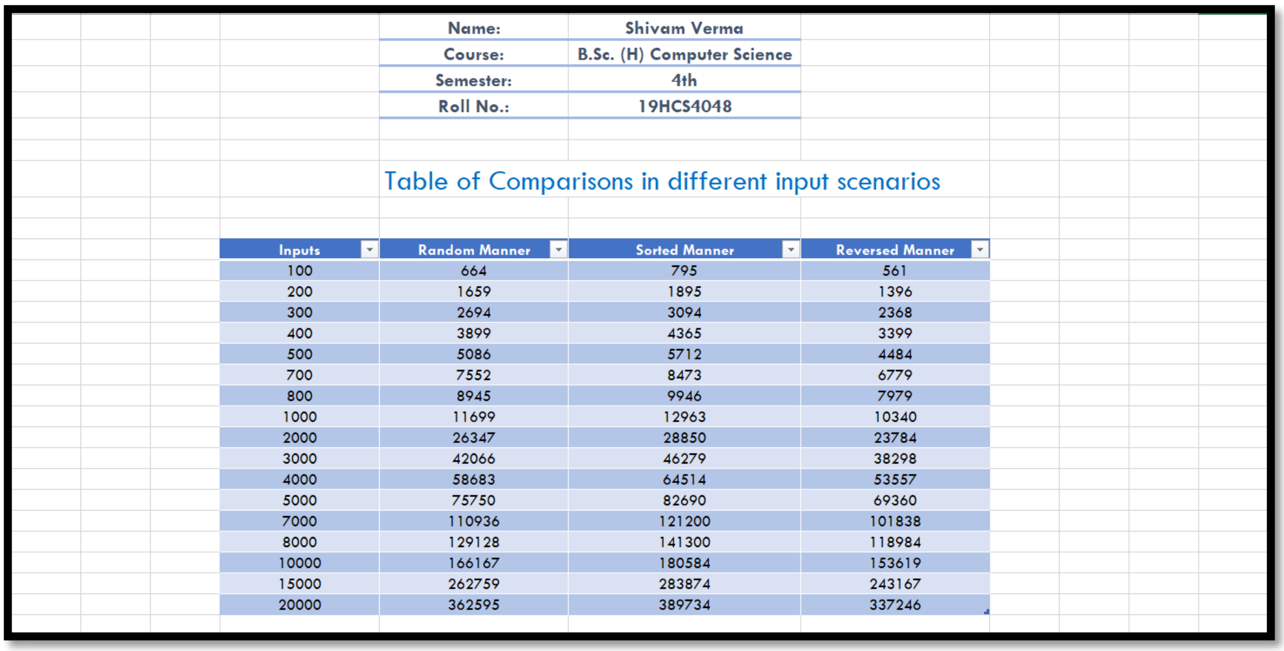

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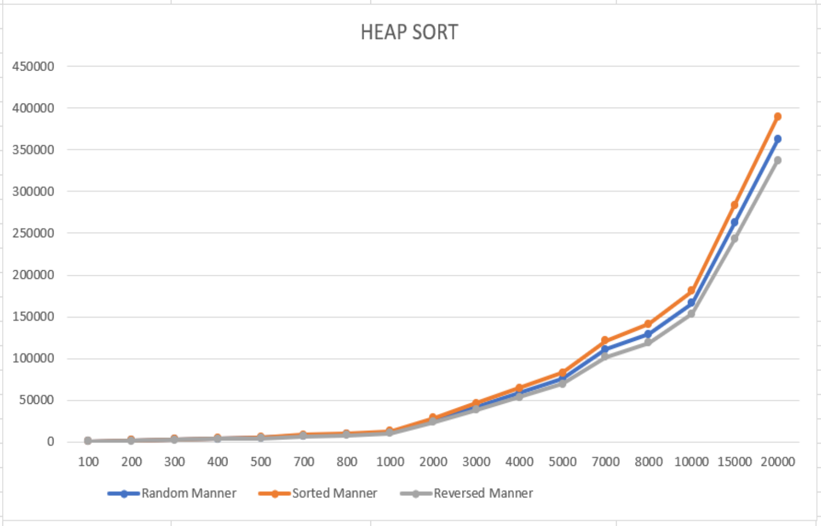
Table of Comparisons in different input scenarios

Inputs	Random Manner	Sorted Manner	Reversed Manner
100	664	795	561
200	1659	1895	1396
300	2694	3094	2368
400	3899	4365	3399
500	5086	5712	4484
700	7552	8473	6779
800	8945	9946	7979
1000	11699	12963	10340
2000	26347	28850	23784
3000	42066	46279	38298
4000	58683	64514	53557
5000	75750	82690	69360
7000	110936	121200	101838
8000	129128	141300	118984
10000	166167	180584	153619
15000	262759	283874	243167
20000	362595	389734	337246



Q2. Given a set of positive integers and a sum value S, find out if there exists a subset in array whose sum is equal to given sum S using Dynamic Programming.

<u>CODE</u>

```
/* Given a set of positive integers and a sum value S, find out if there exists a su
bset in array whose sum is equal to given sum S using Dynamic Programming.

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*/


#include <bits/stdc++.h>


using namespace std;


bool** dp;


void display(const vector<int>& v)

{

    for (int index = 0; index < v.size(); ++index)

        cout << v[index] << " ";


    cout << endl;

}


void printSubsets(int array[], int i, int sum, vector<int>& p)

{

    if (i == 0 && sum != 0 && dp[0][sum])

    {

        p.push_back(array[i]);
```
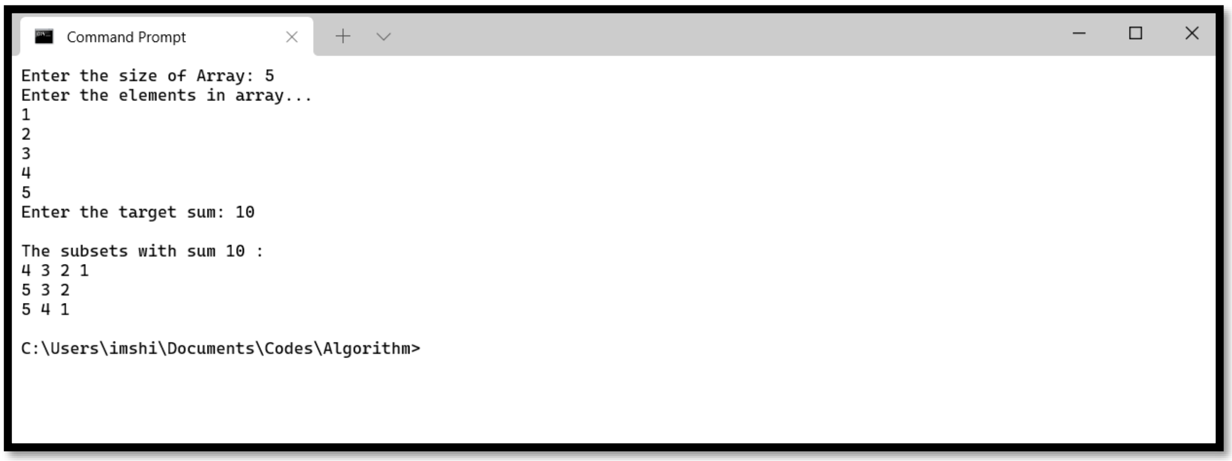

```
          if (array[i] == sum)
              display(p);
        return;
    }

    if (i == 0 && sum == 0)
    {
        display(p);
        return;
    }

    if (dp[i - 1][sum])
    {
        vector<int> b = p;
        printSubsets(array, i - 1, sum, b);
    }

    if (sum >= array[i] && dp[i - 1][sum - array[i]])
    {
        p.push_back(array[i]);
        printSubsets(array, i - 1, sum - array[i], p);
    }
}

void printAllSubsets(int arr[], int n, int sum)
{
    if (n == 0 || sum < 0)
       return;

    dp = new bool*[n];
    for (int i = 0; i < n; ++i)
    {
        dp[i] = new bool[sum + 1];
        dp[i][0] = true;
    }

    if (arr[0] <= sum)
       dp[0][arr[0]] = true;

    for (int i = 1; i < n; ++i)
        for (int j = 0; j < sum + 1; ++j)
            dp[i][j] = (arr[i] <= j) ? dp[i - 1][j] || dp[i - 1][j - arr[i]] : dp[i
- 1][j];

    if (dp[n - 1][sum] == false)
    {
        cout << "There are no subsets with sum " << sum;
        return;
    }

    vector<int> p;
    cout << "\nThe subsets with sum " << sum << " : \n";
    printSubsets(arr, n - 1, sum, p);
}

int main()
{
    int *array, size, sum = 0;

    system("cls");

    cout << "Enter the size of Array: ";
    cin >> size;
    array = new int[size];

    cout << "Enter the elements in array...\n";
    for(int index = 0; index < size; ++index)
        cin >> array[index];

    cout << "Enter the target sum: ";
    cin >> sum;

    printAllSubsets(array, size, sum);

    return 0;
}
```

<u>OUTPUT</u>



```
Enter the size of Array: 5
Enter the elements in array...
1
2
3
4
5
Enter the target sum: 10

The subsets with sum 10 :
4 3 2 1
5 3 2
5 4 1

C:\Users\imshi\Documents\Codes\Algorithm>
```