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LAB WORKS

1. Write iterative algorithm for the following problem, write program in C/C++. Also analyze their complexity.

a. Greatest Common Divisor (GCD)

Algorithm:

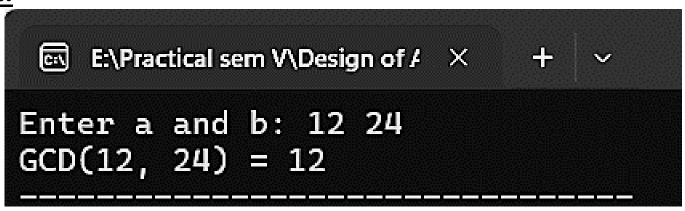
Step 1: Start
Step 2: Read any two numbers, say a and b
Step 3: If b == 0, return the value of a as the answer and terminate
Step 4: If a == 0, return the value of b as the answer and terminate
Step 5: Divide a by b and assign the value of the remainder to r
Step 6: Assign the value of b to a and the value of r to b, then go to step 3
Step 7: Stop.

Source Code:

```
#include<stdio.h>
void GCD(int a, int b) {
    if(a==0)
    printf("GCD(%d, %d) = %d",a, b, b);
    else if(b==0)
    printf("GCD(%d, %d) = %d",a, b, a);
    else{
            printf("GCD(%d, %d) = ",a, b);
            while(b!=0) {
                    int r=a%b;
                    a=b;
                    b=r;
            } printf("%d",a); } }

main() {
    int a, b;
    printf("Enter a and b: ");
    scanf("%d %d", &a, &b);
    GCD(a, b);
    return 0;
}
```

Output:



b. Fibonacci Number

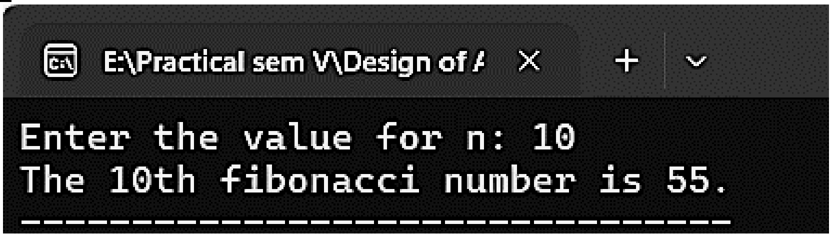
Algorithm:

Step 1: Start
Step 2: Set first = 0, second = 1
Step 3: Read term of Fibonacci number, say n
Step 4: Set I = 2
Step 5: While(i <= n)
5.1: Set temp = first + second
5.2: Set first = second
5.3: Set second = temp
5.4: Increment I by 1 as i++
Step 6: Print temp as required Fibonacci number
Step 7: Stop.

Source Code:

```
#include<stdio.h>
fibonacci(n) {
        int i, first=0, second=1, temp=1;
        for (i=2; i<=n; i++) {
                temp=first+second;
                first=second;
                second=temp;
        } return temp; }
main() {
        int n;
        printf("Enter the value for n: ");
        scanf("%d", &n);
        printf("The %dth fibonacci number is %d.", n, fibonacci(n));
        return 0;
}
```

Output:



c. Sequential Search

Algorithm:

Step 1: start
Step 2: Read the search element
Step 3: Compare the search element with the first element in the list
Step 4: If both are matching, then display “Given element found!!!” and terminate the program
Step 5: If both are not matching, then compare the search element with the next element in the list
Step 6: Repeat steps 4 and 5 until the search element is compared with the last element in the list
Step 7: If the last element in the list is also doesn’t match, then display “Element not found!!!” and terminate the program
Step 8: Stop.

Source Code:

```
#include<stdio.h>
int sequentialSearch(int E[], int n, int key) {
        int i;
        for (i=0; i<n; i++) {
                if (E[i]==key)
        return i; }
  return -1; }

int main() {
        int i, n, E[n], key;
        printf("Enter total number of elements: ");
        scanf("%d", &n);
        printf("Enter %d elements: ", n);
        for(i=0; i<n; i++)
                scanf("%d", &E[i]);
        printf("Enter the key to be searched: ");
        scanf("%d", &key);
        printf("The searched element '%d' is found at index '%d'.",key,  sequentialSearch(E, n, key));
        return 0;
}
```

Output:

```
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Enter total number of elements: 10
Enter 10 elements: 1 5 6 8 9 4 7 2 3 0
Enter the key to be searched: 7
The searched element '7' is found at index '6'.
--------------------------------
```

d. Bubble Sort

Algorithm:

Step 1: Start
Step 2: For the first iteration, compare all the elements n. For the subsequent runs, compare (n-1) (n-2) and so on
Step 3: Compare each element with its right side neighbor
Step 4: Swap the smallest element to the left
Step 5: Keep repeating steps 1-3 until the wholw list is covered
Step 6: Stop.

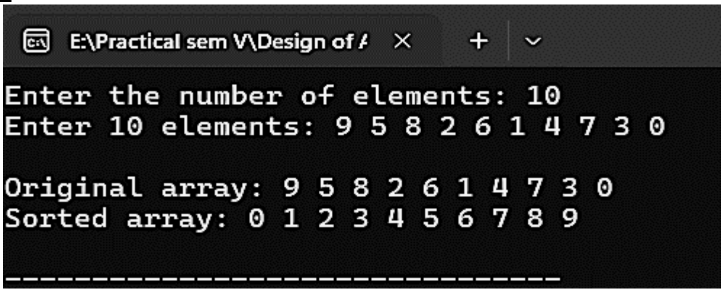
Source Code:

```
#include <stdio.h>
void bubble_sort(int arr[], int n) {
int i, j, temp;
for (i = 0; i < n - 1; i++) {
    for (j = 0; j < n - i - 1; j++) {
      if (arr[j] > arr[j + 1]) {
        temp = arr[j];
        arr[j] = arr[j + 1];
        arr[j + 1] = temp;
} }
} }

void print_array(int arr[], int n) {
  int i;
  for (i = 0; i < n; i++)
    printf("%d ", arr[i]);
  printf("\n");
}

int main()
{
  int i, n;
  printf("Enter the number of elements: ");
  scanf("%d", &n);
  int arr[n];
  printf("Enter %d elements: ", n);
  for (i = 0; i < n; i++)
    scanf("%d", &arr[i]);
  printf("\nOriginal array: ");
  print_array(arr, n);
  bubble_sort(arr, n);
  printf("Sorted array: ");
  print_array(arr, n);
  return 0;
}
```

Output:



e. Selection Sort

Algorithm:

Step 1: Start
Step 2: Consider the first element to be sorted and the rest to be unsorted
Step 3: Assume the first element to be the smallest element
Step 4: Check if the first element is smaller than each of the other elements:
  4.1: If yes, do nothing
  4.2: If no, choose the other smaller element as minimum and repeat step 3
Step 5: After completion of one iteration through the list, swap the smallest element with the first element of the list
Step 6: Now consider the second element in the list to be the smallest and so on till all the elements in the list are covered
Step 7: Stop.

Source Code:

```
#include <stdio.h>
void selection_sort(int arr[], int n) {
  int i, j, min_idx, temp;
  for (i = 0; i < n - 1; i++) {
    min_idx = i;
    for (j = i + 1; j < n; j++) {
      if (arr[j] < arr[min_idx]) min_idx = j;
    }
    temp = arr[min_idx];
    arr[min_idx] = arr[i];
    arr[i] = temp;
  } }
void print_array(int arr[], int n) {
  int i;
  for (i = 0; i < n; i++)
    printf("%d ", arr[i]);
  printf("\n");
}
int main() {
  int i, n;
  printf("Enter the number of elements: ");
  scanf("%d", &n);
  int arr[n];
  printf("Enter %d elements: ", n);
  for (i = 0; i < n; i++)
    scanf("%d", &arr[i]);
  printf("\nOriginal array: ");
  print_array(arr, n);
  selection_sort(arr, n);
  printf("Sorted array: ");
  print_array(arr, n);
  return 0;
}
```

Output:

```
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Enter the number of elements: 10
Enter 10 elements: 9 0 8 1 7 3 4 2 5 6

Original array: 9 0 8 1 7 3 4 2 5 6
Sorted array: 0 1 2 3 4 5 6 7 8 9

--------------------------------
```

f. Insertion Sort

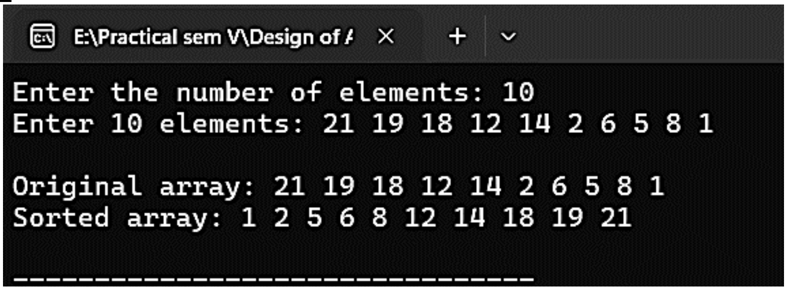
Algorithm:

Step 1: Start
Step 2: Consider the first element to be sorted and the rest to be unsorted
Step 3: Compare with the second element
  3.1: If the second element < the first element, insert the element in the correct position of the sorted portion
  3.2: Else, leave it as it's
Step 4: Repeat 2 and 3 until all elements are sorted
Step 5: Stop.

Source Code:

```c
#include <stdio.h>
void selection_sort(int arr[], int n) {
  int i, j, min_idx, temp;
  for (i = 0; i < n - 1; i++) {
    min_idx = i;
    for (j = i + 1; j < n; j++) {
      if (arr[j] < arr[min_idx])
        min_idx = j;
    }
    temp = arr[min_idx];
    arr[min_idx] = arr[i];
    arr[i] = temp;
  } }
void print_array(int arr[], int n) {
  int i;
  for (i = 0; i < n; i++)
    printf("%d ", arr[i]);
  printf("\n");
}
int main() {
  int i, n;
  printf("Enter the number of elements: ");
  scanf("%d", &n);
  int arr[n];
  printf("Enter %d elements: ", n);
  for (i = 0; i < n; i++)
    scanf("%d", &arr[i]);
  printf("\nOriginal array: ");
  print_array(arr, n);
  selection_sort(arr, n);
  printf("Sorted array: ");
  print_array(arr, n);
  return 0;
}
```

Output:



g. Min-Max Algorithm

Algorithm:

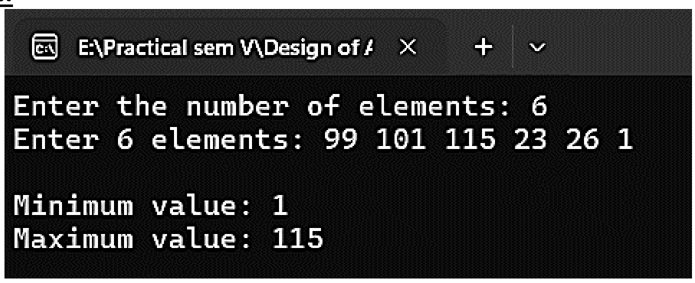
```
Max-Min-Element(numbers[])
Max = numbers[0]
Min = numbers[0]
For i = 1 to n do
        If numbers[i] > max then
                Max = numbers[i]
        If numbers[i] < min then
                Min = numbers[i]
Return(max, min)
```

Source Code:

```
#include <stdio.h>
void find_min_max(int arr[], int n, int *min, int *max) {
        int i;
  *min = *max = arr[0];
  for (i = 1; i < n; i++) {
    if (arr[i] < *min) {
      *min = arr[i];
    }
        else if (arr[i] > *max) {
      *max = arr[i];
    } } }

int main() {
  int i, n;
  printf("Enter the number of elements: ");
  scanf("%d", &n);
  int arr[n];
  printf("Enter %d elements: ", n);
  for (i = 0; i < n; i++)
    scanf("%d", &arr[i]);
  int min, max;
  find_min_max(arr, n, &min, &max);
  printf("\nMinimum value: %d\n", min);
  printf("Maximum value: %d\n", max);
  return 0;
}
```

Output:



	GCD	Fibonacci Numbers	Linear Search	Bubble Sort	Selection Sort	Insertion Sort	Min-Max Algorithm
Time Complexity	**O**(n)	**O**(n)	**O**(n)	**O**(n^2)	**O**(n^2)	**O**(n^2)	**O**(n)
Space Complexity	**O**(1)	**O**(1)	**O**(n)	**O**(1)	**O**(1)	**O**(1)	**O**(1)

2. Write algorithm and program to search an item in ordered list using binary search as divide and conquer Approach.

Algorithm:

Step 1: start
Step 2: Read the search element from the user
Step 3: Find the middle element in the sorted list
Step 4: Compare the search element with the middle element in the sorted list
Step 5: If both are matching, then display "Given element found!!!" and terminate the program
Step 6: If both are not matching, then check whether the search element is smaller or larger than the middle element
Step 7: If the search element is smaller than the middle element, then repeat 3, 4, 5 and 6 for the left sub-list of the middle element
Step 8: If the search element is larger than the middle element, then repeat 3, 4, 5 and 6 for the right sub-list of the middle element
Step 9: Repeat the same process until we find the search element in the list or until sub list contains only one element
Step 10: If that element also doesn't match with the search element, then display "Element not found!!!" and terminate the program
Step 11: Stop.

Source Code:

```
#include <stdio.h>
int binary_search(int arr[], int target, int low, int high) {
   if (low > high)
      return -1; // not found
   int mid = (low + high) / 2;
   if (arr[mid] == target) {
      return mid; // found
   }
         else if (arr[mid] < target) {
      return binary_search(arr, target, mid + 1, high);
   }
         else {
      return binary_search(arr, target, low, mid - 1);
} }
int main() {
   int n;
   printf("Enter the number of elements: ");
   scanf("%d", &n);
   int arr[n];
   printf("Enter %d elements in sorted order: ", n);
   for (int i = 0; i < n; i++)
      scanf("%d", &arr[i]);
   int target;
   printf("Enter the target element: ");
   scanf("%d", &target);
   int result = binary_search(arr, target, 0, n - 1);
   if (result != -1) {
      printf("The searched element '%d' is found at index '%d'.", target, result);
```

```
  }
          else {
    printf("Element not found!!!\n");
  }
  return 0;
}
```

Output:

```
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Enter the number of elements: 10
Enter 10 elements in sorted order: 21 23 25 29 35 46 58 68 78 79
Enter the target element: 78
The searched element '78' is found at index '8'.
--------------------------------
```

3. Write algorithm and program to find the maximum and minimum element in a list of numbers using divide and conquer approach.

Algorithm:

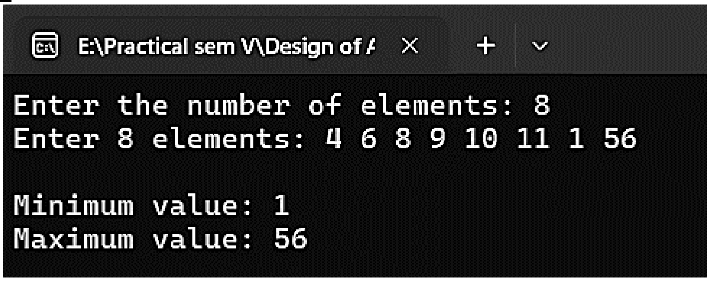
```
Max - Min(x, y)
if y – x ≤ 1 then
        return (max(numbers[x],numbers[y]),min((numbers[x],numbers[y]))
else
        (max1, min1):= maxmin(x, ⌊((x + y)/2)⌋)
        (max2, min2):= maxmin(⌊((x + y)/2) + 1)⌋,y)
return (max(max1, max2), min(min1, min2))
```

Source Code:

```c
#include <stdio.h>
void find_min_max(int arr[], int low, int high, int *min, int *max) {
  if (low == high) {
    *min = *max = arr[low];
  }
      else if (low + 1 == high) {
    if (arr[low] < arr[high]) {
      *min = arr[low];
      *max = arr[high];
    }
      else {
      *min = arr[high];
      *max = arr[low];
    }
  }
      else {
    int mid = (low + high) / 2;
    int min1, max1, min2, max2;
    find_min_max(arr, low, mid, &min1, &max1);
    find_min_max(arr, mid + 1, high, &min2, &max2);
    *min = (min1 < min2) ? min1 : min2;
    *max = (max1 > max2) ? max1 : max2;
  }
}
int main() {
  int i, n;
  printf("Enter the number of elements: ");
  scanf("%d", &n);
  int arr[n];
  printf("Enter %d elements: ", n);
```

```
    for (i = 0; i < n; i++)
        scanf("%d", &arr[i]);
    int min, max;
    find_min_max(arr, 0, n - 1, &min, &max);
    printf("\nMinimum value: %d\n", min);
    printf("Maximum value: %d\n", max);
    return 0;
}
```

Output:



4. Write algorithms and program using divide and conquer approach for following sorting algorithms

a. Heap Sort

Algorithms:

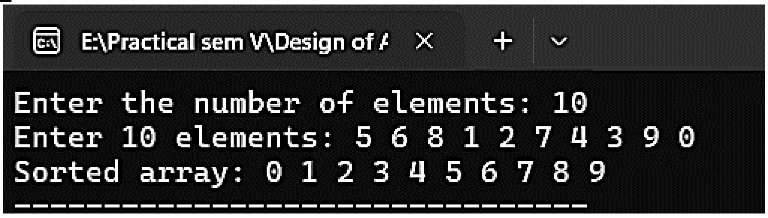
```
HeapSort(A){
        BuildHeap(A);
    N = length[A];
    For(i = n; i >= 2; i--){
        Swap(A[1], A[n]);
                n = n-1;
                Heapify(A, 1);
        }
}
```

Source Code:

```
#include <stdio.h>
void heapify(int arr[], int n, int i) {
    int largest = i;
    int left = 2 * i + 1;
    int right = 2 * i + 2;
    if (left < n && arr[left] > arr[largest])
        largest = left;
    if (right < n && arr[right] > arr[largest])
        largest = right;
    if (largest!= i) {
        int temp = arr[i];
        arr[i] = arr[largest];
        arr[largest] = temp;
        heapify(arr, n, largest);
    }
}
void heapSort(int arr[], int n) {
        int i;
    for (i = n / 2 - 1; i >= 0; i--)
        heapify(arr, n, i);
    for (i = n - 1; i >= 0; i--) {
        int temp = arr[0];
        arr[0] = arr[i];
        arr[i] = temp;
```

```
        heapify(arr, i, 0);
    } }
int main() {
    int i, n;
    printf("Enter the number of elements: ");
    scanf("%d", &n);
    int arr[n];
    printf("Enter %d elements: ", n);
    for (i = 0; i < n; i++)
        scanf("%d", &arr[i]);
    heapSort(arr, n);
    printf("Sorted array: ");
    for (i = 0; i < n; i++)
        printf("%d ", arr[i]);
    return 0;
}
```

Output:



b. Quick Sort

Algorithm:

Step 1: Start
Step 2: Choose a pivot
Step 3: Set a left pointer and right pointer
Step 4: Compare the left pointer element (lelement) with the pivot and the right pointer element (relement) with the pivot
Step 5: Check if lelement < pivot and relement > pivot:
    5.1: If yes, increment the left pointer and decrement the right pointer
    5.2: If not, swap the lelement and relement
Step 6: When left >= right, swap the pivot with either left or right pointer
Step 7: Repeat steps 2-5 on the left half and the right half of the list till the entire list is sorted
Step 8: Stop.

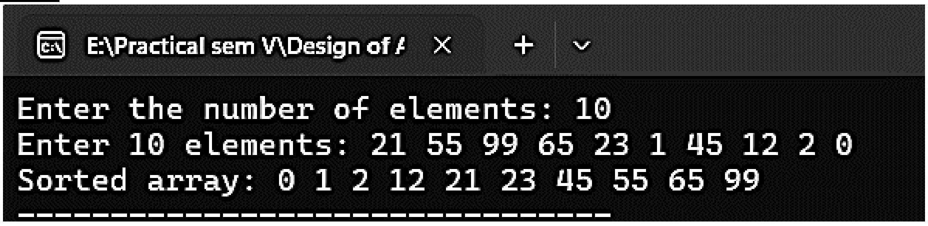
Source Code:

```
#include <stdio.h>
int partition(int arr[], int low, int high) {
    int pivot = arr[high];
    int j, i = low - 1;
    for (j = low; j < high; j++) {
        if (arr[j] < pivot) {
            i++;
            int temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
        } }
    int temp = arr[i + 1];
    arr[i + 1] = arr[high];
    arr[high] = temp;
    return i + 1;
}
void quickSort(int arr[], int low, int high) {
    if (low < high) {
```

```
      int pivot = partition(arr, low, high);
      quickSort(arr, low, pivot - 1);
      quickSort(arr, pivot + 1, high);
    } }

int main() {
    int i, n;
    printf("Enter the number of elements: ");
    scanf("%d", &n);
    int arr[n];
    printf("Enter %d elements: ", n);
    for (i = 0; i < n; i++)
        scanf("%d", &arr[i]);
    quickSort(arr, 0, n - 1);
    printf("Sorted array: ");
    for (i = 0; i < n; i++)
        printf("%d ", arr[i]);
    return 0;
}
```

Output:



c. Randomized quick Sort

Algorithm:

```
int partition_left(int arr[], int low, int high) {
        int pivot = arr[high];
        int i = low; // Place for swapping
        for (int j = low; j < high; j++) {
                if (arr[j] <= pivot) {
                swap(&arr[i], &arr[j]);
                i++;
                }
        }
        swap(&arr[i], &arr[high]);
        return i; }
int partition_right(int arr[], int low, int high) {
        int r = RandomNumber(low, high); // Randomly choose pivot index
        swap(&arr[r], &arr[high]);
        return partition_left(arr, low, high); }
void quicksort(int arr[], int low, int high) {
        if (low < high) {
        int pivot = partition_right(arr, low, high);
        quicksort(arr, low, pivot - 1);
        quicksort(arr, pivot + 1, high);
        }
}
```

Source Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
```

```c
void swap(int* a, int* b) {
   int temp = *a;
   *a = *b;
   *b = temp;
}
// Function to partition the array
int partition(int arr[], int low, int high) {
   // Choose a random pivot index
   int pivot_index = low + rand() % (high - low + 1);
   int pivot = arr[pivot_index];
   // Move the pivot element to the end of the array
   swap(&arr[pivot_index], &arr[high]);
   int i = low - 1, j;
   for (j = low; j < high; j++) {
      if (arr[j] < pivot) {
         i++;
         swap(&arr[i], &arr[j]);
      }
   }
   // Move the pivot element to its final sorted position
   swap(&arr[i + 1], &arr[high]);
   return i + 1;
}
// Function to perform randomized quick sort
void randomized_quick_sort(int arr[], int low, int high) {
   if (low < high) {
      int pivot = partition(arr, low, high);
      // Recursively sort the two sub-arrays
      randomized_quick_sort(arr, low, pivot - 1);
      randomized_quick_sort(arr, pivot + 1, high);
   }
}
// Function to print the array
void print_array(int arr[], int size) {
            int i;
   for (i = 0; i < size; i++)
      printf("%d ", arr[i]);
   printf("\n");
}
int main() {
   int i, size;
   printf("Enter the size of the array: ");
   scanf("%d", &size);
   int* arr = (int*)malloc(size * sizeof(int));
   printf("Enter the elements of the array: ");
   for (i = 0; i < size; i++)
      scanf("%d", &arr[i]);
   // Seed the random number generator
   srand(time(NULL));
   printf("\nOriginal array: ");
   print_array(arr, size);
   randomized_quick_sort(arr, 0, size - 1);
   printf("Sorted array: ");
   print_array(arr, size);
   free(arr);
   return 0;
}
```

Output:

```
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Enter the size of the array: 10
Enter the elements of the array: 85 76 23 54 45 36 61 2 1 6

Original array: 85 76 23 54 45 36 61 2 1 6
Sorted array: 1 2 6 23 36 45 54 61 76 85
```

d. Merge Sort

Algorithm:

Step 1: Start
Step 2: Split the unsorted list into two groups recursively until there is one element per group
Step 3: Compare each of the elements and then sort and group them
Step 4: Repeat step 2 until the whole list is merged and sorted in the process
Step 5: Stop.

Source Code:

```
#include <stdio.h>
// Function to merge two sub-arrays
void merge(int arr[], int left, int mid, int right) {
   int i, j, k;
   int n1 = mid - left + 1;
   int n2 = right - mid;
   // Create temporary arrays
   int left_arr[n1], right_arr[n2];
   // Copy data to temporary arrays
   for (i = 0; i < n1; i++)
      left_arr[i] = arr[left + i];
   for (j = 0; j < n2; j++)
      right_arr[j] = arr[mid + 1 + j];
   // Merge the temporary arrays
   i = 0;
   j = 0;
   k = left;
   while (i < n1 && j < n2) {
      if (left_arr[i] <= right_arr[j]) {
         arr[k] = left_arr[i];
         i++;
      }
else{
         arr[k] = right_arr[j];
         j++;
      }
      k++;
   }
   // Copy the remaining elements of left_arr[], if there are any
   while (i < n1) {
      arr[k] = left_arr[i];
      i++;
      k++;
   }
   // Copy the remaining elements of right_arr[], if there are any
   while (j < n2) {
      arr[k] = right_arr[j];
      j++;
      k++;
   }
```

```
}
// Function to perform merge sort
void merge_sort(int arr[], int left, int right) {
  if (left < right) {
    int mid = left + (right - left) / 2;
    // Recursively sort the two halves
    merge_sort(arr, left, mid);
    merge_sort(arr, mid + 1, right);
    // Merge the two sorted halves
    merge(arr, left, mid, right);
  }
}
// Function to print the array
void print_array(int arr[], int size){
       int i;
  for (i = 0; i < size; i++)
    printf("%d ", arr[i]);
  printf("\n");
}
int main() {
  int i, size;
  printf("Enter the size of the array: ");
  scanf("%d", &size);
  int arr[size];
  printf("Enter the elements of the array: ");
  for (i = 0; i < size; i++)
    scanf("%d", &arr[i]);
  printf("\nOriginal array: ");
  print_array(arr, size);
  merge_sort(arr, 0, size - 1);
  printf("Sorted array: ");
  print_array(arr, size);
  return 0;
}
```

Output:

```
E:\Practical sem V\Design of /

Enter the size of the array: 15
Enter the elements of the array: 212 11 5 63 512 983 654 223 75 15 65 0 9 1452 1212

Original array: 212 11 5 63 512 983 654 223 75 15 65 0 9 1452 1212
Sorted array: 0 5 9 11 15 63 65 75 212 223 512 654 983 1212 1452
```

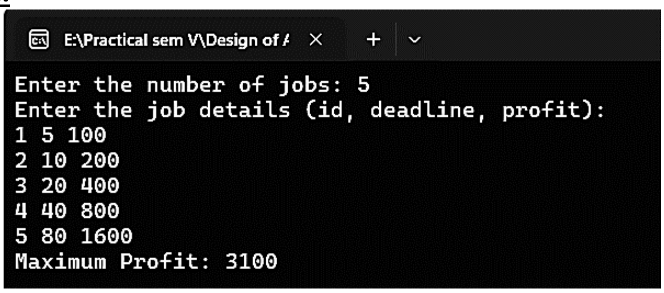
5. Write a program to implement problem Job Sequencing with deadline using greedy algorithm

Source Code:

```
#include <stdio.h>
// Structure to represent a job
typedef struct {
  int id;
  int deadline;
  int profit;
}Job;
// Function to compare two jobs based on their profits
int compare(const void *a, const void *b) {
  Job *job1 = (Job *)a;
  Job *job2 = (Job *)b;
  return job2->profit - job1->profit;
```

```
}
// Function to find the maximum profit
void jobSequencing(Job jobs[], int n) {
        int i, j;
  // Sort the jobs based on their profits
  qsort(jobs, n, sizeof(Job), compare);
  // Create a boolean array to track the deadlines
  int deadlines[10] = {0};
  // Initialize the maximum profit
  int maxProfit = 0;
  // Iterate through the sorted jobs
  for (i = 0; i < n; i++) {
    // Find a deadline that can accommodate the current job
    for (j = jobs[i].deadline; j >= 1; j--) {
      if (!deadlines[j]) {
        deadlines[j] = 1;
        maxProfit += jobs[i].profit;
        break;
      } } }
  printf("Maximum Profit: %d\n", maxProfit);
}
int main() {
  int i, n;
  printf("Enter the number of jobs: ");
  scanf("%d", &n);
  Job jobs[n];
  printf("Enter the job details (id, deadline, profit):\n");
  for (i = 0; i < n; i++)
    scanf("%d %d %d", &jobs[i].id, &jobs[i].deadline, &jobs[i].profit);
  jobSequencing(jobs, n);
  return 0;
}
```

Output:



6. Implement the Floyd- Warshall's algorithm to compute all pair shortest path problem using dynamic programming approach.

Source Code:

```
#include <iostream>
#include <climits>
int main() {
  int V;
  std::cout << "Enter the number of vertices: ";
  std::cin >> V;
  int graph[V][V];
  std::cout << "Enter the adjacency matrix:" << std::endl;
  for (int i = 0; i < V; i++) {
    for (int j = 0; j < V; j++) {
      std::cin >> graph[i][j];
```

```
          if (graph[i][j] == 0 && i != j) {
            graph[i][j] = INT_MAX;
          } } }
    std::cout << "\nOriginal graph:" << std::endl;
    for (int i = 0; i < V; i++) {
      for (int j = 0; j < V; j++) {
        std::cout << graph[i][j] << " ";
      }
      std::cout << std::endl;
    }
    for (int k = 0; k < V; k++) {
      for (int i = 0; i < V; i++) {
        for (int j = 0; j < V; j++) {
          if (graph[i][k] + graph[k][j] < graph[i][j])
            graph[i][j] = graph[i][k] + graph[k][j];
        } } }
    std::cout << "\nShortest distances between all pairs of vertices:" << std::endl;
    for (int i = 0; i < V; i++) {
      for (int j = 0; j < V; j++) {
        std::cout << graph[i][j] << " ";
      }
      std::cout << std::endl;
    }
    return 0;
}
```

Output:

```
D:\Practical sem V\Design of

Enter the number of vertices: 3
Enter the adjacency matrix:
0 4 11
6 0 2
3 10000000000000000000 0

Original graph:
0 4 11
6 0 2
3 2147483647 0

Shortest distances between all pairs of vertices:
0 4 6
5 0 2
3 7 0
```

7. Write a program to implement Matrix Chain Multiplication using dynamic programming algorithm.

Source Code:

```
#include <stdio.h>
#include <limits.h>
int MatrixChainOrder(int p[], int n) {
  int m[100][100];
  int i, j, k, L, q;
  for (i = 1; i <= n; i++)
    m[i][i] = 0;
        for (L = 2; L < n; L++) {
    for (i = 1; i < n - L + 1; i++) {
      j = i + L - 1;
      m[i][j] = INT_MAX;
      for (k = i; k <= j - 1; k++) {
```

```
            q = m[i][k] + m[k + 1][j] + p[i - 1] * p[k] * p[j];
            if (q < m[i][j])
                m[i][j] = q;
        } } }
    return m[1][n - 1];
}
int main() {
    int i, n;
    printf("Enter the number of matrices: ");
    scanf("%d", &n);
    int p[n + 1];
    printf("Enter the dimensions of the matrices:\n");
    for (i = 0; i <= n; i++) {
        scanf("%d", &p[i]);
    }
    printf("\nThe optimal multiplication cost is %d.", MatrixChainOrder(p, n + 1));
    return 0;
}
```

Output: