VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT on

ANALYSIS AND DESIGN OF ALGORITHMS

Submitted by

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in partial fulfillment for the award of the degree of

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(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**ANALYSIS AND DESIGN OF ALGORITHMS(23CS4PCADA)**" carried out by **Harbakhshish Singh (1BM23CS104) ,** who is a bonafide student of **B. M. S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2025. The Lab report has been approved as it satisfies the academic requirements in respect of **ANALYSIS AND DESIGN OF ALGORITHMS(23CS4PCADA)** work prescribed for the said degree.

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Course Outcome

CO1	Analyze time complexity of recursive and non-recursive algorithms using asymptotic notations
CO2	Apply various algorithm design techniques for the given problem
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms and conduct practical experiments to solve problems.

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LAB-1

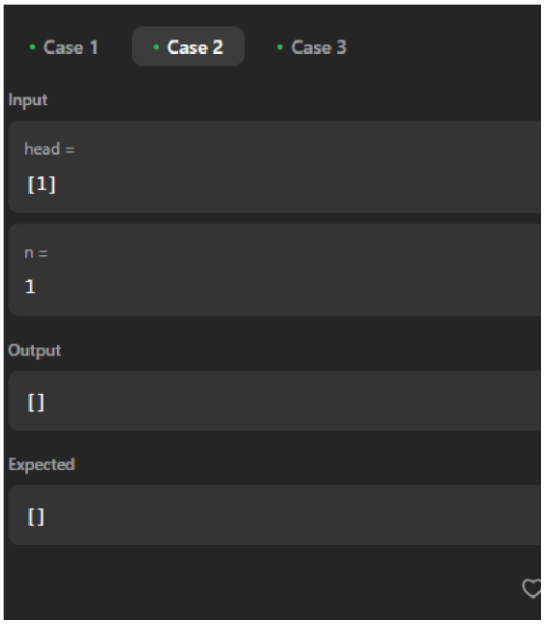
Question- 1:

LeetCode Problem - Remove Nth Node from end of a List **Code:**

```
    struct ListNode* removeNthFromEnd(struct ListNode*
head, int n) {     struct ListNode* temp1=(head);
struct ListNode* temp2=(head);
          for (int
i=0;i<n;i++){
temp1=temp1->next;
    }     if (head-
>next==NULL){
return NULL;
    }
if(temp1==NULL){
head=head->next;
return head;


    }
```

```
            while(temp1-
>next!=NULL){
temp1=temp1->next;
temp2=temp2->next;
    }      temp2->next=temp2->next-
>next;      return head;


}
```

Result:



Question -2:

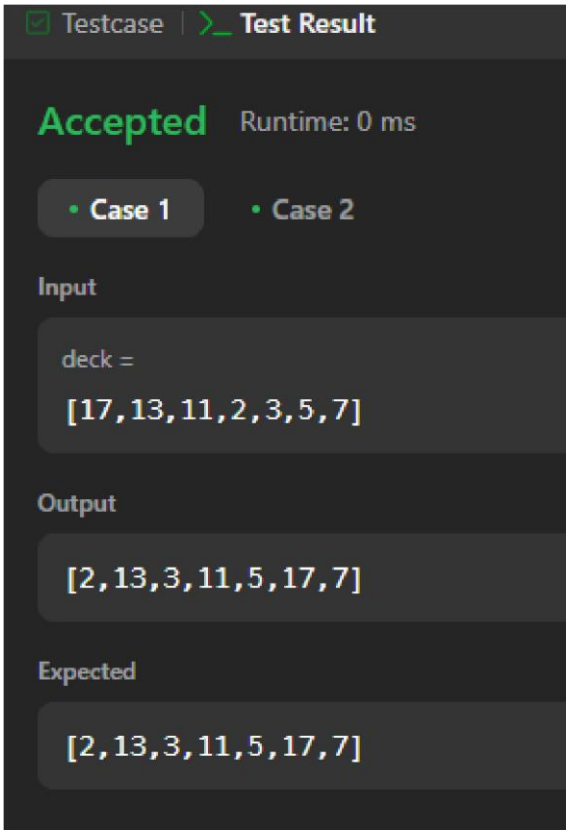
LeetCode Problem- Reveal Cards in Increasing Order

CODE:

```
int cmp(const void *a , const void *b )
{
    return *(int*)a - *(int*)b;
}



void PushBack(int deck[static 1] , int size , int currFull)
{
    //Swap      int end =
deck[size-1];     deck[size-
currFull-1] = end;

    //PushBack
    for(int i= size-1 ; i>=(size-currFull); i--)
    {
        deck[i] = deck[i-1];
    }
}



int*
deckRevealedIncreasing(
        int deck[static 1],          int
deckSize,          int* returnSize //
Reference
    )
{
    int *res = malloc(sizeof(int) * deckSize);
```

```
    *returnSize = deckSize;

    qsort(deck,deckSize , sizeof(int) , cmp);

    res[deckSize-1] = deck[deckSize-1];
    int currFull = 1;

    for(int i = deckSize - 2 ; i>= 0 ; --i )
    {
        PushBack(res,deckSize,currFull);
        currFull++;         res[deckSize-
currFull] = deck[i];
    }
    return res;

}
```

OUTPUT:



Question 3:

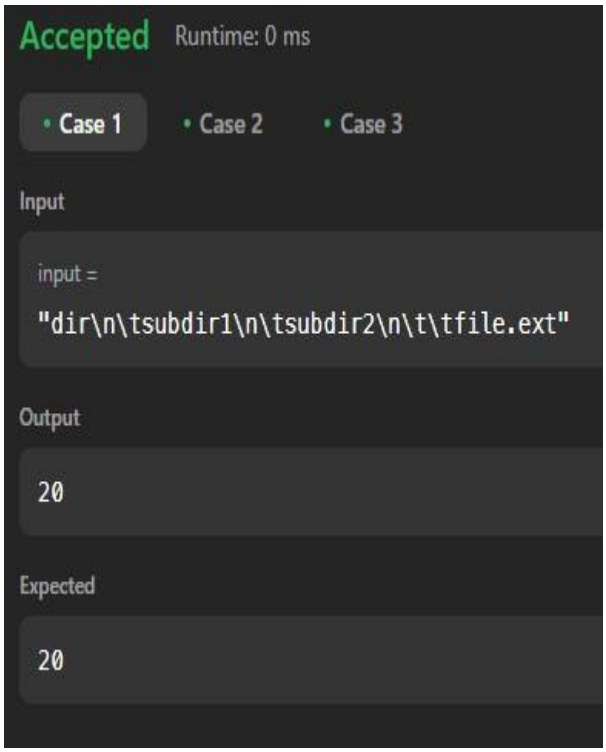
LeetCode Problem: Longest Absolute File Path

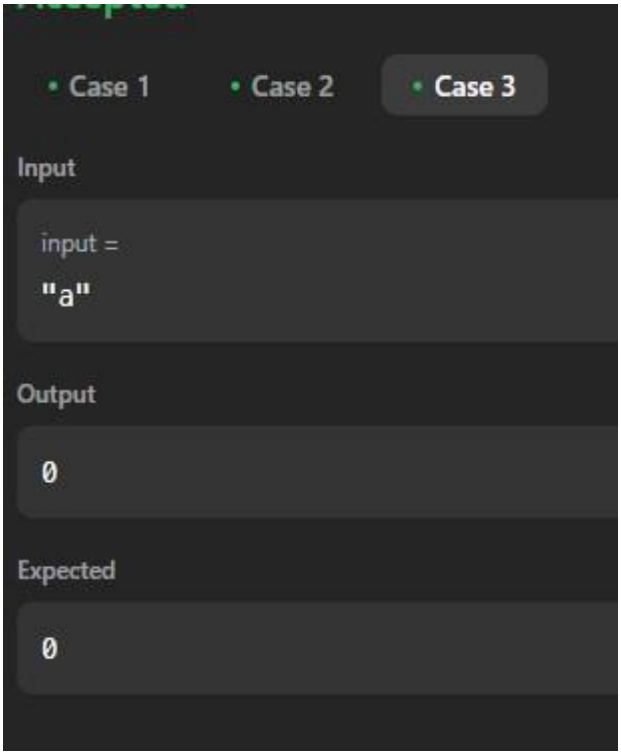
Code:

```
int lengthLongestPath(char *input) {
char *token;     int len[100] = {0};
int ans = 0;


   token = strtok(input, "\n");
while (token != NULL) {
```

```
        int l = 0;         while
(token[l] == '\t') {
            l++;
        }

        len[l] = strlen(token) - l;

        if (strchr(token, '.')) {
int totalLength = 0;             for
(int i = 0; i <= l; i++) {
totalLength += len[i];
            }
            ans = (ans > totalLength + l) ? ans : totalLength + l;
        }

        token = strtok(NULL, "\n");
    }

    return ans;
}
```

Output:





LAB 2

QUESTION 1:

Write a program to obtain the Topological ordering of vertices in a given digraph.

CODE:

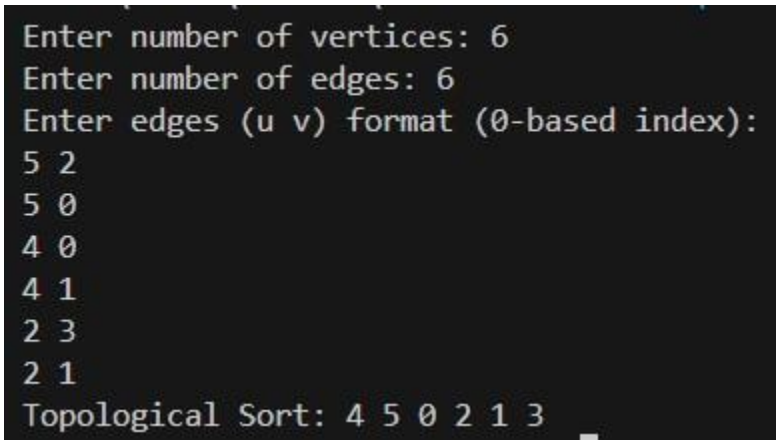
```
#include <stdio.h>
#include <stdlib.h>

#define MAX_VERTICES 100

typedef struct Graph {
    int vertices;
```

```
    int adj[MAX_VERTICES][MAX_VERTICES];
int in_degree[MAX_VERTICES];
} Graph;

void initGraph(Graph *g, int vertices) {
g->vertices = vertices;     for (int i = 0;
i < vertices; i++) {         g-
>in_degree[i] = 0;         for (int j = 0; j
< vertices; j++) {             g->adj[i][j] =
0;
        }
    }
}

void addEdge(Graph *g, int u, int v) {
g->adj[u][v] = 1;     g->in_degree[v]++;
}

void topologicalSort(Graph *g) {     int
queue[MAX_VERTICES], front = 0, rear = 0;     int
topOrder[MAX_VERTICES];
    int index = 0;

    for (int i = 0; i < g->vertices; i++) {
if (g->in_degree[i] == 0) {
queue[rear++] = i;
        }
    }
```

```
    while (front < rear) {
int u = queue[front++];
topOrder[index++] = u;

        for (int v = 0; v < g->vertices; v++) {
if (g->adj[u][v] == 1) {                g-
>in_degree[v]--;                if (g-
>in_degree[v] == 0) {
queue[rear++] = v;
                }
            }
        }
    }

    if (index != g->vertices) {         printf("Graph contains a cycle,
topological sorting is not possible.\n");
        return;
    }

    printf("Topological Sort: ");     for
(int i = 0; i < g->vertices; i++) {
printf("%d ", topOrder[i]);

    }
    printf("\n");
}
```

```
int main() {     Graph g;
int vertices, edges, u, v;

    printf("Enter number of vertices: ");
scanf("%d", &vertices);     initGraph(&g,
vertices);

    printf("Enter number of edges: ");
scanf("%d", &edges);

    printf("Enter edges (u v) format (0-based index):\n");
    for (int i = 0; i < edges; i++) {
scanf("%d %d", &u, &v);
addEdge(&g, u, v);
    }

    topologicalSort(&g);

    return 0;
}
```

OUTPUT:



QUESTION 2:

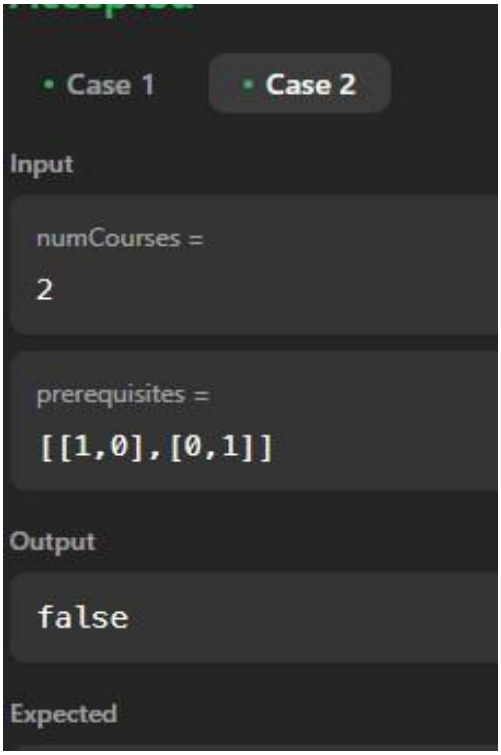
LeetCode Problem: Course Scheduling

CODE:

```
#define MAX (13)

bool Cycle( int id, int coursemap[][MAX], int cpr[], int *visited ) {

   if ( visited[id] > 0 )
return true;



   if ( visited[id] == 0 ) {         visited[id] = 1;         for ( int i=0;
i<cpr[id]; i++ ) {             if ( Cycle( coursemap[id][i],
coursemap, cpr, visited ) ) {
               return true;
          }
}
       visited[id] = -1;
   }
```

```
    return false;
}

bool canFinish(int numCourses, int** prerequisites, int prerequisitesSize, int*
prerequisitesColSize){     int coursemap[2001][MAX];
    int cpr[2001]     = { 0 };
int visited[2001] = { 0 };



    for ( int i=0; i<prerequisitesSize; i++ ) {
int course = prerequisites[i][0];         int
prereq = prerequisites[i][1];

        coursemap[course][cpr[course]++] = prereq;
    }

    for ( int i=0; i<numCourses; i++ ) {

        if ( Cycle( i, coursemap, cpr, visited ) ) {
return false;
        }
    }

    return true;
}
```

OUTPUT:



LAB 3

QUESTION 1:

Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

CODE:

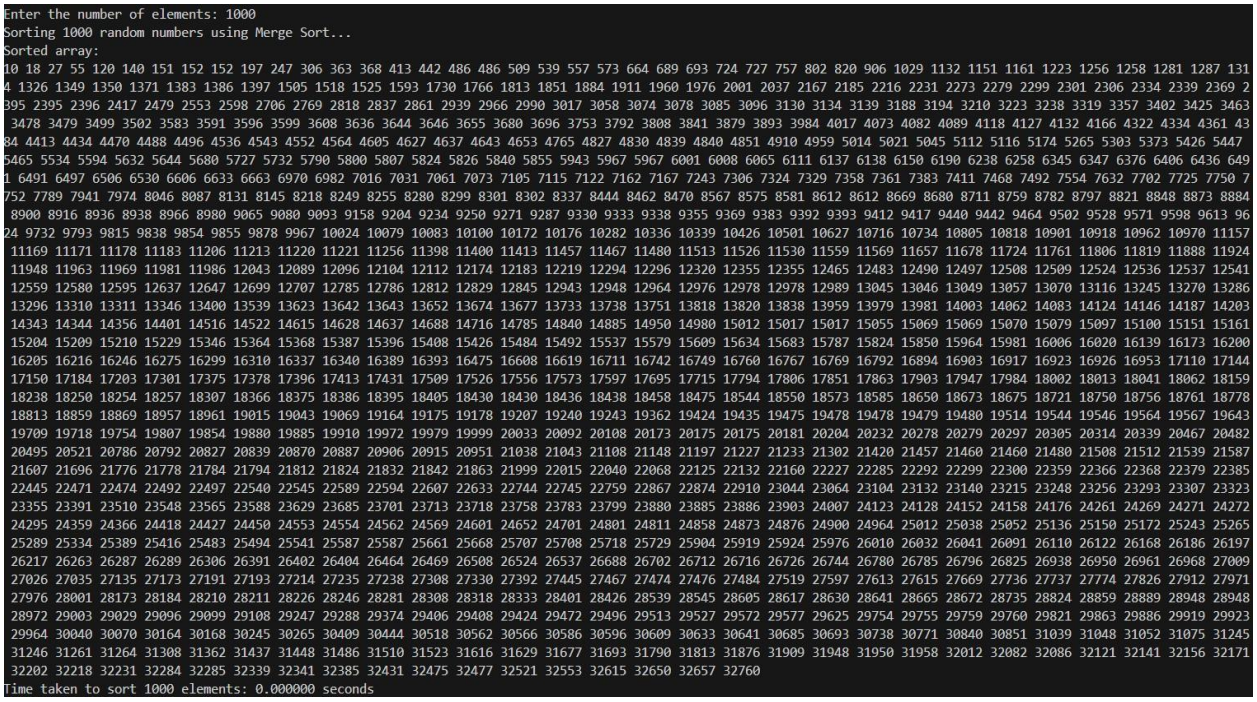
```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>


void merge(int arr[], int left, int mid, int right) {

int n1 = mid - left + 1;      int n2 = right - mid;

int L[n1], R[n2];
```

```
    for (int i = 0; i < n1; i++)
L[i] = arr[left + i];     for (int
j = 0; j < n2; j++)
        R[j] = arr[mid + 1 + j];

    int i = 0, j = 0, k = left;
    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
arr[k] = L[i];
i++;         } else {
arr[k] = R[j];
j++;         }
        k++;
    }

    while (i < n1) {
arr[k] = L[i];         i++;
        k++;
    }

    while (j < n2) {
arr[k] = R[j];
j++;         k++;
    }
}

void mergeSort(int arr[], int left, int right) {
```

```
    if (left < right) {         int mid =
left + (right - left) / 2;
mergeSort(arr, left, mid);
mergeSort(arr, mid + 1, right);
merge(arr, left, mid, right);
    }
}

int main() {
    int n;

    printf("Enter the number of elements: ");
scanf("%d", &n);

    int arr[n];
    srand(time(0));

    for (int i = 0; i < n; i++) {
        arr[i] = rand() % 100000;  // Random integers between 0 and 99999
    }

    printf("Running Merge Sort for N = %d...\n", n);

    clock_t start = clock();
mergeSort(arr, 0, n - 1);     clock_t
end = clock();
```

```
    double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
printf("Time taken to sort N = %d elements: %f seconds\n", n, time_taken);


    return 0;
}
```

OUTPUT:



QUESTION 2:

Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

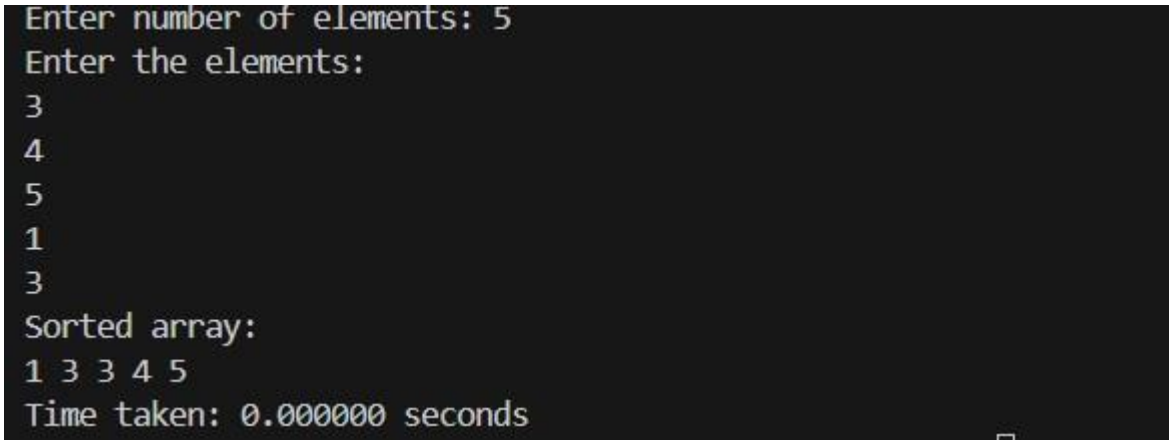
CODE:

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>
```

```
void swap(int *a, int *b) {
    int t = *a;
*a = *b;
    *b = t;
}

int partition(int arr[], int low, int high) {
int pivot = arr[high];     int i = low - 1;
for (int j = low; j < high; j++) {         if
(arr[j] < pivot) {             i++;
            swap(&arr[i], &arr[j]);
        }
    }
    swap(&arr[i + 1], &arr[high]);
return i + 1;
}

void quickSort(int arr[], int low, int high) {
if (low < high) {         int pi = partition(arr,
low, high);         quickSort(arr, low, pi -
1);         quickSort(arr, pi + 1, high);
    }
}

int main() {
    int n;
    printf("Enter number of elements: ");
scanf("%d", &n);     int *arr = (int
```

```
*)malloc(n * sizeof(int)); printf("Enter
the elements:\n");
    for (int i = 0; i < n; i++) {
scanf("%d", &arr[i]);
    }

    clock_t start = clock();
quickSort(arr, 0, n - 1);     clock_t
end = clock();

    double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

    printf("Sorted array:\n");
for (int i = 0; i < n; i++) {
printf("%d ", arr[i]);
    }
    printf("\nTime taken: %f seconds\n", time_taken);

    free(arr);
return 0;
}
```

OUTPUT:



QUESTION 3:

LeetCode Problem : 3Sum

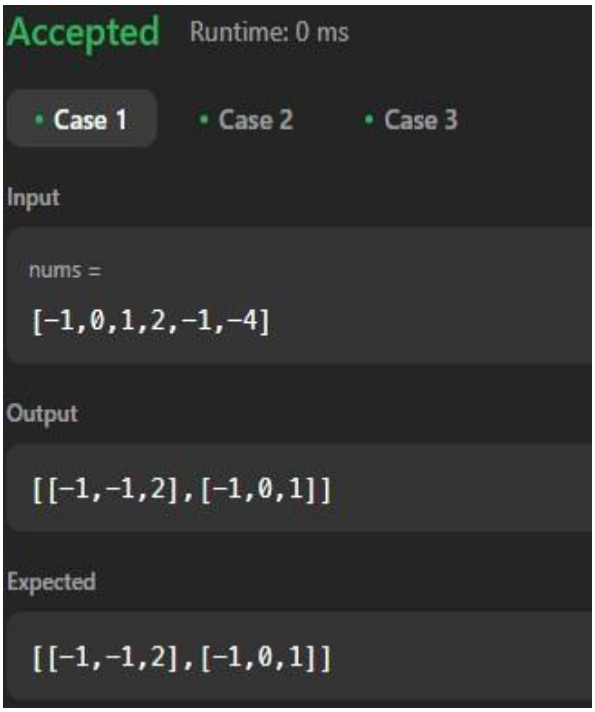
Given an integer array nums, return all the triplets [nums[i], nums[j], nums[k]] such that i != j, i != k, and j != k, and nums[i] + nums[j] + nums[k] == 0.

CODE:

```
int compare(const void *a, const void *b) {
    return (*(int*)a - *(int*)b);
}


int** threeSum(int* nums, int numsSize, int* returnSize, int** returnColumnSizes)
{
    if (numsSize < 3) {
*returnSize = 0;        return
NULL;
    }
    qsort(nums, numsSize, sizeof(int), compare);     int** result =
(int**)malloc(sizeof(int*) * numsSize * numsSize);
    *returnColumnSizes = (int*)malloc(sizeof(int) * numsSize * numsSize);
*returnSize = 0;
```

```
    for (int i = 0; i < numsSize - 2; i++) {         if (i
> 0 && nums[i] == nums[i - 1]) continue;         int
left = i + 1, right = numsSize - 1;         while (left
< right) {
            int sum = nums[i] + nums[left] + nums[right];
            if (sum == 0) {                 result[*returnSize] =
(int*)malloc(sizeof(int) * 3);
result[*returnSize][0] = nums[i];
result[*returnSize][1] = nums[left];
result[*returnSize][2] = nums[right];
                (*returnColumnSizes)[*returnSize] = 3;
                (*returnSize)++;                 while (left < right && nums[left]
== nums[left + 1]) left++;                 while (left < right && nums[right]
== nums[right - 1]) right--;
                left++; right--;
} else if (sum < 0) left++;
else right--;
        }
    }
    return result;
}
```

OUTPUT:



LAB4:

QUESTION 1:

Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.

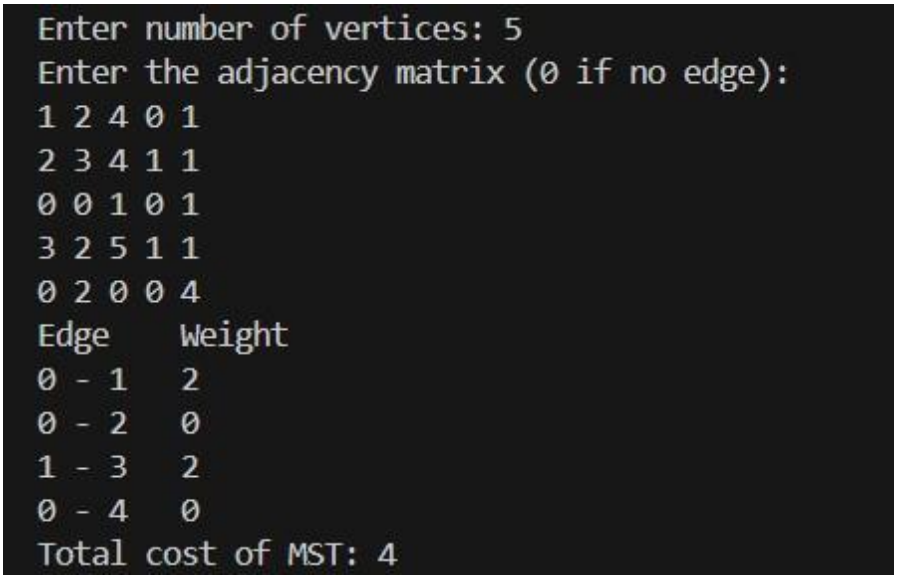
CODE:

```
#include <stdio.h>
#include <limits.h>

#define MAX 100

int minKey(int key[], int mstSet[], int n) {
    int min = INT_MAX, min_index;
    for (int v = 0; v < n; v++) {        if
(mstSet[v] == 0 && key[v] < min) {
min = key[v];            min_index = v;
```

```
        }
    }
    return min_index;
}

void primMST(int graph[MAX][MAX], int n) {
int parent[MAX];     int key[MAX];     int
mstSet[MAX];

    for (int i = 0; i < n; i++) {
        key[i] = INT_MAX;
mstSet[i] = 0;
    }

    key[0] = 0;
parent[0] = -1;

    for (int count = 0; count < n - 1; count++) {
int u = minKey(key, mstSet, n);         mstSet[u]
= 1;

        for (int v = 0; v < n; v++) {             if (graph[u][v] &&
mstSet[v] == 0 && graph[u][v] < key[v]) {
                parent[v] = u;
key[v] = graph[u][v];
            }
        }
    }
```

```
    int totalCost = 0;
printf("Edge \tWeight\n");
    for (int i = 1; i < n; i++) {          printf("%d - %d \t%d\n",
parent[i], i, graph[i][parent[i]]);          totalCost +=
graph[i][parent[i]];
    }
    printf("Total cost of MST: %d\n", totalCost);
}

int main() {
    int n;
    int graph[MAX][MAX];

    printf("Enter number of vertices: ");
scanf("%d", &n);

    printf("Enter the adjacency matrix (0 if no edge):\n");
    for (int i = 0; i < n; i++) {
for (int j = 0; j < n; j++) {
scanf("%d", &graph[i][j]);

        }
    }

    primMST(graph, n);
    return 0;
}
```

OUTPUT:



QUESTION 2:

Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.

CODE:

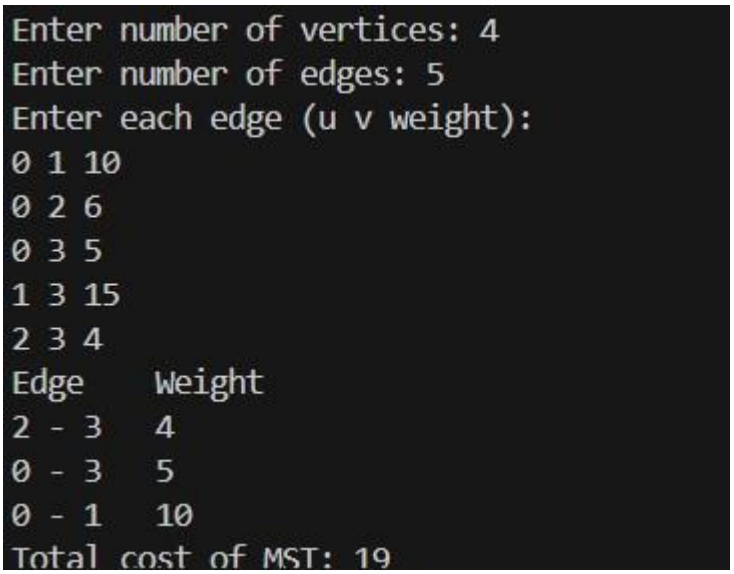
```
#include <stdio.h>

#include <stdlib.h>


#define MAX 100


typedef struct {

int u, v, weight;

} Edge;


int parent[MAX];
```

```
int find(int i) {     while
(parent[i] != i)         i =
parent[i];     return i;
}

void unionSet(int i, int j) {
int a = find(i);     int b =
find(j);     parent[a] = b;
}

void kruskal(Edge edges[], int n, int e) {
Edge result[MAX];
   int i = 0, j = 0, totalCost = 0;

   for (int k = 0; k < n; k++)
parent[k] = k;


   while (j < n - 1 && i < e) {
int u = edges[i].u;         int v
= edges[i].v;         int set_u
= find(u);         int set_v =
find(v);

       if (set_u != set_v) {
result[j++] = edges[i];
totalCost += edges[i].weight;
unionSet(set_u, set_v);
```

```
        }
i++;
    }

    printf("Edge \tWeight\n");     for (int k = 0; k < j; k++)
printf("%d - %d \t%d\n", result[k].u, result[k].v, result[k].weight);
printf("Total cost of MST: %d\n", totalCost);
}

int compare(const void *a, const void *b) {
    Edge *e1 = (Edge *)a;     Edge
*e2 = (Edge *)b;     return e1-
>weight - e2->weight;
}

int main() {
    int n, e;
    Edge edges[MAX];

    printf("Enter number of vertices: ");
scanf("%d", &n);

    printf("Enter number of edges: ");
scanf("%d", &e);

    printf("Enter each edge (u v weight):\n");
    for (int i = 0; i < e; i++)
        scanf("%d %d %d", &edges[i].u, &edges[i].v, &edges[i].weight);
```

```
    qsort(edges, e, sizeof(Edge), compare);
kruskal(edges, n, e);

    return 0;
}
```

OUTPUT:



LAB 5:

QUESTION 1:

From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

CODE:

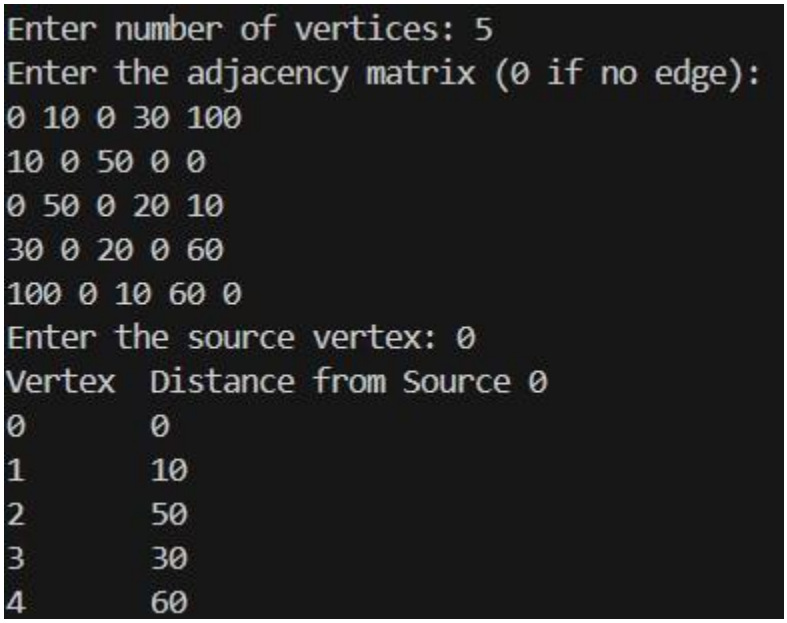
```
#include <stdio.h>
#include <limits.h>

#define MAX 100
#define INF 99999
```

```
int minDistance(int dist[], int visited[], int n) {
int min = INF, min_index;     for (int v = 0; v
< n; v++) {         if (!visited[v] && dist[v] <=
min) {             min = dist[v];
           min_index = v;
       }
   }
   return min_index;
}

void dijkstra(int graph[MAX][MAX], int n, int src) {
int dist[MAX], visited[MAX];

   for (int i = 0; i < n; i++) {
dist[i] = INF;         visited[i]
= 0;
   }

   dist[src] = 0;

   for (int count = 0; count < n - 1; count++) {
int u = minDistance(dist, visited, n);
visited[u] = 1;

       for (int v = 0; v < n; v++) {             if (!visited[v] &&
graph[u][v] && dist[u] != INF &&                dist[u] +
```

```
graph[u][v] < dist[v]) {                dist[v] = dist[u] +
graph[u][v];
            }
        }
    }

    printf("Vertex\tDistance from Source %d\n", src);
    for (int i = 0; i < n; i++)
printf("%d\t%d\n", i, dist[i]);
}

int main() {
    int n, src;
    int graph[MAX][MAX];

    printf("Enter number of vertices: ");
scanf("%d", &n);

    printf("Enter the adjacency matrix (0 if no edge):\n");
    for (int i = 0; i < n; i++)
for (int j = 0; j < n; j++)
scanf("%d", &graph[i][j]);

    printf("Enter the source vertex: ");
scanf("%d", &src);

    dijkstra(graph, n, src);
```

```
    return 0;
}
```

OUTPUT:



QUESTION 2:

Implement Johnson Trotter algorithm to generate permutations.

CODE:

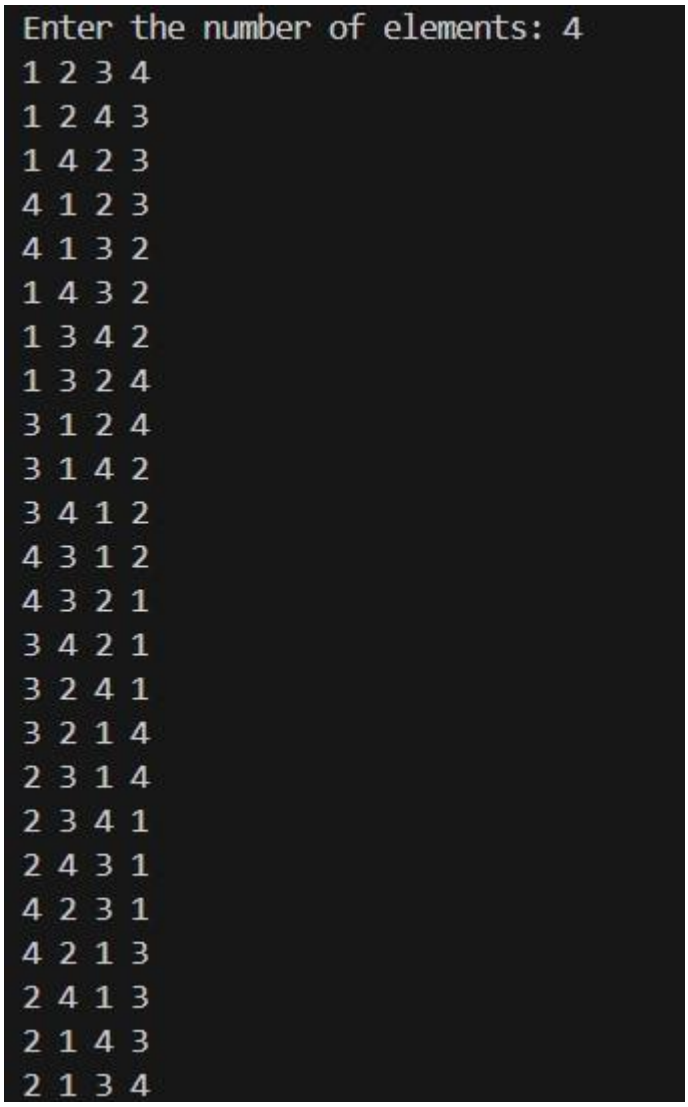
```
#include <stdio.h>

#define LEFT -1
#define RIGHT 1

typedef struct {
    int value;
    int dir;
```

```
} Element;

int getMobile(Element perm[], int n) {
int mobile = 0, mobileIndex = -1;
   for (int i = 0; i < n; i++) {
int next = i + perm[i].dir;
       if (next >= 0 && next < n && perm[i].value > perm[next].value) {
           if (perm[i].value > mobile) {
mobile = perm[i].value;
mobileIndex = i;
           }
       }
   }
   return mobileIndex;
}

void printPermutation(Element perm[], int n) {
   for (int i = 0; i < n; i++)
printf("%d ", perm[i].value);
printf("\n");
}

void generatePermutations(int n) {
Element perm[n];
   for (int i = 0; i < n; i++) {
perm[i].value = i + 1;         perm[i].dir
= LEFT;
   }
```

```
    printPermutation(perm, n);

    while (1) {
        int mobileIndex = getMobile(perm, n);
if (mobileIndex == -1)
            break;

        int swapIndex = mobileIndex + perm[mobileIndex].dir;
Element temp = perm[mobileIndex];         perm[mobileIndex]
= perm[swapIndex];         perm[swapIndex] = temp;

        mobileIndex = swapIndex;

        for (int i = 0; i < n; i++) {
            if (perm[i].value > perm[mobileIndex].value)
                perm[i].dir *= -1;
        }

        printPermutation(perm, n);
    }
}

int main() {
    int n;
    printf("Enter the number of elements: ");
scanf("%d", &n);     generatePermutations(n);

    return 0;
```

}

OUTPUT:



LAB 6:

QUESTION 1:

Implement fractional knapsack problem using Greedy technique.

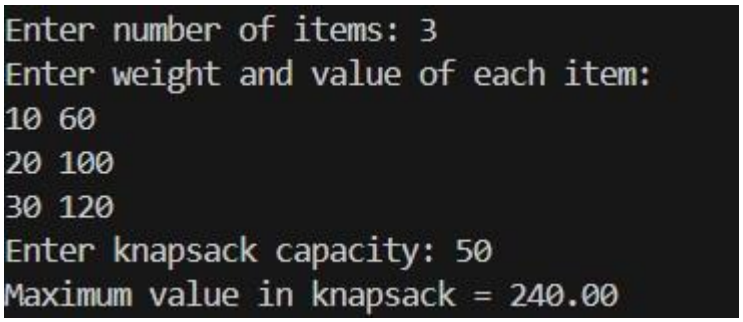
CODE:

```
#include <stdio.h>

typedef struct {
int weight;     int
value;     float
ratio;
} Item;

void sortItems(Item items[], int n) {
   for (int i = 0; i < n - 1; i++) {         for (int j
= 0; j < n - i - 1; j++) {             if
(items[j].ratio < items[j + 1].ratio) {
Item temp = items[j];                 items[j] =
items[j + 1];                items[j + 1] = temp;
           }
       }
   }
}

void fractionalKnapsack(Item items[], int n, int capacity) {     sortItems(items, n);

   float totalValue = 0.0;
int currWeight = 0;

   for (int i = 0; i < n; i++) {
```

```
        if (currWeight + items[i].weight <= capacity) {
currWeight += items[i].weight;              totalValue
+= items[i].value;
        } else {
            int remain = capacity - currWeight;
totalValue += items[i].ratio * remain;
            break;
        }
    }

    printf("Maximum value in knapsack = %.2f\n", totalValue);
}

int main() {     int
n, capacity;

    printf("Enter number of items: ");
scanf("%d", &n);

    Item items[n];

    printf("Enter weight and value of each item:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d %d", &items[i].weight, &items[i].value);
items[i].ratio = (float)items[i].value / items[i].weight;
    }
```

```
    printf("Enter knapsack capacity: ");
scanf("%d", &capacity);

    fractionalKnapsack(items, n, capacity);

    return 0;
}
```

OUTPUT:



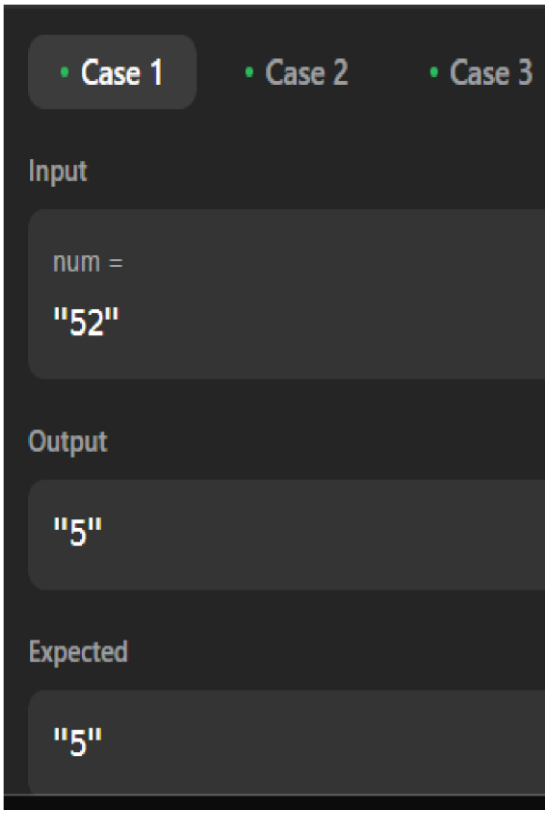
QUESTION 2:

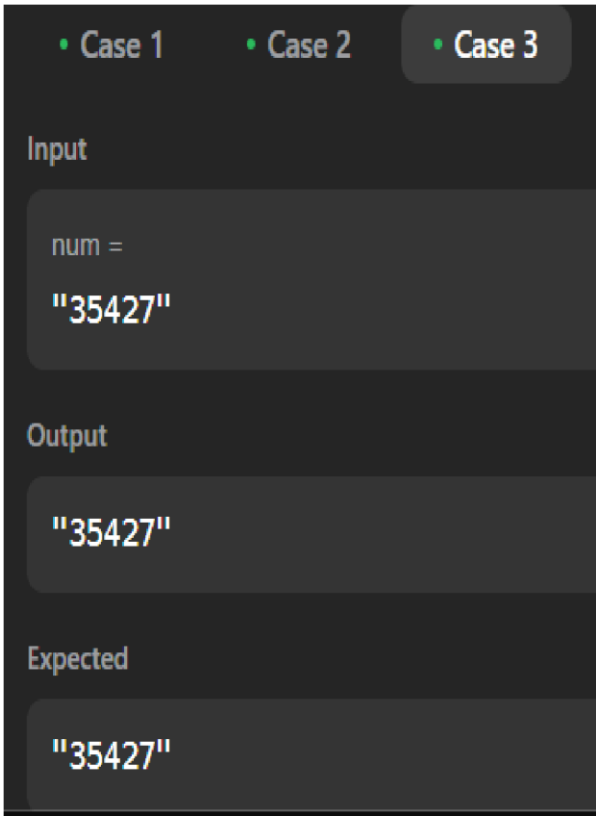
LeetCode Problem- Largest Odd Number in a String You are given a string num, representing a large integer. Return *the **largest-valued odd** integer (as a string) that is a **non-empty substring** of* num*, or an empty string* "" *if no odd integer exists*.

Code:

```
class Solution {
    public:
        string largestOddNumber(string num) {            return
num.substr(0, num.find_last_not_of("0|2|4|6|8") + 1);
        }
    };
```

OUTPUT:





LAB 7:

QUESTION 1:

Implement 0/1 Knapsack problem using dynamic programming.

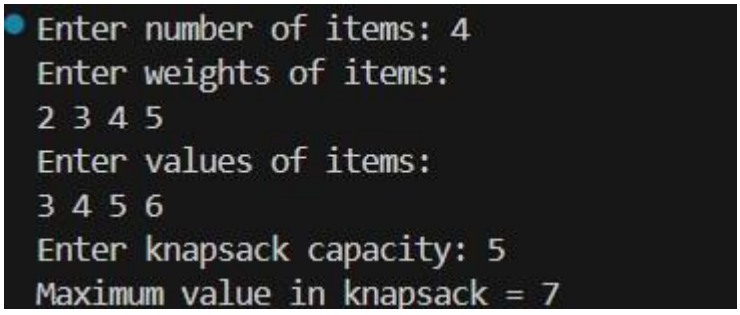
CODE:

```
#include <stdio.h>

int max(int a, int b) {
return (a > b) ? a : b;
}

int knapsack(int weight[], int value[], int n, int capacity) {
int dp[n + 1][capacity + 1];
```

```
    for (int i = 0; i <= n; i++) {         for (int
w = 0; w <= capacity; w++) {
            if (i == 0 || w == 0)                 dp[i][w] = 0;             else if (weight[i -
1] <= w)                dp[i][w] = max(value[i - 1] + dp[i - 1][w - weight[i - 1]],
dp[i - 1][w]);
            else                dp[i][w]
= dp[i - 1][w];
        }
    }

    return dp[n][capacity];
}

int main() {     int
n, capacity;

    printf("Enter number of items: ");
scanf("%d", &n);

    int weight[n], value[n];

    printf("Enter weights of items:\n");
    for (int i = 0; i < n; i++)
scanf("%d", &weight[i]);

    printf("Enter values of items:\n");
```

```
    for (int i = 0; i < n; i++)
scanf("%d", &value[i]);

    printf("Enter knapsack capacity: ");
scanf("%d", &capacity);

    int maxValue = knapsack(weight, value, n, capacity);
printf("Maximum value in knapsack = %d\n", maxValue);

    return 0;
}
```

OUPUT:



QUESTION 2:

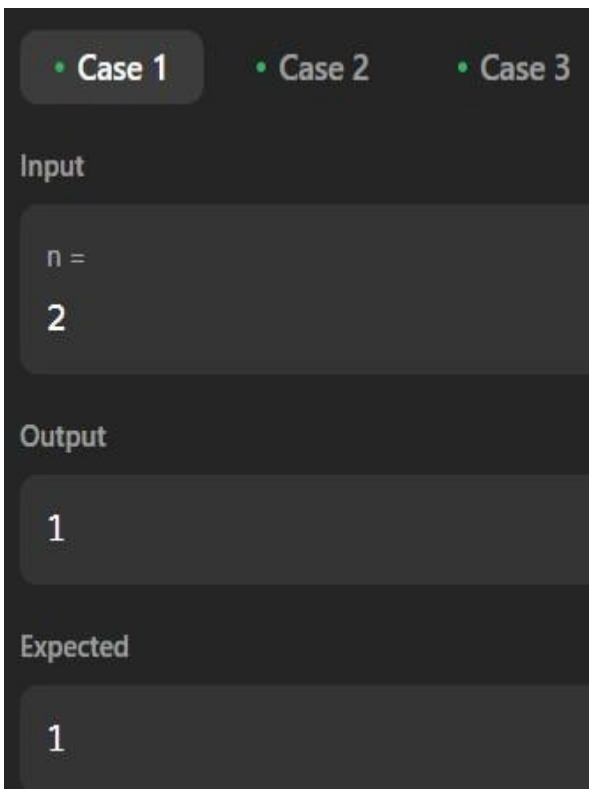
LeetCode Problemm : Fibonacci Number

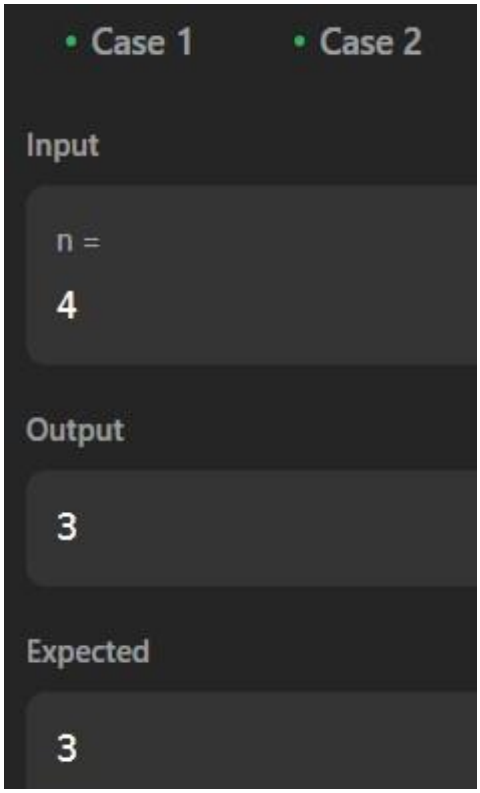
CODE:

```
int fib(int n){
if (n <= 1)
return n;

    // Array to store Fibonacci numbers      int
f[n + 1]; // 1 extra to handle case n = 0
```

```
    // First two Fibonacci numbers
    f[0] = 1;
f[1] = 1;

    // Build the Fibonacci sequence
    for (int i = 2; i <= n; i++) {
        f[i] = f[i - 1] + f[i - 2];
    }

    return f[n - 1];
}
```

OUTPUT:





LAB 8:

QUESTION 1:

Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

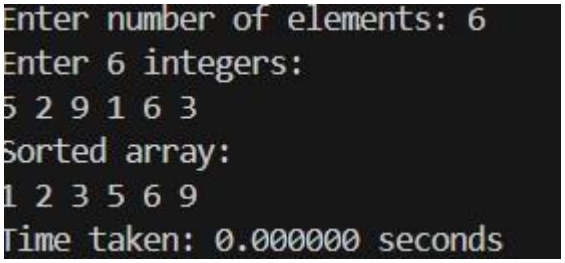
CODE:

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

void heapify(int arr[], int n, int i) {
int largest = i;     int l = 2 * i + 1;
int r = 2 * i + 2;

   if (l < n && arr[l] > arr[largest])
largest = l;

   if (r < n && arr[r] > arr[largest])
largest = r;

   if (largest != i) {         int
temp = arr[i];         arr[i] =
arr[largest];
arr[largest] = temp;
heapify(arr, n, largest);
   }
}

void heapSort(int arr[], int n) {
```

```
    for (int i = n / 2 - 1; i >= 0; i--)
heapify(arr, n, i);

    for (int i = n - 1; i >= 0; i--) {
int temp = arr[0];          arr[0] =
arr[i];
        arr[i] = temp;
heapify(arr, i, 0);
    }
}

int main() {
    int n;
    printf("Enter number of elements: ");
scanf("%d", &n);

    int arr[n];
    printf("Enter %d integers:\n", n);
    for (int i = 0; i < n; i++)
scanf("%d", &arr[i]);

    clock_t start, end;
start = clock();
heapSort(arr, n);     end
= clock();

    printf("Sorted array:\n");
for (int i = 0; i < n; i++)
```

```
printf("%d ", arr[i]);
printf("\n");

    double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
printf("Time taken: %.6f seconds\n", time_taken);


    return 0;
}
```

OUTPUT:



QUESTION 2:

Implement All Pair Shortest paths problem using Floyd’s algorithm.

CODE:

```
#include <stdio.h>
#include <limits.h>

#define INF 99999
#define MAX 100

void floydWarshall(int graph[MAX][MAX], int n) {
int dist[MAX][MAX];
```

```
   for (int i = 0; i < n; i++) {         for
(int j = 0; j < n; j++) {             if
(graph[i][j] == 0 && i != j) {
dist[i][j] = INF; // No edge between
i and j

          } else {                dist[i][j] = graph[i][j]; // Set
initial distances             }
       }
   }



   for (int k = 0; k < n; k++) {         for (int i = 0; i < n; i++) {             for (int j = 0; j
< n; j++) {                if (dist[i][k] != INF && dist[k][j] != INF && dist[i][k] + dist[k][j]
< dist[i][j]) {
                  dist[i][j] = dist[i][k] + dist[k][j]; // Update the distance if shorter path is
found
              }
          }
       }
   }


   printf("Shortest distances between every pair of vertices:\n");
   for (int i = 0; i < n; i++) {
for (int j = 0; j < n; j++) {
if (dist[i][j] == INF) {
printf("INF ");
```

```
            } else {
printf("%d ", dist[i][j]);
            }
        }
        printf("\n");
    }
}

int main() {
    int n;
    printf("Enter number of vertices: ");
scanf("%d", &n);

    int graph[MAX][MAX];

    printf("Enter the adjacency matrix (0 if no edge, for diagonal enter 0):\n");
    for (int i = 0; i < n; i++) {
for (int j = 0; j < n; j++) {
scanf("%d", &graph[i][j]);
        }
    }

    floydWarshall(graph, n);

    return 0;
}
```

OUTPUT:

```
Enter number of vertices: 4
Enter the adjacency matrix (0 if no edge, for diagonal enter 0):
0 3 0 0
3 0 1 0
0 1 0 7
0 0 7 0
Shortest distances between every pair of vertices:
0 3 4 11
3 0 1 8
4 1 0 7
11 8 7 0
```

QUESTION 3:

LeetCode Problem :Shortest Path Visiting All Nodes

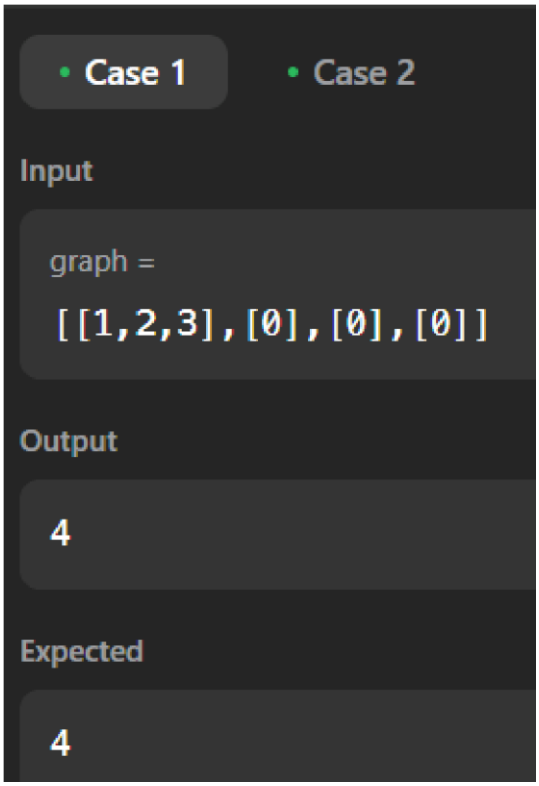
CODE:

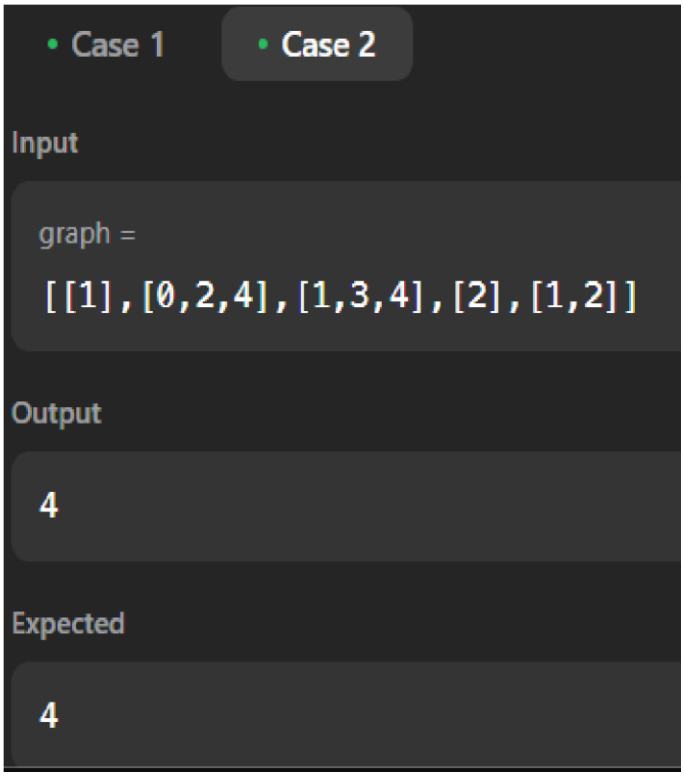
```
struct Node {
    int id;
    int mask;
    int level;
};

struct Queue {     struct
Node data[10000];
    int i;
int j;
    int size;
};
```

```
void qpush(struct Queue* q, struct Node n) {
q->size ++;     q->data[q->i++] = n;     q->i =
q->i % 10000;
}

struct Node qpop(struct Queue* q) {
struct Node r = q->data[q->j++];
    q->size --;
    q->j = q->j % 10000;
    return r;
}

int qempty(struct Queue* q) {
return q->size == 0;
}

int shortestPathLength(int** graph, int graphSize, int* graphColSize) {
struct Queue q;     char V[(1<<(13+4)) + 100] = {0}; // visited
memset(&q, 0, sizeof(q));
    for (int i = 0; i < graphSize; i++) {
struct Node n = {i, 1 << i, 1};
qpush(&q, n);
    }

    while (!qempty(&q)) {         struct
Node n = qpop(&q);         if (n.mask ==
(1<<graphSize)-1) {
```

```
            return n.level-1;
        }

        for (int i = 0; i < graphColSize[n.id]; i++) {
int mask = n.mask;
            int jd = graph[n.id][i];
mask |= 1<<jd;

            struct Node m = {jd, mask, n.level+1};

            if (!V[(jd << 13) | mask]) {
V[(jd << 13) | mask] = 1;
qpush(&q, m);
            }
        }
    }
    return -1;
}
```

OUTPUT:





LAB 9:

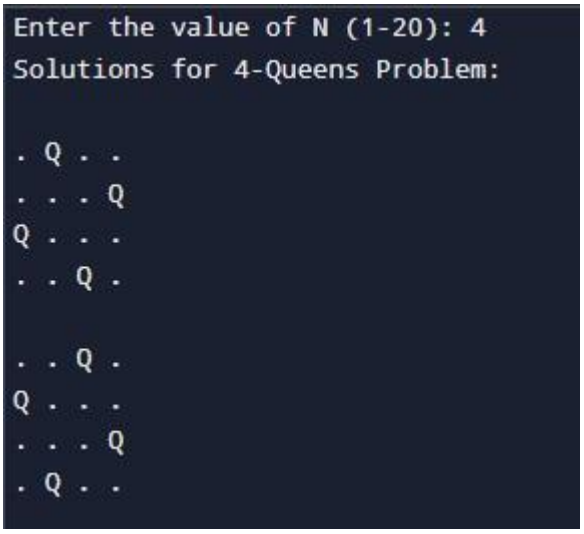
QUESTION 1:

Implement “N-Queens Problem” using Backtracking.

CODE:

```
#include <stdio.h>
#include <stdbool.h>

#define MAX 20

int board[MAX];
int N;
```

```
bool isSafe(int row, int col) {
for (int i = 0; i < row; i++) {
if (board[i] == col ||
board[i] - i == col - row ||
board[i] + i == col + row)
return false;
   }
   return true;
}

void solveNQueens(int row) {
   if (row == N) {        for (int i =
0; i < N; i++) {           for (int j =
0; j < N; j++) {               if
(board[i] == j)
printf("Q ");              else
printf(". ");
           }
printf("\n");        }
       printf("\n");
return;
   }

   for (int col = 0; col < N; col++) {
       if (isSafe(row, col)) {
board[row] = col;
solveNQueens(row + 1);
       }
```

```
    }
}

int main() {     printf("Enter the value of N (1-
%d): ", MAX);     scanf("%d", &N);

    if (N < 1 || N > MAX) {         printf("Invalid input. N should be
between 1 and %d.\n", MAX);
        return 1;
    }

    printf("Solutions for %d-Queens Problem:\n\n", N);
solveNQueens(0);

    return 0;
}
```

OUTPUT: