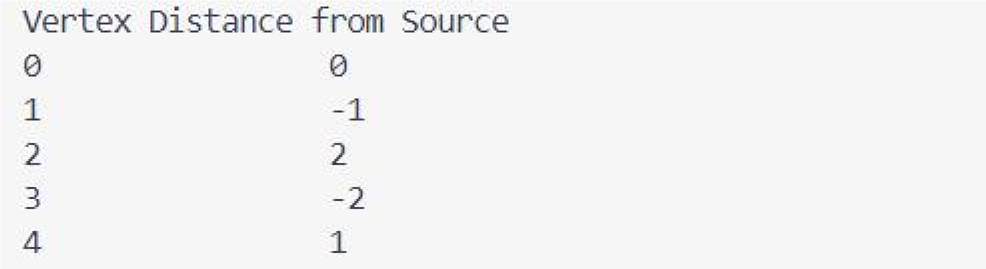
Code for Bellman Ford Algorithm:

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

typedef struct {
    int src;
    int dest;
    int wt;
} Edge;

void bellmanFord(Edge* graph, int V, int E, int src) {
    int* dist = (int*)malloc(V * sizeof(int));

    for (int i = 0; i < V; i++) {
        dist[i] = INT_MAX;
    }
    dist[src] = 0;

    for (int i = 0; i < V - 1; i++) {
        for (int j = 0; j < E; j++) {
            if (dist[graph[j].src] != INT_MAX && dist[graph[j].src] + graph[j].wt <
dist[graph[j].dest]) {
                dist[graph[j].dest] = dist[graph[j].src] + graph[j].wt;
            }
        }
    }

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

    free(dist);
}

int main() {
    int V = 5;
    int E = 8;

    Edge* graph = (Edge*)malloc(E * sizeof(Edge));

    graph[0].src = 0; graph[0].dest = 1; graph[0].wt = -1;
    graph[1].src = 0; graph[1].dest = 2; graph[1].wt = 4;
    graph[2].src = 1; graph[2].dest = 2; graph[2].wt = 3;
    graph[3].src = 1; graph[3].dest = 3; graph[3].wt = 2;
    graph[4].src = 1; graph[4].dest = 4; graph[4].wt = 2;
    graph[5].src = 3; graph[5].dest = 2; graph[5].wt = 5;
    graph[6].src = 3; graph[6].dest = 1; graph[6].wt = 1;
    graph[7].src = 4; graph[7].dest = 3; graph[7].wt = -3;

    bellmanFord(graph, V, E, 0);

    return 0;
}
```

Output



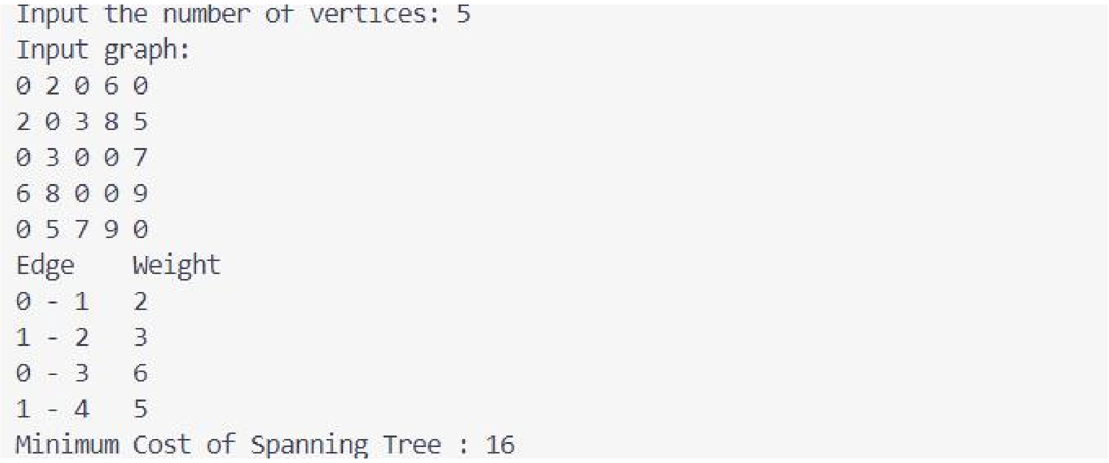
```
Vertex Distance from Source
0                0
1                -1
2                2
3                -2
4                1
```

Code for Prim’s Algorithm:

```
#include <stdio.h>
#include <limits.h>
#define N 100

int minKey(int key[], int mst[], int vertices) {
    int min = INT_MAX, minIndex;

    for (int i = 0; i < vertices; i++) {
        if (!mst[i] && key[i] < min) {
            min = key[i];
            minIndex = i;
        }
    }

    return minIndex;
}

void printMST(int parent[], int graph[N][N], int vertices) {
    printf("Edge \tWeight\n");
    int cost  = 0;
    for (int i = 1; i < vertices; i++) {
        cost += graph[i][parent[i]];
        printf("%d - %d \t%d\n", parent[i], i, graph[i][parent[i]]);
    }

    printf("Minimum Cost of Spanning Tree : %d", cost);
}

void primMST(int graph[N][N], int vertices) {
    int parent[N];
    int key[N];
    int mstSet[N];

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

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

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

        mstSet[u] = 1;

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

    printMST(parent, graph, vertices);
}
```

```c
int main() {
    int vertices;

    printf("Input the number of vertices: ");
    scanf("%d", &vertices);

    int graph[N][N];

    printf("Input graph:\n");
    for (int i = 0; i < vertices; i++) {
        for (int j = 0; j < vertices; j++) {
            scanf("%d", &graph[i][j]);
        }
    }

    primMST(graph, vertices);

    return 0;
}
```

Output



```
Input the number of vertices: 5
Input graph:
0 2 0 6 0
2 0 3 8 5
0 3 0 0 7
6 8 0 0 9
0 5 7 9 0
Edge    Weight
0 - 1   2
1 - 2   3
0 - 3   6
1 - 4   5
Minimum Cost of Spanning Tree : 16
```

Code for Kruskal’s Algorithm:

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

typedef struct {
    int src;
    int dest;
    int wt;
} Edge;
```

```c
int* parent;
int* rank;
```

```c
void init(int V) {
    parent = (int*)malloc(V * sizeof(int));
    rank = (int*)malloc(V * sizeof(int));
    for (int i = 0; i < V; i++) {
        parent[i] = i;
        rank[i] = 0;
    }
}
```

```c
int find(int node) {
    if (parent[node] != node) {
        parent[node] = find(parent[node]);
    }
    return parent[node];
}
```

```c
void unionSets(int u, int v) {
    int rootU = find(u);
    int rootV = find(v);

    if (rootU != rootV) {
        if (rank[rootU] > rank[rootV]) {
            parent[rootV] = rootU;
        } else if (rank[rootU] < rank[rootV]) {
            parent[rootU] = rootV;
        } else {
            parent[rootV] = rootU;
            rank[rootU]++;
        }
    }
}
```

```c
int compareEdges(const void* a, const void* b) {
    return ((Edge*)a)->wt - ((Edge*)b)->wt;
}
```

```c
void kruskalsMST(Edge* edges, int E, int V) {
    init(V);
    qsort(edges, E, sizeof(Edge), compareEdges);

    int ans = 0;
    int count = 0;
```

```c
    for (int i = 0; count < V - 1; i++) {
        Edge e = edges[i];

        int parA = find(e.src);
        int parB = find(e.dest);

        if (parA != parB) {
            unionSets(e.src, e.dest);
            ans += e.wt;
            count++;
        }
    }
    printf("MST cost = %d\n", ans);
    free(parent);
    free(rank);
}

int main() {
    int V = 5;
    int E = 7;

    Edge* edges = (Edge*)malloc(E * sizeof(Edge));

    edges[0] = (Edge){0, 1, 10};
    edges[1] = (Edge){0, 2, 6};
    edges[2] = (Edge){0, 3, 5};
    edges[3] = (Edge){1, 3, 15};
    edges[4] = (Edge){2, 3, 4};
    edges[5] = (Edge){1, 2, 5};
    edges[6] = (Edge){2, 4, 9};

    kruskalsMST(edges, E, V);

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

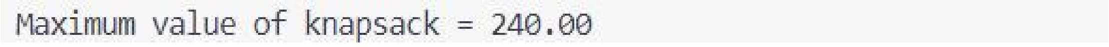
Output

```
MST cost = 23
```

Code for Fractional Knapsack:

```
#include <stdio.h>

void swap(float arr[][2], int i, int j) {
    float temp0 = arr[i][0];
    float temp1 = arr[i][1];
    arr[i][0] = arr[j][0];
    arr[i][1] = arr[j][1];
    arr[j][0] = temp0;
    arr[j][1] = temp1;
}

int partition(float arr[][2], int low, int high) {
    int i = low + 1;
    int j = high;
    int pivot = low;

    while (i <= j) {
        while (i <= high && arr[i][1] <= arr[pivot][1]) {
            i++;
        }

        while (j >= low && arr[j][1] > arr[pivot][1]) {
            j--;
        }

        if (i < j) {
            swap(arr, i, j);
        }
    }
    swap(arr, pivot, j);
    return j;
}

void quickSort(float arr[][2], int low, int high) {
    if (low >= high) {
        return;
    }

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

void fractionalKnapsack(int b[], int wt[], int W, int n) {
    float val[n][2];

    for (int i = 0; i < n; i++) {
        val[i][0] = i;
        val[i][1] = b[i] / (float)wt[i];
    }

    quickSort(val, 0, n - 1);

    float finalVal = 0.0;
    int w = W;

    for (int i = n - 1; i >= 0; i--) {
        int idx = (int)val[i][0];
        if (wt[idx] <= w) {
            w -= wt[idx];
            finalVal += b[idx];
        } else {
            finalVal += (b[idx] * (float)w / wt[idx]);
            break;
        }
    }

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

int main() {
    int b[] = {60, 100, 120};
    int wt[] = {10, 20, 30};
    int W = 50;

    fractionalKnapsack(b, wt, W, 3);

    return 0;
}
```

Output

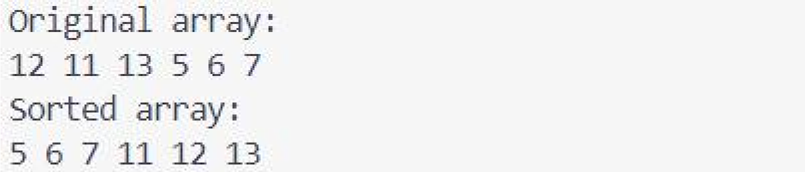


```
Maximum value of knapsack = 240.00
```

Code for Heap Sort:

```
#include <stdio.h>

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

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) {
        swap(&arr[i], &arr[largest]);

        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--) {
        swap(&arr[0], &arr[i]);
        heapify(arr, i, 0);
    }
}

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

int main() {
    int arr[] = {12, 11, 13, 5, 6, 7};
    int n = sizeof(arr) / sizeof(arr[0]);

    printf("Original array:\n");
    printArray(arr, n);

    heapSort(arr, n);

    printf("Sorted array:\n");
    printArray(arr, n);

    return 0;
}
```

Output

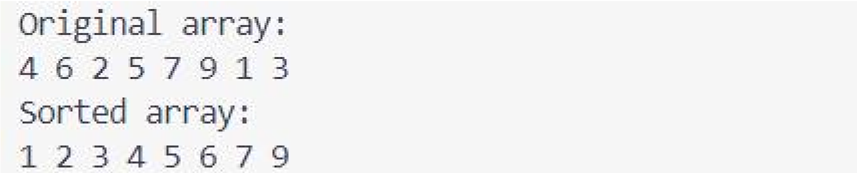


```
Original array:
12 11 13 5 6 7
Sorted array:
5 6 7 11 12 13
```

Code for Non Recursive Merge Sort:

```
#include <stdio.h>

void mergeSort(int a[], int n);
void merge(int arr[], int si, int mid, int ei);
void printArray(int arr[], int n);

int main(){
    int arr[] = {4, 6, 2, 5, 7, 9, 1, 3};

    int len = sizeof(arr)/sizeof(arr[0]);

    printf("Original array:\n");
    printArray(arr, len);

    mergeSort(arr, len-1);

    printf("Sorted array:\n");
    printArray(arr, len);
    return 0;
}

void mergeSort(int arr[], int n){
    int p, i, s, e, mid;
    for(p=2; p<=n; p*=2){
        for(i=0; i+p-1<=n; i+=p){
            s = i;
            e = i+p-1;
            mid = (e+s)/2;

            merge(arr, s, mid, e);
        }
    }

    if(p/2 < n){
        merge(arr, 0, p/2-1, n-1);
    }
}

void merge(int arr[], int si, int mid, int ei){
    int temp[ei-si+1];
    int i = si;
    int j = mid+1;
    int k = 0;

    while(i<=mid && j<=ei){
        if(arr[i]<arr[j]){
            temp[k++]=arr[i++];
        }
        else{
            temp[k++] = arr[j++];
        }
    }

    while(i<=mid){
        temp[k++] = arr[i++];
    }
    while(j<=ei){
        temp[k++] = arr[j++];
    }

    for (k = 0, i = si; k < ei - si + 1; k++, i++) {
    arr[i] = temp[k];
    }
}

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

Output

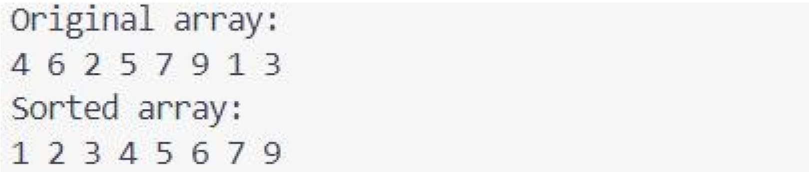


```
Original array:
4 6 2 5 7 9 1 3
Sorted array:
1 2 3 4 5 6 7 9
```

Code for Non Recursive Quick Sort:

```c
#include <stdio.h>
#define MAX 100

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

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) {
    int stack[MAX];

    int top = -1;
    stack[++top] = low;
    stack[++top] = high;

    while (top >= 0) {
        high = stack[top--];
        low = stack[top--];
        int pivot = partition(arr, low, high);

        if (pivot - 1 > low) {
            stack[++top] = low;
            stack[++top] = pivot - 1;
        }

        if (pivot + 1 < high) {
            stack[++top] = pivot + 1;
            stack[++top] = high;
        }
    }
}

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

int main() {
    int arr[] = {4, 6, 2, 5, 7, 9, 1, 3};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("Original array:\n");
    printArray(arr, n);

    quickSort(arr, 0, n - 1);

    printf("Sorted array:\n");
    printArray(arr, n);

    return 0;
}
```

Output

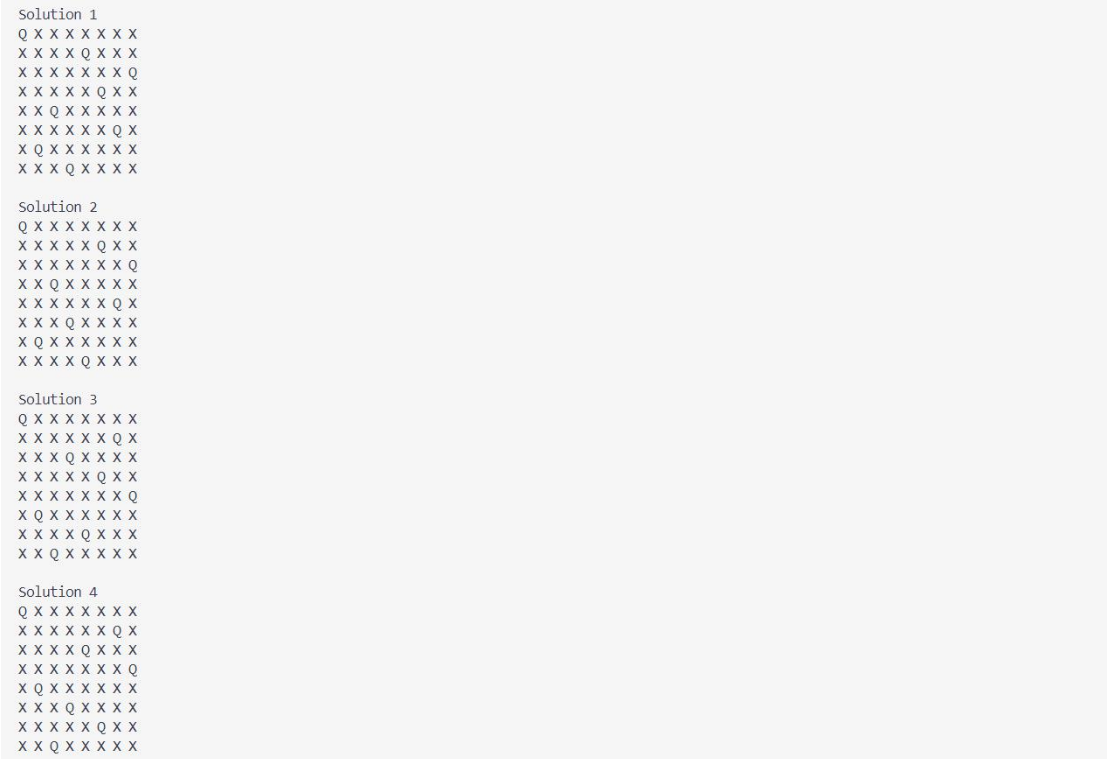


```
Original array:
4 6 2 5 7 9 1 3
Sorted array:
1 2 3 4 5 6 7 9
```

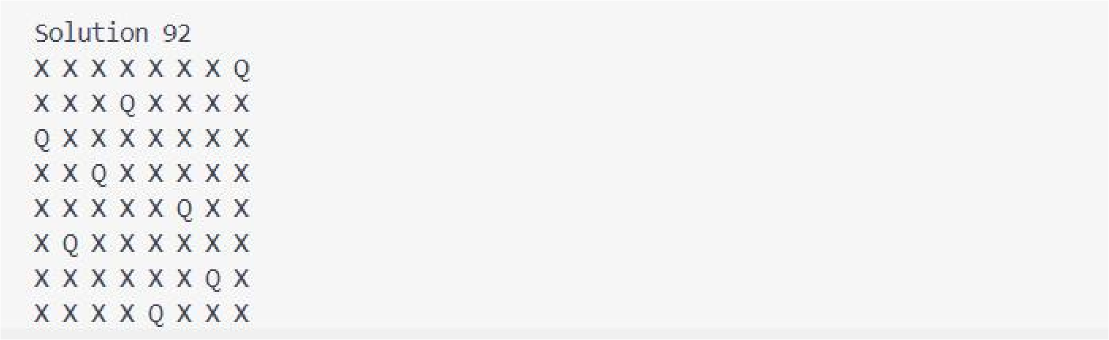
Code for N Queens Problem:

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

#define MAX 8

typedef struct {
    int *C;
    int no_queen;
} BOARD;

void initialisation(BOARD *, int);
void display_board(BOARD, int, int *);
int is_safe(BOARD, int, int);
void n_queen(BOARD *, int, int, int *);

void initialisation(BOARD *B, int n) {
    B->no_queen = n;
    B->C = (int *)malloc(sizeof(int) * (n + 1));
    for (int i = 1; i <= n; i++)
        B->C[i] = -1;
}

void display_board(BOARD B, int n, int *a_sol_no) {
    printf("\n\n Solution %d ", ++(*a_sol_no));
    for (int i = 1; i <= n; i++) {
        printf("\n");
        for (int j = 1; j <= n; j++) {
            if (B.C[i] == j)
                printf(" Q");
            else
                printf(" X");
        }
    }
}

int is_safe(BOARD B, int x, int y) {
    for (int i = 1; i < x; i++) {
        if (B.C[i] == y || abs(x - i) == abs(y - B.C[i]))
            return 0;
    }
    return 1;
}

void n_queen(BOARD *B, int k, int n, int *a_sol_no) {
    for (int j = 1; j <= n; j++) {
        if (is_safe(*B, k, j)) {
            B->C[k] = j;
            if (k == n)
                display_board(*B, n, a_sol_no);
            else
                n_queen(B, k + 1, n, a_sol_no);
        }
    }
}

int main() {
    BOARD *p;
    int sol_no = 0;
    p = (BOARD *)malloc(sizeof(BOARD));
    initialisation(p, 8);
    n_queen(p, 1, 8, &sol_no);
    free(p->C);
    free(p);
    return 0;
}
```

Output:



```
Solution 1
Q X X X X X X X
X X X X Q X X X
X X X X X X X Q
X X X X X Q X X
X X Q X X X X X
X X X X X X Q X
X Q X X X X X X
X X X Q X X X X

Solution 2
Q X X X X X X X
X X X X X Q X X
X X X X X X X Q
X X Q X X X X X
X X X X X X Q X
X X X Q X X X X
X Q X X X X X X
X X X X Q X X X

Solution 3
Q X X X X X X X
X X X X X X Q X
X X X Q X X X X
X X X X X Q X X
X X X X X X X Q
X Q X X X X X X
X X X X Q X X X
X X Q X X X X X

Solution 4
Q X X X X X X X
X X X X X X Q X
X X X X Q X X X
X X X X X X X Q
X Q X X X X X X
X X X Q X X X X
X X X X X Q X X
X X Q X X X X X
```

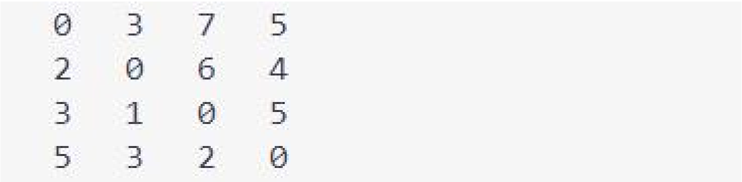


```
Solution 92
X X X X X X X Q
X X X Q X X X X
Q X X X X X X X
X X Q X X X X X
X X X X X Q X X
X Q X X X X X X
X X X X X X Q X
X X X X Q X X X
```

Code for Floyd algorithm:

```
#include <stdio.h>
#define n 4

#define INF 999

void printMatrix(int matrix[][n]);

void floydWarshall(int graph[][n]) {
    int matrix[n][n], i, j, k;

    for (i = 0; i < n; i++)
    for (j = 0; j < n; j++)
    matrix[i][j] = graph[i][j];

    for (k = 0; k < n; k++) {
        for (i = 0; i < n; i++) {
            for (j = 0; j < n; j++) {
                if (matrix[i][k] + matrix[k][j] < matrix[i][j])
                    matrix[i][j] = matrix[i][k] + matrix[k][j];
            }
        }
    }
    printMatrix(matrix);
}

void printMatrix(int matrix[][n]) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            if (matrix[i][j] == INF)
                printf("%4s", "INF");
            else
            printf("%4d", matrix[i][j]);
        }
        printf("\n");
    }
}

int main() {
    int graph[n][n] = {{0, 3, INF, 5},
                        {2, 0, INF, 4},
                        {INF, 1, 0, INF},
                        {INF, INF, 2, 0}};
    floydWarshall(graph);
}
```

Output



```
   0   3   7   5
   2   0   6   4
   3   1   0   5
   5   3   2   0
```