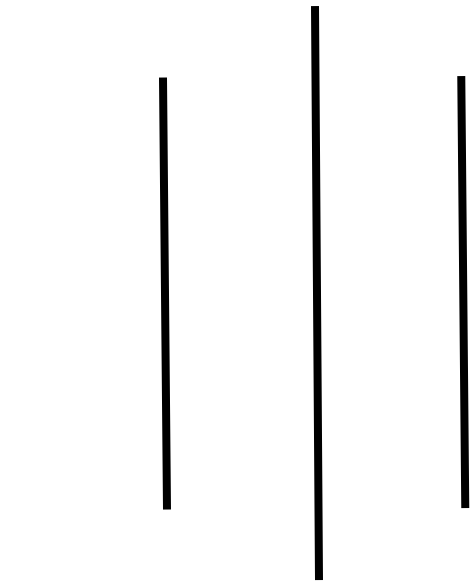

LAB REPORT ON

DESIGN AND ANALYSIS OF ALGORITHMS

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FACULTY : BSC.CSIT 5TH SEMESTER

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LAB-3.4 Order Statistics

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
void selectionSort(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;
      }
    }
    if (min_idx != i) {
      temp = arr[i];
      arr[i] = arr[min_idx];
      arr[min_idx] = temp;
    }
  }
}
int generateRandom(int lower, int upper) {
  return (rand() % (upper - lower + 1)) + lower;
}
int main() {
  int arr[20], k;
  char choice;
  srand(time(0));
  do {
    printf("Original Array: ");
    for (int i = 0; i < 20; i++) {
      arr[i] = generateRandom(1, 100);
      printf("%d ", arr[i]);
    }
    printf("\n");
    printf("Enter the value of k (1 to 20): ");
    scanf("%d", &k);
    if (k < 1 || k > 20) {
      printf("Invalid k! Please enter a value between 1 and 20.\n");
    } else {
```

```
        selectionSort(arr, 20);
        printf("Sorted Array: ");
        for (int i = 0; i < 20; i++) {
            printf("%d ", arr[i]);
        }
        printf("\nThe %d-th smallest element is: %d\n", k, arr[k - 1]);
    }
    printf("Do you want to find order statistic again? (y/n): ");
    scanf(" %c", &choice);
  } while (choice == 'y' || choice == 'Y');

  printf("Exiting the program!\n");
  return 0;
}
```

Output:

```
C:\Users\PC\Documents\prime college\Fifth Semester\samyak manandhar\DAA\10.exe
Original Array: 42 76 84 1 40 12 16 9 40 50 73 46 57 21 18 35 77 78 98 20
Enter the value of k (1 to 20): 7
Sorted Array: 1 9 12 16 18 20 21 35 40 40 42 46 50 57 73 76 77 78 84 98
The 7-th smallest element is: 21
Do you want to find order statistic again? (y/n): n
Exiting the program!

--------------------------------
Process exited after 13.22 seconds with return value 0
Press any key to continue . . .
```

Greedy algorithms

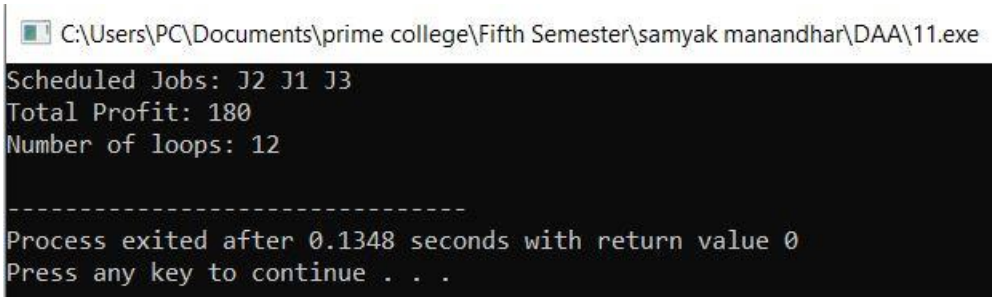
LAB-4.1 Job sequencing algorithm

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
typedef struct {
  char id[5];
  int deadline;
  int profit;
} Job;
int min(int a, int b) {
  return (a < b) ? a : b;
}
int compare(const void* a, const void* b) {
  return ((Job*)b)->profit - ((Job*)a)->profit;
}
int main() {
  Job jobs[] = { {"J1", 2, 60}, {"J2", 1, 100}, {"J3", 3, 20}, {"J4", 2, 40}, {"J5", 1, 20} };
  int n = sizeof(jobs) / sizeof(jobs[0]);
  int result[n];
  int slot[n];
  memset(slot, 0, sizeof(slot));
  int totalProfit = 0;
  int loopCount = 0;
  qsort(jobs, n, sizeof(Job), compare);
  loopCount++;
  for (int i = 0; i < n; i++) {
    loopCount++;
    for (int j = min(n, jobs[i].deadline) - 1; j >= 0; j--) {
      loopCount++;
      if (!slot[j]) {
        result[j] = i;
        slot[j] = 1;
        totalProfit += jobs[i].profit;
        break;
      }
    }
  }
  printf("Scheduled Jobs: ");
```

```
    for (int i = 0; i < n; i++) {
        if (slot[i])
            printf("%s ", jobs[result[i]].id);
    }
    printf("\nTotal Profit: %d\n", totalProfit);
    printf("Number of loops: %d\n", loopCount);
    return 0;
}
```

Output:

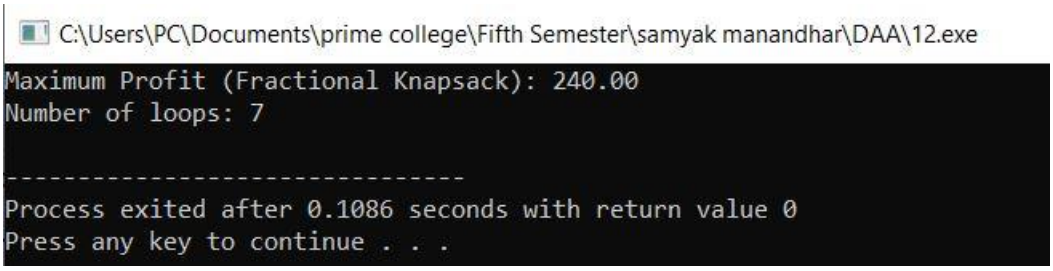


LAB-4.2 Fractional Knapsack

Code:

```
#include <stdio.h>
#include <stdlib.h>
typedef struct {
   int weight, profit;
   float ratio;
} Item;
int compare(const void* a, const void* b) {
   return ((Item*)b)->ratio > ((Item*)a)->ratio ? 1 : -1;}
int main() {
   int capacity = 50;
   Item items[] = { {10, 60}, {20, 100}, {30, 120} };
   int n = sizeof(items) / sizeof(items[0]);
   float totalProfit = 0.0;
   int loopCount = 0;
   for (int i = 0; i < n; i++) {
      loopCount++;
      items[i].ratio = (float)items[i].profit / items[i].weight;    }
   qsort(items, n, sizeof(Item), compare);
   loopCount++;
   for (int i = 0; i < n; i++) {
      loopCount++;
      if (capacity >= items[i].weight) {
         totalProfit += items[i].profit;
         capacity -= items[i].weight;
      } else {
         totalProfit += items[i].ratio * capacity;
         break;      }   }
   printf("Maximum Profit (Fractional Knapsack): %.2f\n", totalProfit);
   printf("Number of loops: %d\n", loopCount);
   return 0;
}
```

Output:



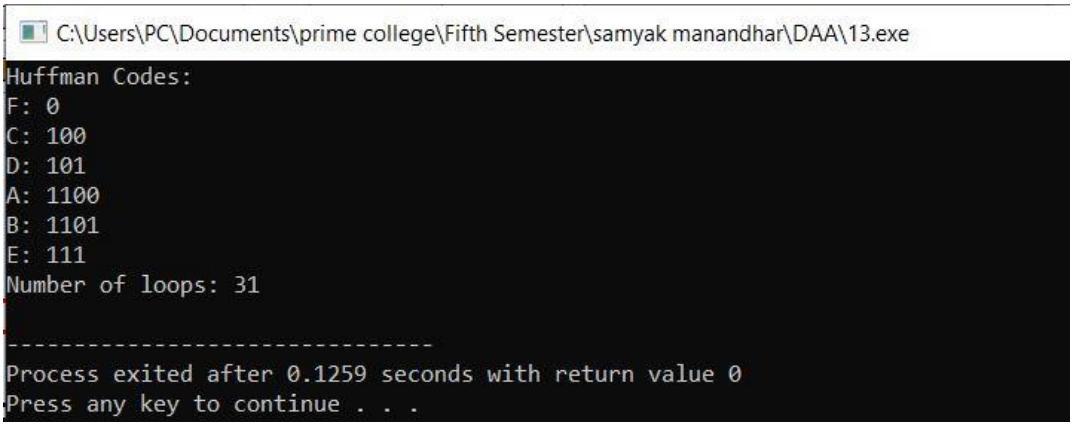
LAB-4.3 Huffmann Coding

Code:

```
#include <stdio.h>
#include <stdlib.h>
#define SIZE 100
typedef struct Node {
  char data;
  int freq;
  struct Node *left, *right;
} Node;
Node* createNode(char data, int freq) {
  Node* n = (Node*)malloc(sizeof(Node));
  n->data = data;
  n->freq = freq;
  n->left = n->right = NULL;
  return n;}
void printCodes(Node* root, int arr[], int top, int* loopCount) {
  if (root->left) {
    (*loopCount)++;
    arr[top] = 0;
    printCodes(root->left, arr, top + 1, loopCount);   }
  if (root->right) {
    (*loopCount)++;
    arr[top] = 1;
    printCodes(root->right, arr, top + 1, loopCount);   }
  if (!root->left && !root->right) {
    printf("%c: ", root->data);
    for (int i = 0; i < top; i++) printf("%d", arr[i]);
    printf("\n");   }}
Node* buildHuffmanTree(char data[], int freq[], int n, int* loopCount) {
  Node* heap[SIZE];
  int size = n;
  for (int i = 0; i < n; i++) {
    heap[i] = createNode(data[i], freq[i]);
    (*loopCount)++;   }
  while (size > 1) {
    int min1 = 0, min2 = 1;
    (*loopCount)++;
    if (heap[min2]->freq < heap[min1]->freq) {
      int temp = min1; min1 = min2; min2 = temp;      }
    for (int i = 2; i < size; i++) {
```

```
        (*loopCount)++;
        if (heap[i]->freq < heap[min1]->freq) {
          min2 = min1;
          min1 = i;
        } else if (heap[i]->freq < heap[min2]->freq) {
          min2 = i;
        } } Node* left = heap[min1], *right = heap[min2];
      Node* newNode = createNode('-', left->freq + right->freq);
      newNode->left = left;
      newNode->right = right;
      if (min1 < min2) {
        heap[min1] = newNode;
        heap[min2] = heap[size - 1];
      } else {
        heap[min2] = newNode;
        heap[min1] = heap[size - 1];      }
      size--;   }
   return heap[0];}
int main() {
   char data[] = { 'A', 'B', 'C', 'D', 'E', 'F' };
   int freq[] = { 5, 9, 12, 13, 16, 45 };
   int n = sizeof(data) / sizeof(data[0]);
   int arr[100], top = 0;
   int loopCount = 0;
   Node* root = buildHuffmanTree(data, freq, n, &loopCount);
   printf("Huffman Codes:\n");
   printCodes(root, arr, top, &loopCount);
   printf("Number of loops: %d\n", loopCount);
   return 0;
}
```

Output:



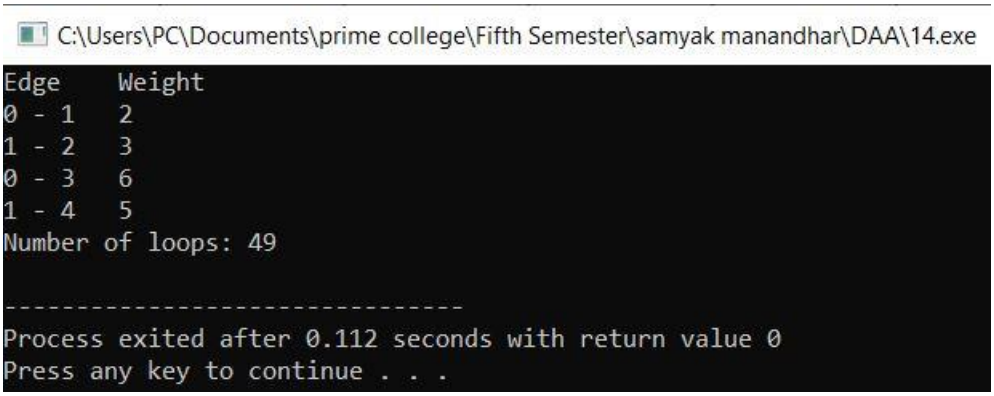
LAB-4.4 Prim's and Kruskal's algorithm

Code:

```
#include <stdio.h>
#include <limits.h>
#define V 5
int minKey(int key[], int mstSet[], int* loopCount) {
  int min = INT_MAX, min_index;
  for (int v = 0; v < V; v++) {
    (*loopCount)++;
    if (!mstSet[v] && key[v] < min) {
      min = key[v];
      min_index = v;
    }
  }
  return min_index;
}
void primMST(int graph[V][V], int* loopCount) {
  int parent[V], key[V], mstSet[V];
  for (int i = 0; i < V; i++) {
    key[i] = INT_MAX;
    mstSet[i] = 0;
    (*loopCount)++;
  }
  key[0] = 0;
  parent[0] = -1;
  for (int count = 0; count < V - 1; count++) {
    (*loopCount)++;
    int u = minKey(key, mstSet, loopCount);
    mstSet[u] = 1;
    for (int v = 0; v < V; v++) {
      (*loopCount)++;
      if (graph[u][v] && !mstSet[v] && graph[u][v] < key[v]) {
        parent[v] = u;
        key[v] = graph[u][v];
      }
    }
  }
  printf("Edge \tWeight\n");
  for (int i = 1; i < V; i++) {
    printf("%d - %d \t%d\n", parent[i], i, graph[i][parent[i]]);
  }
```

```
}
int main() {
   int graph[V][V] = {
      { 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 },
   };
   int loopCount = 0;
   primMST(graph, &loopCount);
   printf("Number of loops: %d\n", loopCount);
   return 0;
}
```

Output:

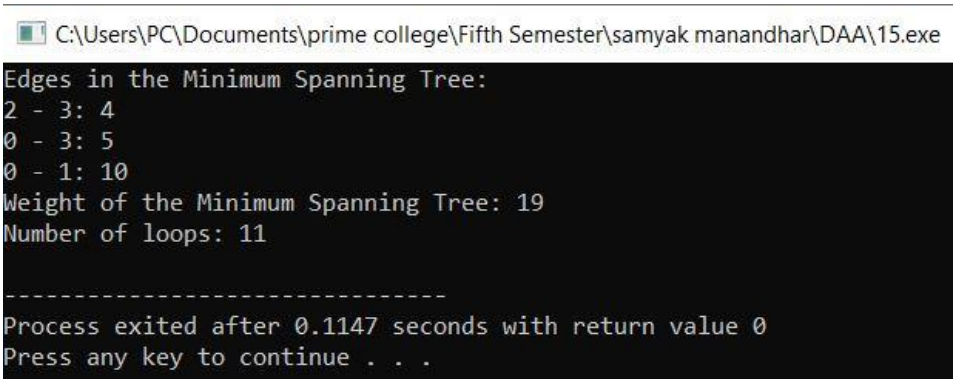


Code:

```
#include <stdio.h>
#include <stdlib.h>
#define MAX 100
typedef struct {
   int u, v, weight;
} Edge;
int findParent(int parent[], int i) {
   if (parent[i] == -1) return i;
   return findParent(parent, parent[i]);}
void unionSets(int parent[], int rank[], int x, int y) {
   int xroot = findParent(parent, x);
   int yroot = findParent(parent, y);
   if (rank[xroot] < rank[yroot]) parent[xroot] = yroot;
   else if (rank[xroot] > rank[yroot]) parent[yroot] = xroot;
   else {
```

```
    parent[yroot] = xroot;
    rank[xroot]++;   }}
int compare(const void* a, const void* b) {
  return ((Edge*)a)->weight - ((Edge*)b)->weight;}
void kruskal(int n, Edge edges[], int* loopCount) {
  int parent[MAX], rank[MAX];
  for (int i = 0; i < n; i++) {
    parent[i] = -1;
    rank[i] = 0;
    (*loopCount)++;   }
  qsort(edges, n, sizeof(Edge), compare);
  (*loopCount)++;
  int mstWeight = 0;
  printf("Edges in the Minimum Spanning Tree:\n");
  for (int i = 0; i < n; i++) {
    (*loopCount)++;
    int x = findParent(parent, edges[i].u);
    int y = findParent(parent, edges[i].v);
    if (x != y) {
      unionSets(parent, rank, x, y);
      mstWeight += edges[i].weight;
      printf("%d - %d: %d\n", edges[i].u, edges[i].v, edges[i].weight);     }   }
  printf("Weight of the Minimum Spanning Tree: %d\n", mstWeight);}
int main() {
  Edge edges[] = {
    {0, 1, 10}, {0, 2, 6}, {0, 3, 5}, {1, 3, 15}, {2, 3, 4}   };
  int n = sizeof(edges) / sizeof(edges[0]);
  int loopCount = 0;
  kruskal(n, edges, &loopCount);
  printf("Number of loops: %d\n", loopCount);
  return 0;}
```

Output:



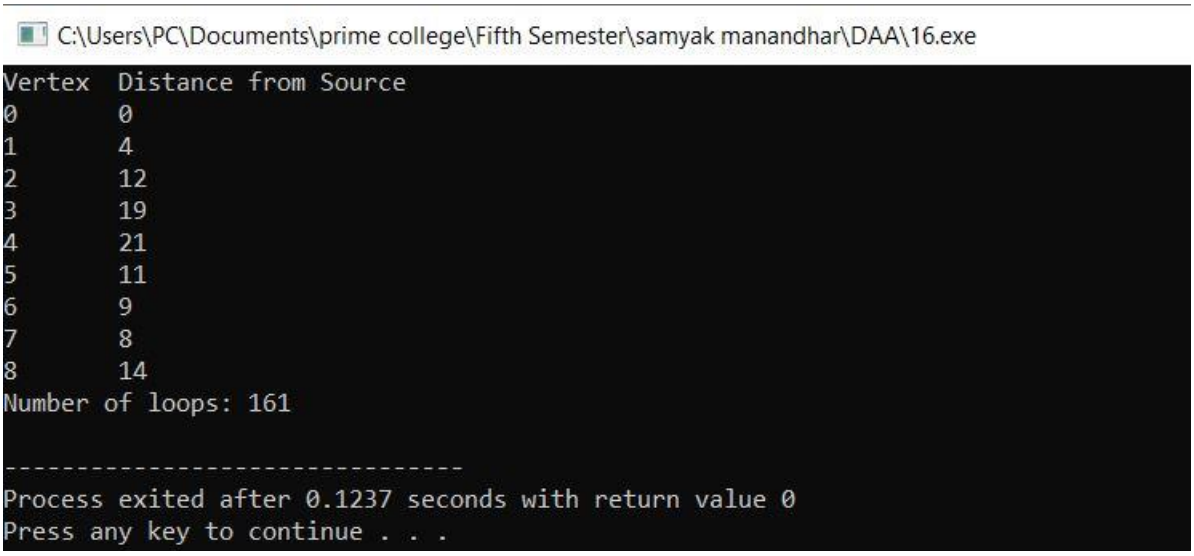
LAB-4.5 Dijkstra's Algorithm

Code:

```
#include <stdio.h>
#include <limits.h>
#define V 9
int minDistance(int dist[], int sptSet[], int* loopCount) {
  int min = INT_MAX, min_index;
  for (int v = 0; v < V; v++) {
    (*loopCount)++;
    if (!sptSet[v] && dist[v] <= min) {
      min = dist[v];
      min_index = v;
    }
  }
  return min_index;
}
void dijkstra(int graph[V][V], int src, int* loopCount) {
  int dist[V], sptSet[V];
  for (int i = 0; i < V; i++) {
    dist[i] = INT_MAX;
    sptSet[i] = 0;
    (*loopCount)++;
  }
  dist[src] = 0;
  for (int count = 0; count < V - 1; count++) {
    (*loopCount)++;
    int u = minDistance(dist, sptSet, loopCount);
    sptSet[u] = 1;
    for (int v = 0; v < V; v++) {
      (*loopCount)++;
      if (!sptSet[v] && graph[u][v] && dist[u] != INT_MAX && dist[u] + graph[u][v] < dist[v]) {
        dist[v] = dist[u] + graph[u][v];
      }
    }
  }
  printf("Vertex \tDistance from Source\n");
  for (int i = 0; i < V; i++) {
    printf("%d \t%d\n", i, dist[i]);
  }
}
int main() {
```

```
    int graph[V][V] = {
        {0, 4, 0, 0, 0, 0, 0, 8, 0},
        {4, 0, 8, 0, 0, 0, 0, 11, 0},
        {0, 8, 0, 7, 0, 4, 0, 0, 2},
        {0, 0, 7, 0, 9, 14, 0, 0, 0},
        {0, 0, 0, 9, 0, 10, 0, 0, 0},
        {0, 0, 4, 14, 10, 0, 2, 0, 0},
        {0, 0, 0, 0, 0, 2, 0, 1, 6},
        {8, 11, 0, 0, 0, 0, 1, 0, 7},
        {0, 0, 2, 0, 0, 0, 6, 7, 0}
    };
    int loopCount = 0;
    dijkstra(graph, 0, &loopCount);
    printf("Number of loops: %d\n", loopCount);
    return 0;
}
```

Output:



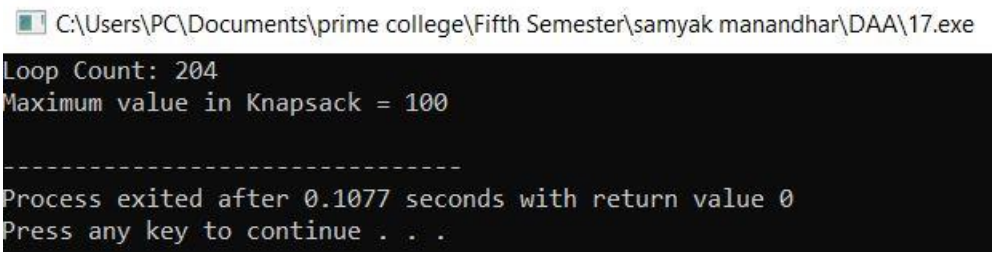
Dynamic Programming

LAB-5.1 0/1 Knapsack Problem

Code:

```
#include <stdio.h>
int knapsack(int W, int wt[], int val[], int n) {
   int dp[n+1][W+1];
   int loopCount = 0;
   for (int i = 0; i <= n; i++) {
      for (int w = 0; w <= W; w++) {
         loopCount++;
         if (i == 0 || w == 0)
            dp[i][w] = 0;
         else if (wt[i-1] <= w)
            dp[i][w] = (val[i-1] + dp[i-1][w-wt[i-1]] > dp[i-1][w]) ? (val[i-1] + dp[i-1][w-wt[i-1]]) : dp[i-1][w];
         else
            dp[i][w] = dp[i-1][w];
      }
   }
   printf("Loop Count: %d\n", loopCount);
   return dp[n][W];
}
int main() {
   int val[] = {30, 40, 60};
   int wt[] = {10, 20, 30};
   int W = 50;
   int n = sizeof(val) / sizeof(val[0]);
   printf("Maximum value in Knapsack = %d\n", knapsack(W, wt, val, n));
   return 0;
}
```

Output:

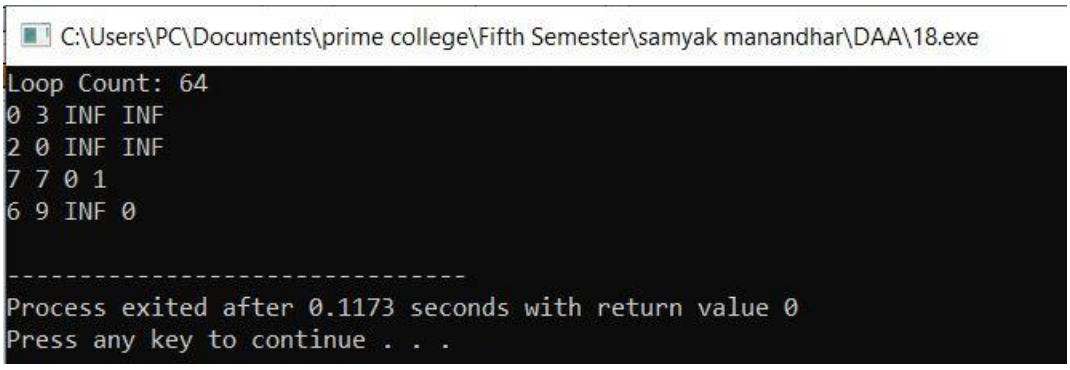


LAB-5.2 Floyd Warshall Problem

Code:

```
#include <stdio.h>
#define INF 99999
void floydWarshall(int graph[][4], int V) {
  int dist[V][V];
  int loopCount = 0;
  for (int i = 0; i < V; i++)
    for (int j = 0; j < V; j++)
      dist[i][j] = graph[i][j];
  for (int k = 0; k < V; k++) {
    for (int i = 0; i < V; i++) {
      for (int j = 0; j < V; j++) {
        loopCount++;
        if (dist[i][j] > dist[i][k] + dist[k][j])
          dist[i][j] = dist[i][k] + dist[k][j];
      }    }  }
  printf("Loop Count: %d\n", loopCount);
  for (int i = 0; i < V; i++) {
    for (int j = 0; j < V; j++) {
      if (dist[i][j] == INF)
        printf("INF ");
      else
        printf("%d ", dist[i][j]);      }
    printf("\n");   }}
int main() {
  int graph[4][4] = { {0, 3, INF, INF}, {2, 0, INF, INF}, {INF, 7, 0, 1}, {6, INF, INF, 0} };
  int V = 4;
  floydWarshall(graph, V);
  return 0;
}
```

Output:

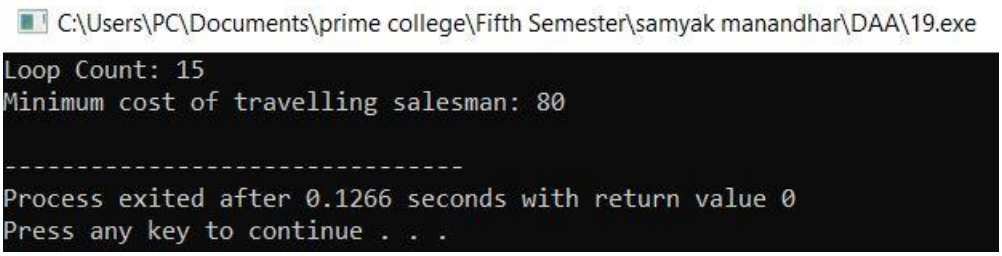


LAB-5.3 Travelling Salesman

Code:

```
#include <stdio.h>
#include <limits.h>
#define V 4
#define INF INT_MAX
int tsp(int dist[][V], int visited[], int currPos, int count, int cost, int ans) {
  static int loopCount = 0;
  if (count == V && dist[currPos][0]) {
    ans = (cost + dist[currPos][0] < ans) ? (cost + dist[currPos][0]) : ans;
    return ans;
  }
  for (int i = 0; i < V; i++) {
    if (!visited[i] && dist[currPos][i]) {
      loopCount++;
      visited[i] = 1;
      ans = tsp(dist, visited, i, count + 1, cost + dist[currPos][i], ans);
      visited[i] = 0;
    }
  }
  if (currPos == 0 && count == 1) {
    printf("Loop Count: %d\n", loopCount);
  }  return ans;
}
int main() {
  int dist[][V] = { {0, 10, 15, 20}, {10, 0, 35, 25}, {15, 35, 0, 30}, {20, 25, 30, 0} };
  int visited[V] = {0};
  visited[0] = 1;
  int ans = INF;
  printf("Minimum cost of travelling salesman: %d\n", tsp(dist, visited, 0, 1, 0, ans));
  return 0;
}
```

Output:



LAB-5.4 Matrix Chain Multiplication (Parenthesis Order)

Code:

```
#include <stdio.h>
#include <limits.h>
int matrixChainOrder(int p[], int n) {
  int m[n][n];
  int s[n][n];
  int loopCount = 0;
  for (int i = 1; i < n; i++)
    m[i][i] = 0;
  for (int len = 2; len < n; len++) {
    for (int i = 1; i < n - len + 1; i++) {
      int j = i + len - 1;
      m[i][j] = INT_MAX;
      for (int k = i; k < j; k++) {
        loopCount++;
        int q = m[i][k] + m[k+1][j] + p[i-1] * p[k] * p[j];
        if (q < m[i][j]) {
          m[i][j] = q;
          s[i][j] = k;
        }       }     }
  }
  printf("Loop Count: %d\n", loopCount);
  return m[1][n-1];
}
int main() {
  int arr[] = {1, 2, 3, 4};
  int n = sizeof(arr) / sizeof(arr[0]);
  printf("Minimum number of multiplications is %d\n", matrixChainOrder(arr, n));
  return 0;
}
```

Output:

```
C:\Users\PC\Documents\prime college\Fifth Semester\samyak manandhar\DAA\20.exe
Loop Count: 4
Minimum number of multiplications is 18

--------------------------------
Process exited after 0.1092 seconds with return value 0
Press any key to continue . . .
```

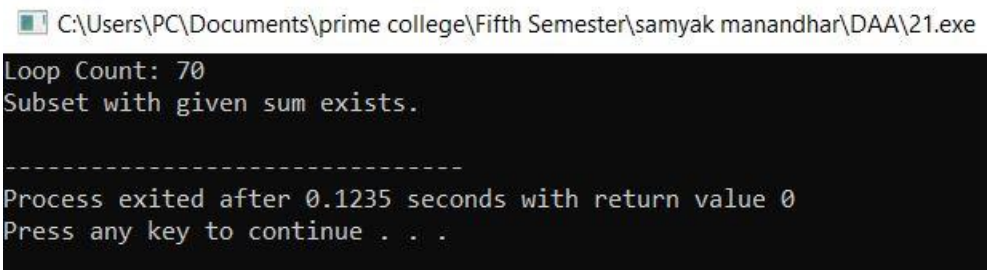
Backtracking Algorithm

LAB-6.1 Sum of subset Problem

Code:

```
#include <stdio.h>
int subsetSum(int set[], int n, int sum) {
   int dp[n+1][sum+1];
   int loopCount = 0;
   for (int i = 0; i <= n; i++) {
      for (int j = 0; j <= sum; j++) {
         loopCount++;
         if (j == 0)
            dp[i][j] = 1;
         else if (i == 0)
            dp[i][j] = 0;
         else if (set[i-1] <= j)
            dp[i][j] = dp[i-1][j] || dp[i-1][j-set[i-1]];
         else
            dp[i][j] = dp[i-1][j];
      }  }
   printf("Loop Count: %d\n", loopCount);
   return dp[n][sum];
}
int main() {
   int set[] = {3, 34, 4, 12, 5, 2};
   int sum = 9;
   int n = sizeof(set) / sizeof(set[0]);
   if (subsetSum(set, n, sum))
      printf("Subset with given sum exists.\n");
   else
      printf("No subset with given sum exists.\n");
   return 0;
}
```

Output:

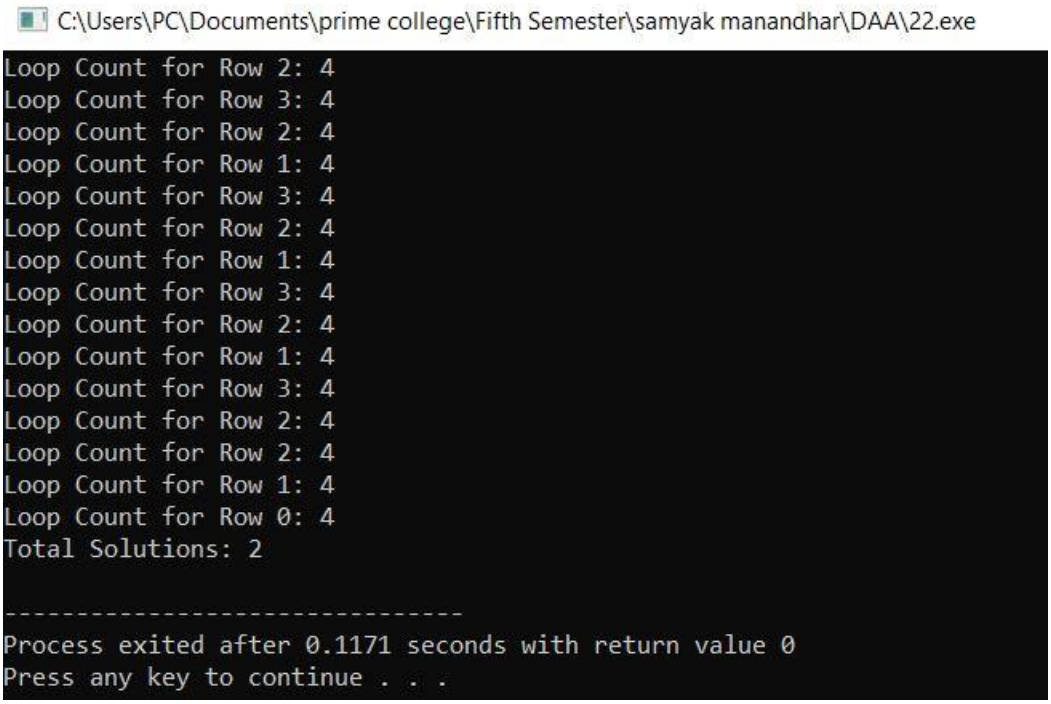


LAB-6.2 N-Queen Problem

Code:

```
#include <stdio.h>
#include <stdbool.h>
int count = 0;
bool isSafe(int board[][10], int row, int col, int N) {
  int i, j;
  for (i = 0; i < row; i++)
    if (board[i][col])
      return false;
  for (i = row, j = col; i >= 0 && j >= 0; i--, j--)
    if (board[i][j])
      return false;
  for (i = row, j = col; i >= 0 && j < N; i--, j++)
    if (board[i][j])
      return false;
  return true;
}
void solveNQueen(int board[][10], int row, int N) {
  int loopCount = 0;
  if (row == N) {
    count++;
    return;
  }
  for (int col = 0; col < N; col++) {
    loopCount++;
    if (isSafe(board, row, col, N)) {
      board[row][col] = 1;
      solveNQueen(board, row + 1, N);
      board[row][col] = 0;
    }
  }
  printf("Loop Count for Row %d: %d\n", row, loopCount);
}
int main() {
  int N = 4;
  int board[10][10] = {0};
  solveNQueen(board, 0, N);
  printf("Total Solutions: %d\n", count);
  return 0;
}
```

Output:


C:\Users\PC\Documents\prime college\Fifth Semester\samyak manandhar\DAA\22.exe
Loop Count for Row 2: 4
Loop Count for Row 3: 4
Loop Count for Row 2: 4
Loop Count for Row 1: 4
Loop Count for Row 3: 4
Loop Count for Row 2: 4
Loop Count for Row 1: 4
Loop Count for Row 3: 4
Loop Count for Row 2: 4
Loop Count for Row 1: 4
Loop Count for Row 3: 4
Loop Count for Row 2: 4
Loop Count for Row 2: 4
Loop Count for Row 1: 4
Loop Count for Row 0: 4
Total Solutions: 2

Process exited after 0.1171 seconds with return value 0
Press any key to continue . . .