VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

Kavana M A (1BM23CS145)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **Kavana M A (1BM23CS145)**, who is 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 2024-25. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)**work prescribed for the said degree.

Prof. Namratha M
Assistant Professor
Department of CSE
BMSCE, Bengaluru

Dr. Kavitha Sooda
Professor and Head
Department of CSE
BMSCE, Bengaluru

Index Sheet

Course outcomes:

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations of different data structures.

Lab program 1:

Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display
The program should print appropriate messages for stack overflow, stack underflow.

```
#include <stdio.h>
#include<stdlib.h>
#define STACK_SIZE 5
void push(int st[],int *top)
{
        int item;
        if(*top==STACK_SIZE-1)
                printf("Stack overflow\n");
        else
        {
                printf("\nEnter an item :");
                scanf("%d",&item);
                (*top)++;
                st[*top]=item;
        }
}
void pop(int st[],int *top)
{
        if(*top==-1)
                printf("Stack underflow\n");
        else
        {
                printf("\n%d item was deleted",st[(*top)--]);
        }
}
void display(int st[],int *top)
{
        int i;
        if(*top==-1)
                printf("Stack is empty\n");
        for(i=0;i<=*top;i++)
                printf("%d\t",st[i]);
}
void main()
{
        int st[10],top=-1, c,val_del;
        while(1)
        {
                printf("\n1. Push\n2. Pop\n3. Display\n");
                printf("\nEnter your choice :");
                scanf("%d",&c);
                switch(c)
                {
```

```
case 1: push(st,&top);
                        break;
                case 2: pop(st,&top);
                        break;
                case 3: display(st,&top);
                        break;
                default: printf("\nInvalid choice!!!");
                        exit(0);
            }
        }
}
```

Output:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL

PS D:\jyothika\DST> cd "d:\jyothika\DST\" ; if ($?) { gcc 1.c -o 1 } ; if ($?) { .\1 }

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :12

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :65

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :45

1. Push
2. Pop
3. Display

Enter your choice :1
Stack overflow
```

```
1. Push
2. Pop
3. Display

Enter your choice :2

45 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2

65 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :3
12
1. Push
2. Pop
3. Display

Enter your choice :2

12 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2
Stack underflow

1. Push
2. Pop
3. Display

Enter your choice :4

Invalid choice!!!
```

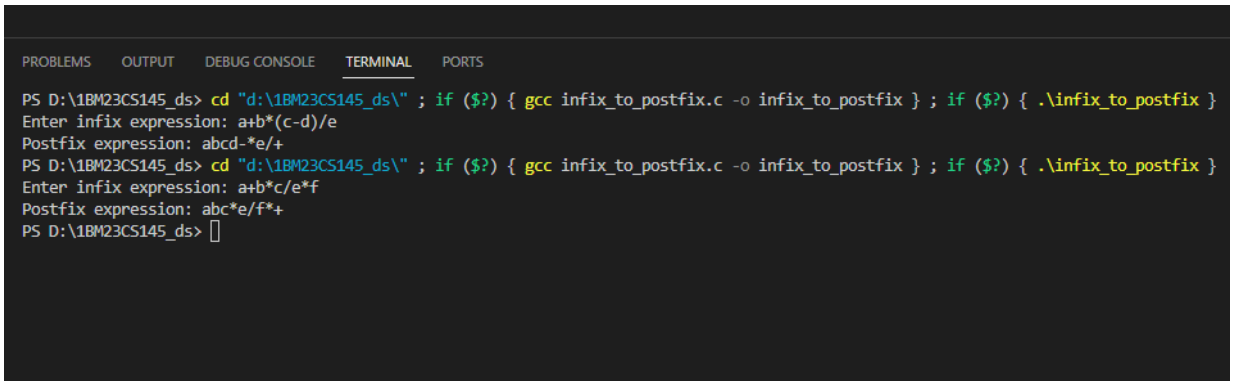
Lab program 2:

Program to convert a given valid parenthesized infix arithmetic expression to postfix expression.

```
#include <stdio.h>
#define STACK_SIZE 15

void push(char s[], int *top, char item) {
   (*top)++;
   s[*top] = item;
}

char pop(char s[], int *top) {
   return s[(*top)--];
}

int pr(char op) {
   switch(op) {
      case '#': return 0;
      case '(': return 1;
      case '+': return 2;
      case '-': return 2;
      case '*': return 3;
      case '/': return 3;
      default: return 0;
   }
}

int main() {
   char s[STACK_SIZE];
   int top = -1;
   char str[30], postfix[30];
   int i = 0, j = 0;

   push(s, &top, '#');
   printf("Enter infix expression: ");
   scanf("%s", str);

   while (str[i] != '\0') {
      if (str[i] != '+' && str[i] != '-' && str[i] != '*' && str[i] != '/' && str[i] != '(' && str[i] !=
')') {
         postfix[j++] = str[i];
      } else if (str[i] == '(') {
         push(s, &top, str[i]);
      } else if (str[i] == ')') {
         while (s[top] != '(') {
```

```
            postfix[j++] = pop(s, &top);
        }
        pop(s, &top);
    } else {
        while (pr(str[i]) <= pr(s[top])) {
            postfix[j++] = pop(s, &top);
        }
        push(s, &top, str[i]);
    }
    i++;
  }

  while (top > 0) {
    postfix[j++] = pop(s, &top);
  }

  postfix[j] = '\0';
  printf("Postfix expression: %s\n", postfix);
  return 0;
}
```

Output:



Lab program 3:

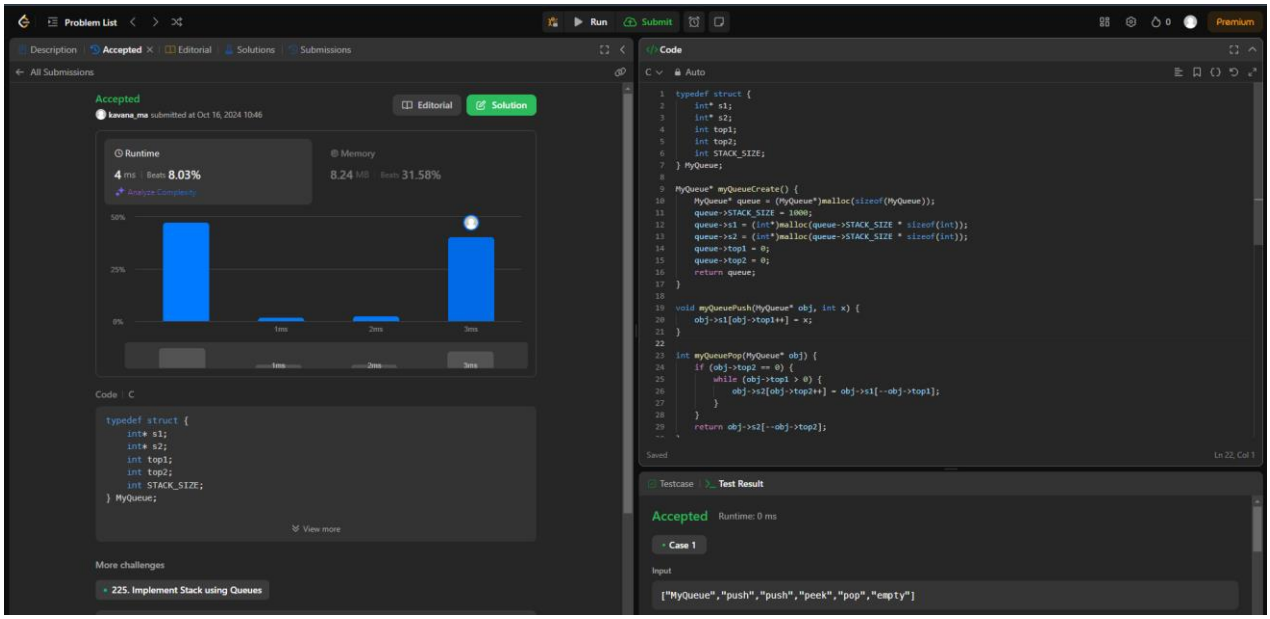
Program to simulate the working of a queue
LeetCode 1: Queue using Stack
Program to simulate the working of a circular queue
LeetCode 2: Valid Parentheses

LeetCode 1: Queue using Stack

```
typedef struct {
    int* s1;
    int* s2;
    int top1;
    int top2;
    int STACK_SIZE;
} MyQueue;

MyQueue* myQueueCreate() {
    MyQueue* queue = (MyQueue*)malloc(sizeof(MyQueue));
    queue->STACK_SIZE = 1000;
    queue->s1 = (int*)malloc(queue->STACK_SIZE * sizeof(int));
    queue->s2 = (int*)malloc(queue->STACK_SIZE * sizeof(int));
    queue->top1 = 0;
    queue->top2 = 0;
    return queue;
}

void myQueuePush(MyQueue* obj, int x) {
    obj->s1[obj->top1++] = x;
}

int myQueuePop(MyQueue* obj) {
    if (obj->top2 == 0) {
        while (obj->top1 > 0) {
            obj->s2[obj->top2++] = obj->s1[--obj->top1];
        }
    }
    return obj->s2[--obj->top2];
}

int myQueuePeek(MyQueue* obj) {
    if (obj->top2 == 0) {
        while (obj->top1 > 0) {
            obj->s2[obj->top2++] = obj->s1[--obj->top1];
        }
```

```
    }
    return obj->s2[obj->top2 - 1];
}

bool myQueueEmpty(MyQueue* obj) {
    return obj->top1 == 0 && obj->top2 == 0;
}

void myQueueFree(MyQueue* obj) {
    free(obj->s1);
    free(obj->s2);
    free(obj);
}

/**
 * Your MyQueue struct will be instantiated and called as such:
 * MyQueue* obj = myQueueCreate();
 * myQueuePush(obj, x);
 * int param_2 = myQueuePop(obj);
 * int param_3 = myQueuePeek(obj);
 * bool param_4 = myQueueEmpty(obj);
 * myQueueFree(obj);
*/
```

Output:



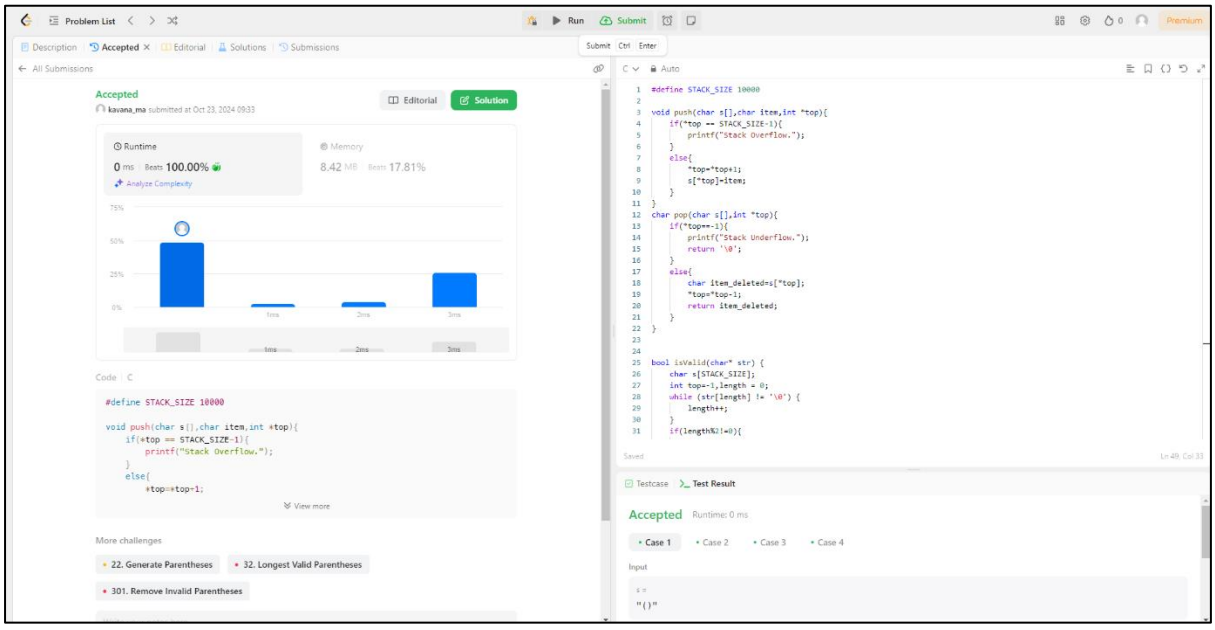
LeetCode 2: Valid Parentheses

```
#define STACK_SIZE 10000
```

```
void push(char s[],char item,int *top){
   if(*top == STACK_SIZE-1){
      printf("Stack Overflow.");
   }
   else{
      *top=*top+1;
      s[*top]=item;
   }
}
char pop(char s[],int *top){
   if(*top==-1){
      printf("Stack Underflow.");
      return '\0';
   }
   else{
      char item_deleted=s[*top];
      *top=*top-1;
      return item_deleted;
   }
}

bool isValid(char* str) {
   char s[STACK_SIZE];
   int top=-1,length = 0;
   while (str[length] != '\0') {
      length++;
   }
   if(length%2!=0){
      return false;
   }

   for(int i=0;i<length;i++){
      if(str[i]=='(' || str[i]=='[' || str[i]=='{'){
         push(s,str[i],&top);
      }
      else{
         if (top == -1) {
            return false;
         }
         if(str[i]==')'){
            if(s[top]=='('){
            pop(s,&top);}
            else{return false;}
         }
```

```
            else if(str[i]==']'){
                if(s[top]=='['){
                pop(s,&top);}
                else{return false;}
            }
            else{
                if(s[top]=='{'){
                pop(s,&top);}
                else{return false;}
            }
        }
    }
    return top == -1;
}
```

Output:



Lab program 4:

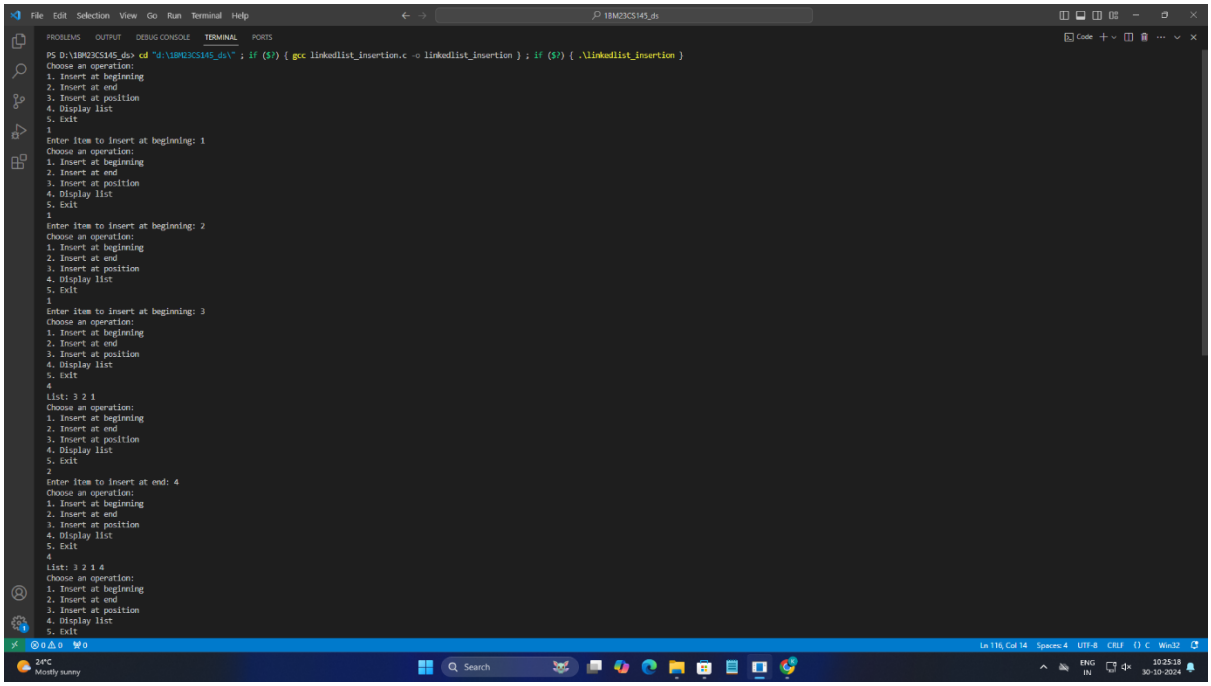
Program to Implement Singly Linked List (Insertion at first position, at any position and at end of list). Display the contents of the linked list.

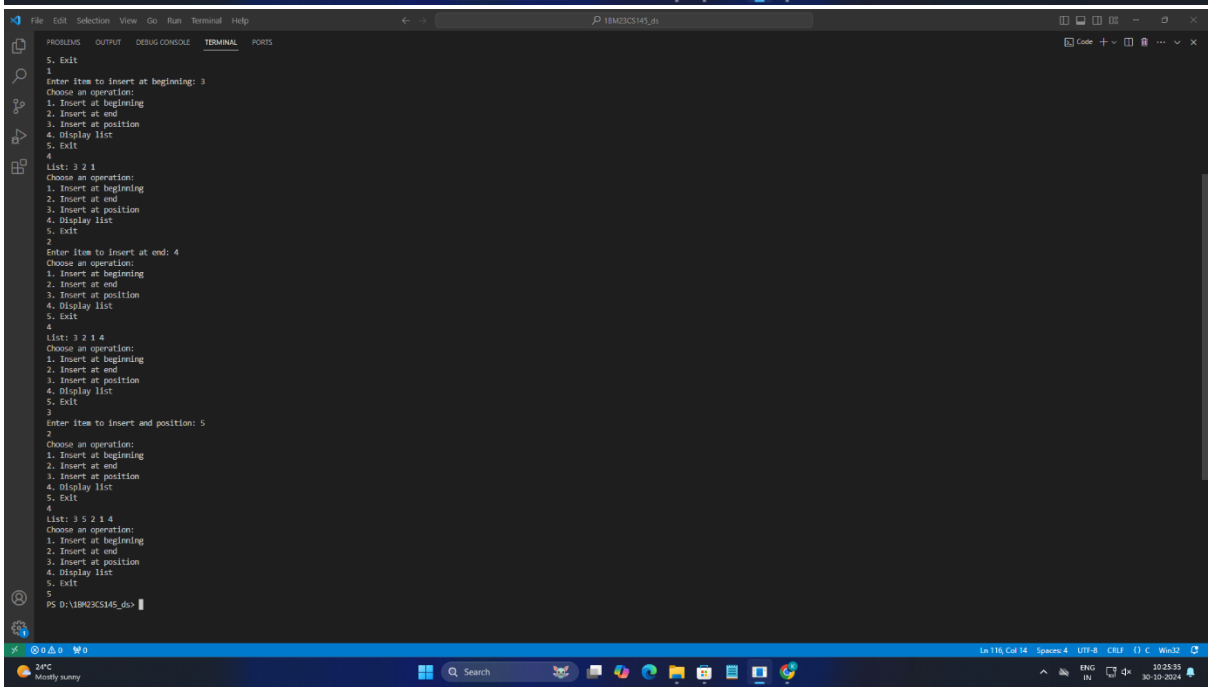
```
#include <stdio.h>
#include <stdlib.h>

struct node {
   int value;
   struct node *next;
};
typedef struct node *NODE;

NODE get_node() {
   NODE ptr = (NODE)malloc(sizeof(struct node));
   if (ptr == NULL) {
      printf("Memory not allocated\n");
   }
   return ptr;
}

NODE insert_beginning(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
   new_node->next = first;
   return new_node;
}

NODE insert_end(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
   new_node->next = NULL;
   if (first == NULL) {
      return new_node;
   }
   NODE temp = first;
   while (temp->next != NULL) {
      temp = temp->next;
   }
   temp->next = new_node;
   return first;
}
```

```
NODE insert_pos(NODE first, int item, int pos) {
   NODE new_node = get_node();
   new_node->value = item;
   if (pos == 1) {
      new_node->next = first;
      return new_node;
   }
   int count = 1;
   NODE prev = NULL, current = first;
   while (count < pos && current != NULL) {
      prev = current;
      current = current->next;
      count++;
   }
   if (prev != NULL) {
      prev->next = new_node;
      new_node->next = current;
   } else {
      printf("Invalid position\n");
   }
   return first;
}

void display(NODE first) {
   NODE temp = first;
   if (first == NULL) {
      printf("Empty\n");
      return;
   }
   while (temp != NULL) {
      printf("%d ", temp->value);
      temp = temp->next;
   }
   printf("\n");
}

int main() {
   int item, pos, choice;
   NODE first = NULL;

   while (1) {
      printf("Choose an operation:\n");
      printf("1. Insert at beginning\n");
      printf("2. Insert at end\n");
```

```
        printf("3. Insert at position\n");
        printf("4. Display list\n");
        printf("5. Exit\n");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter item to insert at beginning: ");
                scanf("%d", &item);
                first = insert_beginning(first, item);
                break;
            case 2:
                printf("Enter item to insert at end: ");
                scanf("%d", &item);
                first = insert_end(first, item);
                break;
            case 3:
                printf("Enter item to insert and position: ");
                scanf("%d %d", &item, &pos);
                first = insert_pos(first, item, pos);
                break;
            case 4:
                printf("List: ");
                display(first);
                break;
            case 5:
                exit(0);
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }

    return 0;
}
```

Output:


PS D:\18M23CS145_ds> cd "d:\18M23CS145_ds\" ; if ($?) { gcc linkedlist_insertion.c -o linkedlist_insertion } ; if ($?) { .\linkedlist_insertion }
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
1
Enter item to insert at beginning: 1
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
1
Enter item to insert at beginning: 2
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
1
Enter item to insert at beginning: 3
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
2
Enter item to insert at end: 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit


5. Exit
1
Enter item to insert at beginning: 3
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
2
Enter item to insert at end: 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
3
Enter item to insert and position: 5
2
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 5 2 1 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
5
PS D:\18M23CS145_ds>

Lab Program 5:
Program to Implement Singly Linked List (Delete first element,Delete last element, Delete,Display)

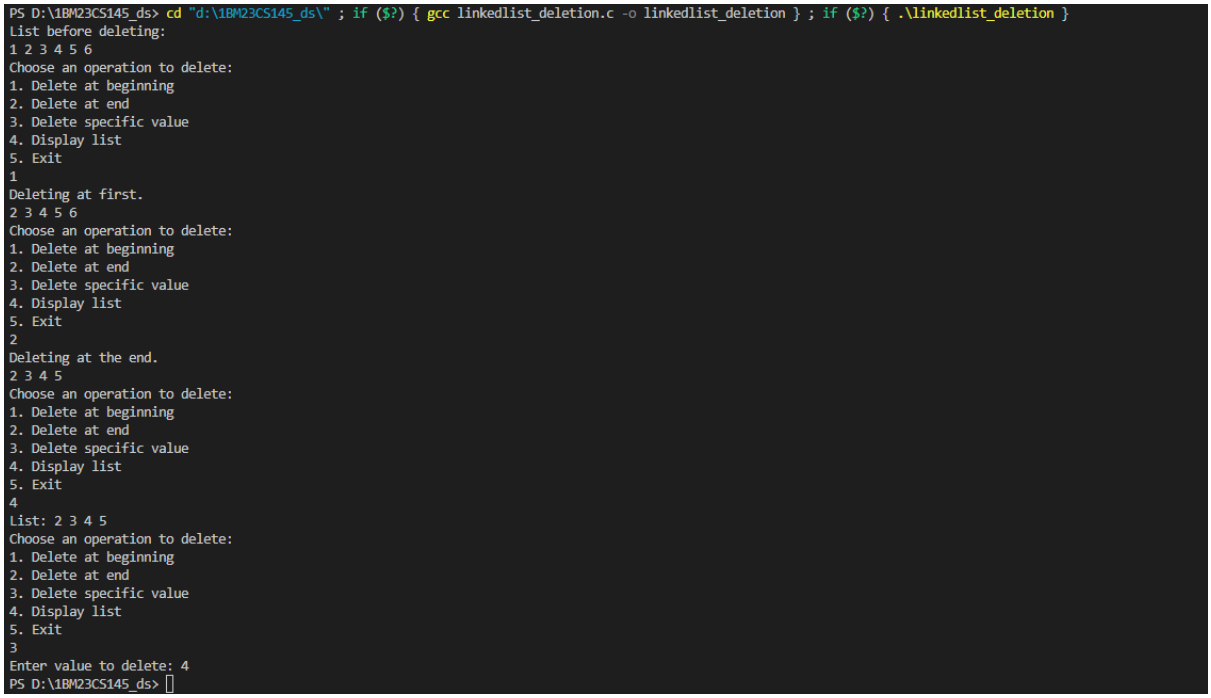
```
#include <stdio.h>
#include <stdlib.h>

struct node {
   int value;
   struct node *next;
};
typedef struct node *NODE;

NODE get_node() {
   NODE ptr = (NODE)malloc(sizeof(struct node));
   if (ptr == NULL) {
      printf("Memory not allocated\n");
   }
   return ptr;
}

NODE delete_first(NODE first){
   NODE temp=first;
   if (first == NULL) {
      printf("Empty\n");
      return NULL;
   }
   first=first->next;
   free(temp);
   return first;
}

NODE delete_end(NODE first){
   if (first == NULL) {
      printf("Empty\n");
      return NULL;
   }
   NODE prev,last;
   prev=NULL;
   last=first;
   while(last->next!=NULL){
      prev=last;
      last=last->next;
   }
   prev->next=NULL;
```

```
    free(last);
    return first;
}

NODE delete_value(NODE first,int value){
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
    NODE prev,current;
    prev=NULL;
    current=first;
    while(value!=current->value || current->next!=NULL){
        prev=current;
        current=current->next;
    }
    if(current==NULL){
        printf("Value notfound");
        return first;
    }
    prev->next=current->next;
    free(current);
    return first;
}

NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}
```

```
int main() {
    int item, choice;
    NODE first = NULL;

    first = insert_beginning(first, 6);
    first = insert_beginning(first, 5);
    first = insert_beginning(first, 4);
    first = insert_beginning(first, 3);
    first = insert_beginning(first, 2);
    first = insert_beginning(first, 1);

    printf("List before deleting:\n");
    display(first);

    while (1) {
        printf("Choose an operation to delete:\n");
        printf("1. Delete at beginning\n");
        printf("2. Delete at end\n");
        printf("3. Delete specific value\n");
        printf("4. Display list\n");
        printf("5. Exit\n");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Deleting at first.\n");
                first = delete_first(first);
                display(first);
                break;
            case 2:
                printf("Deleting at the end.\n");
                first = delete_end(first);
                display(first);
                break;
            case 3:
                printf("Enter value to delete: ");
                scanf("%d", &item);
                first = delete_value(first, item);
                display(first);
                break;
            case 4:
                printf("List: ");
                display(first);
```

```
            break;
        case 5:
            exit(0);
        default:
            printf("Invalid choice. Please try again.\n");
      }
   }

   return 0;
}
```

Output:



Lab Program 6:

a) **Linked list operations (Sort, Reverse, Concatenate)**
b) **Implementation of Queue and Stack using Linked List**

a)

```
#include <stdio.h>
#include <stdlib.h>
struct node {
   int value;
   struct node *next;
};
typedef struct node *NODE;
NODE get_node() {
   NODE ptr = (NODE)malloc(sizeof(struct node));
   if (ptr == NULL) {
      printf("Memory not allocated\n");
   }
   return ptr;
}
NODE insert_beginning(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
   new_node->next = first;
   return new_node;
}
NODE insert_end(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
   new_node->next = NULL;
   if (first == NULL) {
      return new_node;
   }
   NODE temp = first;
   while (temp->next != NULL) {
      temp = temp->next;
   }
   temp->next = new_node;
   return first;
}
NODE delete_first(NODE first){
   NODE temp=first;
   if (first == NULL) {
      printf("Empty\n");
      return NULL;
```

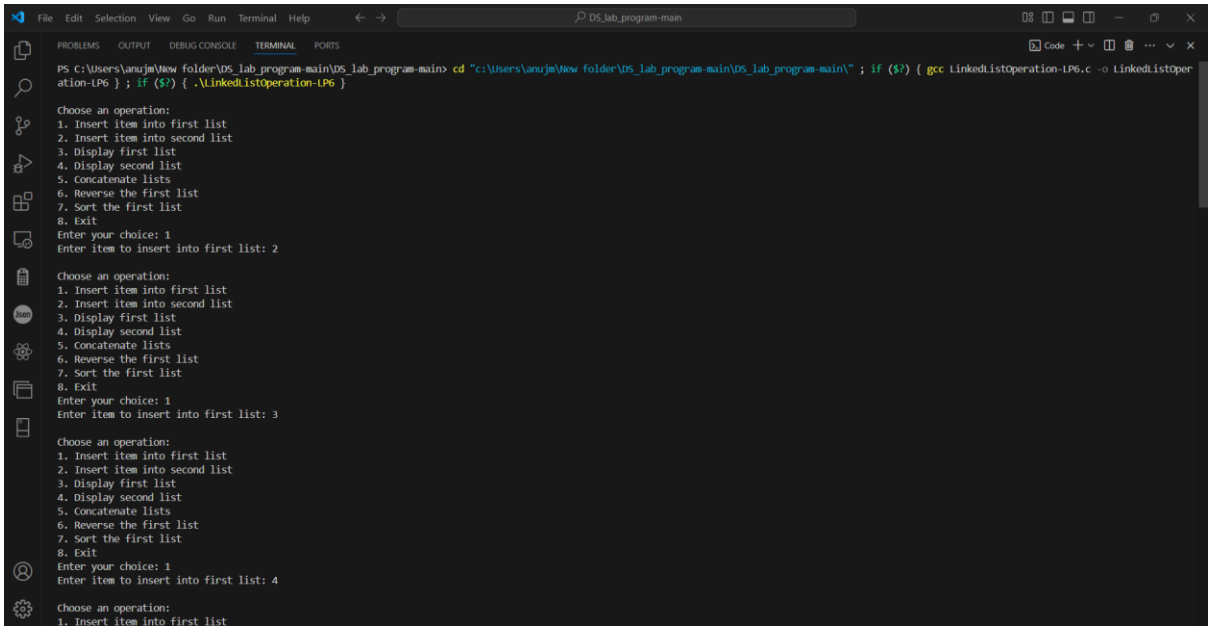
```
    }
    first=first->next;
    free(temp);
    return first;
}
NODE delete_end(NODE first){
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
    NODE prev,last;
    prev=NULL;
    last=first;
    while(last->next!=NULL){
        prev=last;
        last=last->next;
    }
    prev->next=NULL;
    free(last);
    return first;
}
void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

NODE concatenate(NODE first1, NODE first2){
    if(first1 == NULL && first2==NULL){ return NULL;}
    if(first1==NULL){ return first2; }
    if(first2==NULL){ return first1; }
    NODE temp=first1;
    while(temp->next!= NULL){
        temp=temp->next;
    }
    temp->next=first2;
    return first1;
```

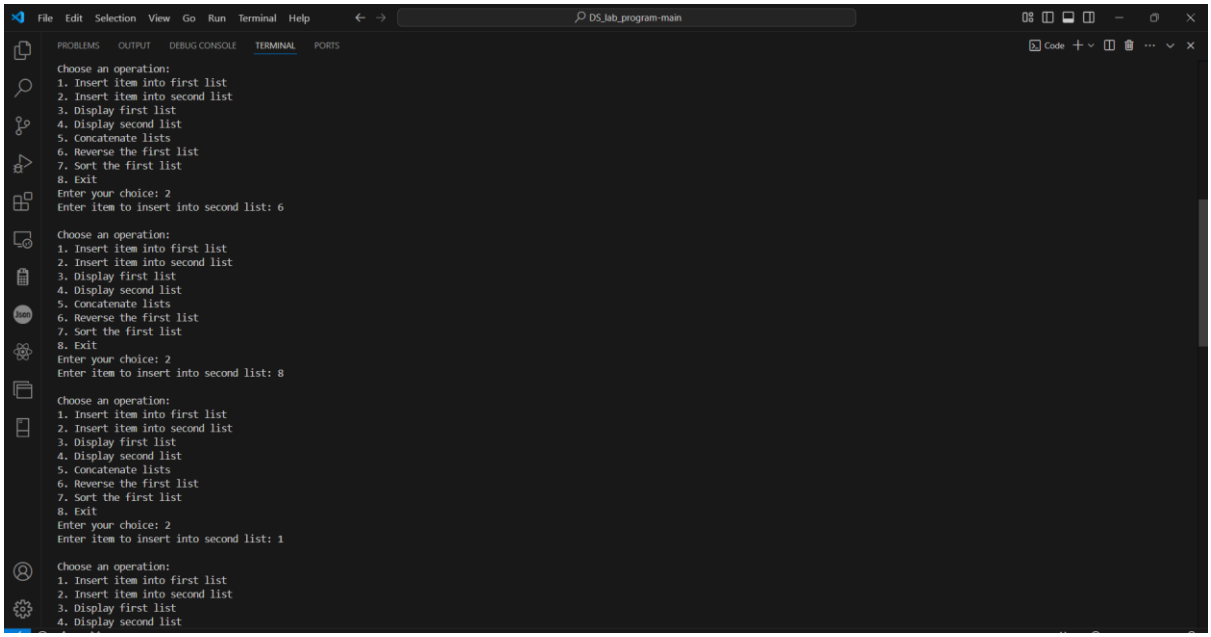
```
}

NODE reverse(NODE first){
   if(first==NULL){
      return NULL;
   }
   NODE curr=NULL,temp;
   while(first!=NULL){
      temp=first;
      first=first->next;
      temp->next=curr;
      curr=temp;
   }
   return curr;
}

void sort(NODE first){
   NODE temp1=first,temp2=first->next;
   while((temp1->next)!=NULL){
      while(temp2!=NULL){
         if(temp1->value >= temp2->value){
            int x=temp1->value;
            temp1->value=temp2->value;
            temp2->value=x;
         }
      temp2=temp2->next;
      }
   temp1=temp1->next;
   }
}

int main() {
   int choice, item;
   NODE first1 = NULL, first2 = NULL, mergedList = NULL;
   NODE ConcatenatedList;

   // Menu to choose operations
   while (1) {
      printf("\nChoose an operation:\n");
      printf("1. Insert item into first list\n");
      printf("2. Insert item into second list\n");
      printf("3. Display first list\n");
      printf("4. Display second list\n");
      printf("5. Concatenate lists\n");
```

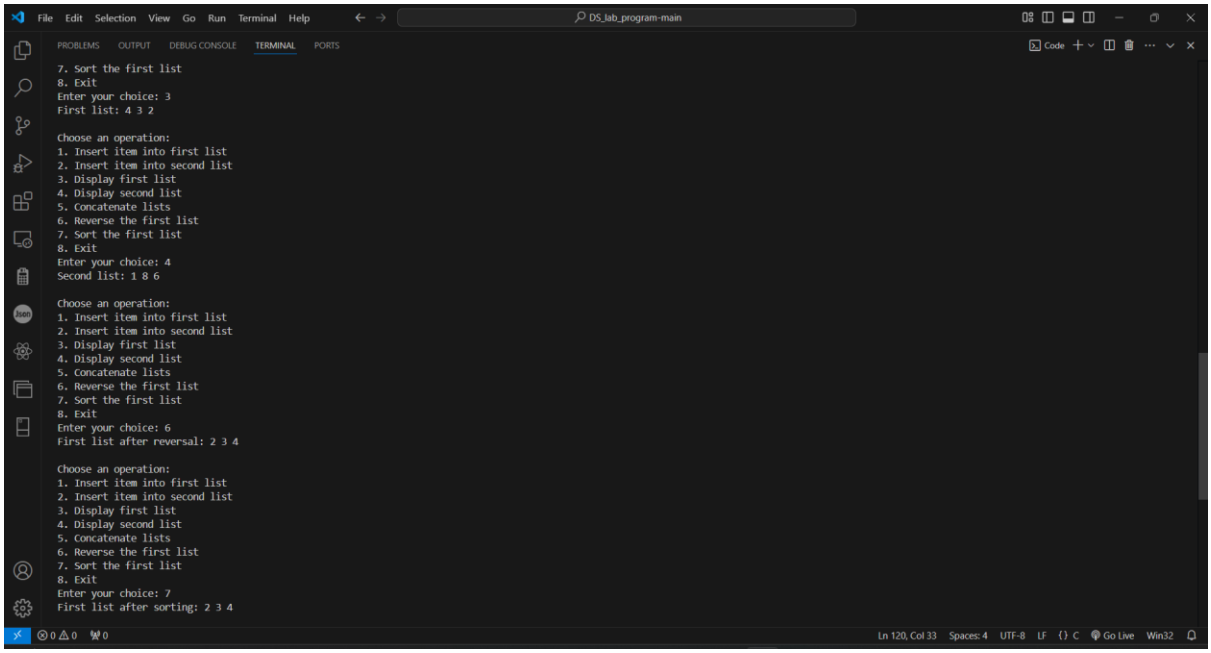
```
printf("6. Reverse the first list\n");
printf("7. Sort the first list\n");
printf("8. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
   case 1:
      printf("Enter item to insert into first list: ");
      scanf("%d", &item);
      first1 = insert_beginning(first1, item);
      break;
   case 2:
      printf("Enter item to insert into second list: ");
      scanf("%d", &item);
      first2 = insert_beginning(first2, item);
      break;
   case 3:
      printf("First list: ");
      display(first1);
      break;
   case 4:
      printf("Second list: ");
      display(first2);
      break;
   case 5:
      ConcatenatedList = concatenate(first1, first2);
      printf(" Concatenated List: ");
      display( ConcatenatedList);
      break;
   case 6:
      first1 = reverse(first1);
      printf("First list after reversal: ");
      display(first1);
      break;
   case 7:
      sort(first1);
      printf("First list after sorting: ");
      display(first1);
      break;
   case 8:
      exit(0);
   default:
      printf("Invalid choice..\n");
```

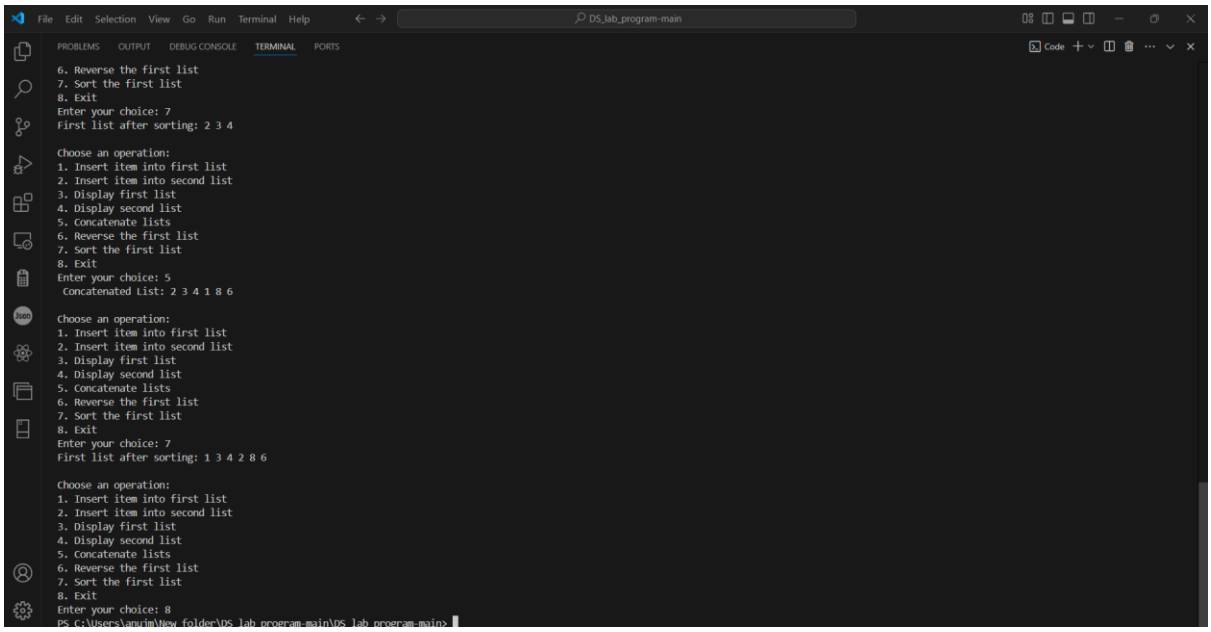
```
        }
    }

    return 0;
}
```

Output:









b)

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

struct node {
    int value;
    struct node *next;
};
typedef struct node *NODE;

NODE get_node() {
    NODE ptr = (NODE)malloc(sizeof(struct node));
```

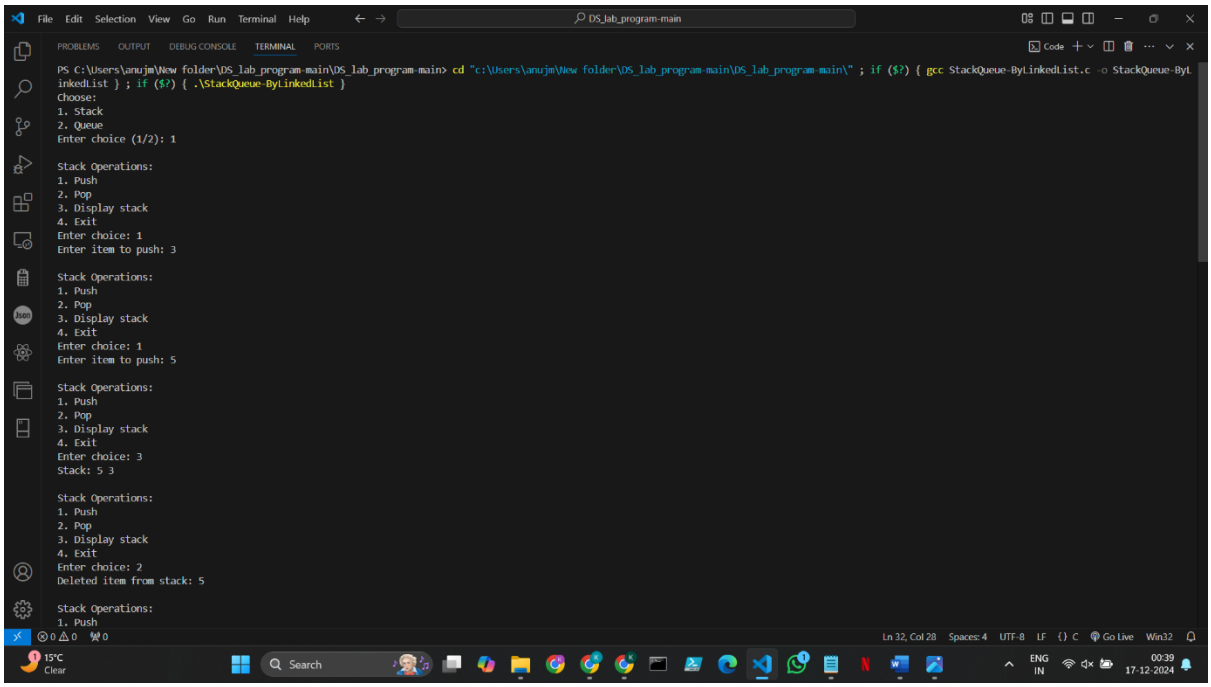
```
    if (ptr == NULL) {
        printf("Memory not allocated\n");
    }
    return ptr;
}

NODE delete_first(NODE first){
    NODE temp=first;
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
    first=first->next;
    free(temp);
    return first;
}

NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}

NODE insert_end(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = NULL;
    if (first == NULL) {
        return new_node;
    }
    NODE temp = first;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = new_node;
    return first;
}

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
```

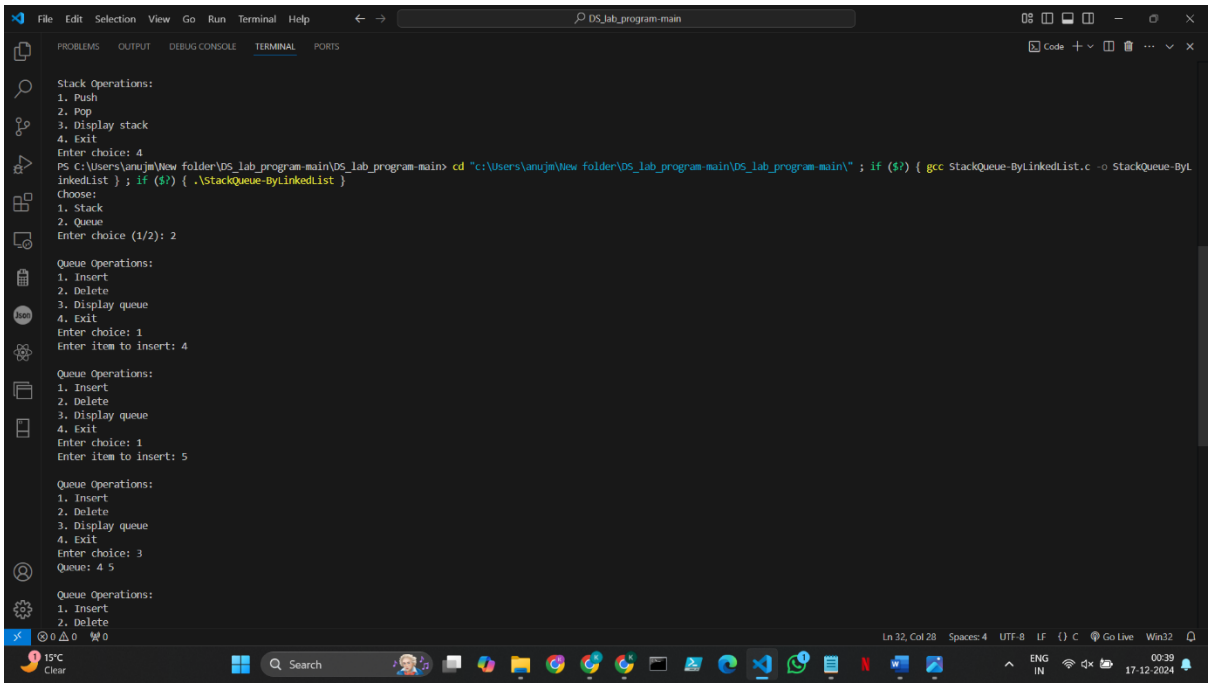
```
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    int item, choice, deleted_item;
    NODE first = NULL;

    printf("Choose:\n");
    printf("1. Stack\n");
    printf("2. Queue\n");
    printf("Enter choice (1/2): ");
    scanf("%d", &choice);

    if (choice == 1) {
        while (1) {
            printf("\nStack Operations:\n");
            printf("1. Push\n");
            printf("2. Pop\n");
            printf("3. Display stack\n");
            printf("4. Exit\n");
            printf("Enter choice: ");
            scanf("%d", &choice);

            switch (choice) {
                case 1:
                    printf("Enter item to push: ");
                    scanf("%d", &item);
                    first = insert_beginning(first, item);
                    break;
                case 2:
                    if (first != NULL) {
                        deleted_item = first->value;
                        first = delete_first(first);
                        printf("Deleted item from stack: %d\n", deleted_item);
                    } else {
                        printf("Stack is empty\n");
                    }
                    break;
                case 3:
```

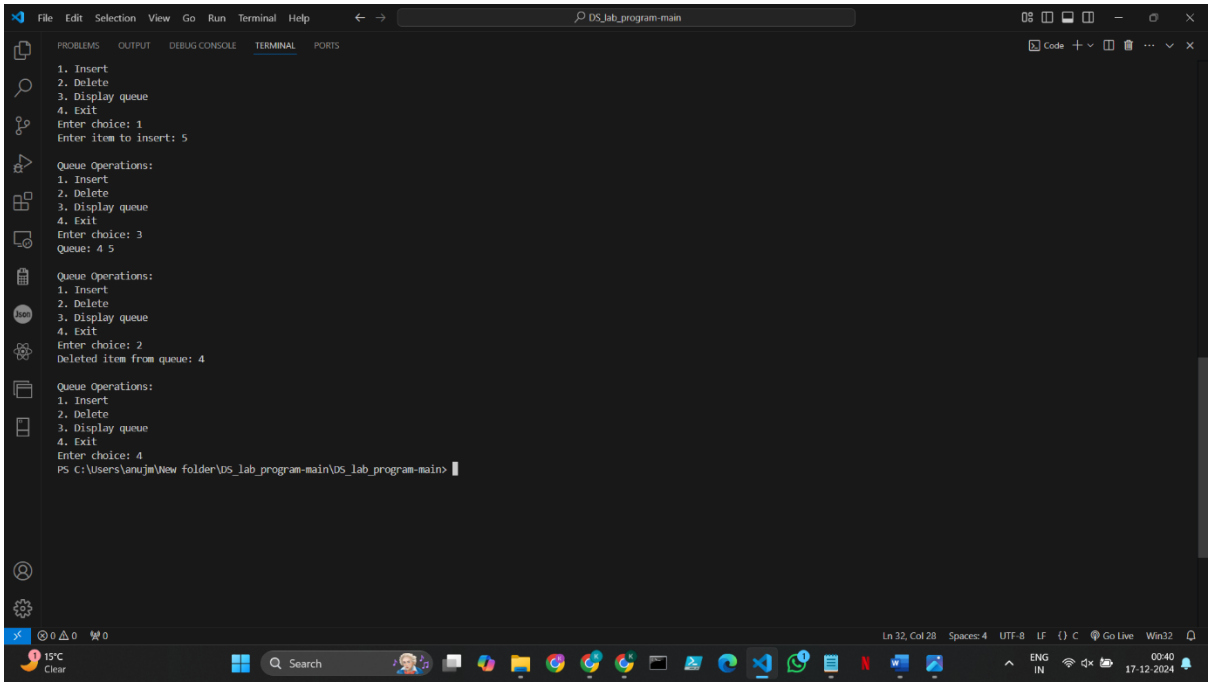
```
                printf("Stack: ");
                display(first);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice.\n");
        }
    }
}
else if (choice == 2) {
    while (1) {
        printf("\nQueue Operations:\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display queue\n");
        printf("4. Exit\n");
        printf("Enter choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter item to insert: ");
                scanf("%d", &item);
                first = insert_end(first, item);
                break;
            case 2:
                if (first != NULL) {
                    deleted_item = first->value;
                    first = delete_first(first);
                    printf("Deleted item from queue: %d\n", deleted_item);
                } else {
                    printf("Queue is empty!\n");
                }
                break;
            case 3:
                printf("Queue: ");
                display(first);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice.\n");
        }
```

```
    }
}
else {
    printf("Invalid operation.\n");
}

return 0;
}
```

Output:






File Edit Selection View Go Run Terminal Help
DS_lab_program-main
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
Code
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 1
Enter item to insert: 5
Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 3
Queue: 4 5
Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 2
Deleted item from queue: 4
Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 4
PS C:\Users\anujm\New folder\DS_lab_program-main\DS_lab_program-main>
Ln 32, Col 28 Spaces: 4 UTF-8 LF C Go Live Win32
15°C Clear
Search
ENG IN
00:40 17-12-2024

Lab Program 7:

a) **Program to Implement doubly link list**
b) **LeetCode 3: Finding middle element of a linked list**

a)

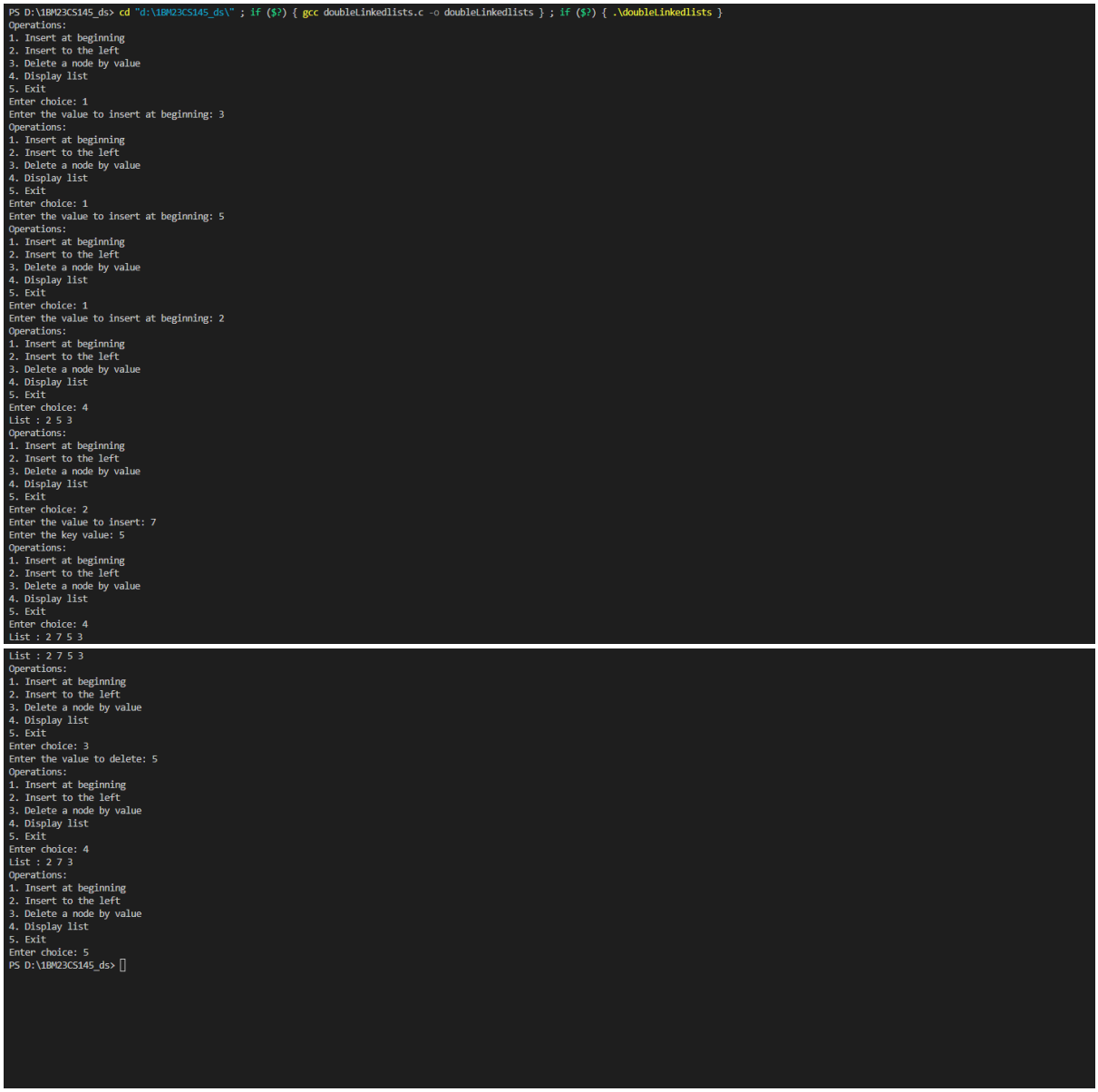
```
#include <stdio.h>
#include <stdlib.h>

struct Node {
   int value;
   struct Node* prev;
   struct Node* next;
};
typedef struct Node* NODE;

NODE get_node() {
   NODE ptr = (NODE)malloc(sizeof(struct Node));
   if (ptr == NULL) {
      printf("Memory not allocated\n");
   }
   return ptr;
}

NODE insert_beginning(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
   new_node->next = first;
   new_node->prev = NULL;
   if (first != NULL) {
      first->prev = new_node;
   }
   return new_node;
}

NODE insert_left_value(NODE first, int item, int key) {
   NODE curr = first;
   NODE new_node = get_node();
   new_node->value = item;

    if (curr == NULL) {
      printf("value not found.\n");
      return first;
   }
```

```
    while (curr != NULL && curr->value != key) {
        curr = curr->next;
    }

    new_node->next = curr;
    new_node->prev = curr->prev;
    (curr->prev)->next = new_node;
    curr->prev = new_node;
}

NODE deleteNode(NODE first, int value) {
    NODE curr = first;
    if (curr == NULL) {
        printf("Value %d not found.\n", value);
        return first;
    }

    while (curr != NULL && curr->value != value) {
        curr = curr->next;
    }
    (curr->prev)->next = curr->next;
    (curr->next)->prev = curr->prev;
    free(curr);
    return first;
}

void displayList(NODE first) {
    if (first == NULL) {
        printf("List is empty.\n");
        return;
    }

    NODE curr = first;
    while (curr != NULL) {
        printf("%d ", curr->value);
        curr = curr->next;
    }
    printf("\n");
}

int main() {
    NODE first = NULL;
    int choice, value, key;
```

```
do {
    printf("Operations:\n");
    printf("1. Insert at beginning\n");
    printf("2. Insert to the left \n");
    printf("3. Delete a node by value\n");
    printf("4. Display list\n");
    printf("5. Exit\n");
    printf("Enter choice: ");
    scanf("%d", &choice);

    switch (choice) {
        case 1:
            printf("Enter the value to insert at beginning: ");
            scanf("%d", &value);
            first = insert_beginning(first, value);
            break;

        case 2:
            printf("Enter the value to insert: ");
            scanf("%d", &value);
            printf("Enter the key value: ");
            scanf("%d", &key);
            insert_left_value(first, value, key);
            break;

        case 3:
            printf("Enter the value to delete: ");
            scanf("%d", &value);
            first = deleteNode(first, value);
            break;

        case 4:
            printf("List : ");
            displayList(first);
            break;

        case 5:
            break;

        default:
            printf("Invalid choice\n");
    }
} while (choice != 5);
```

```
    return 0;
}
```

Output:



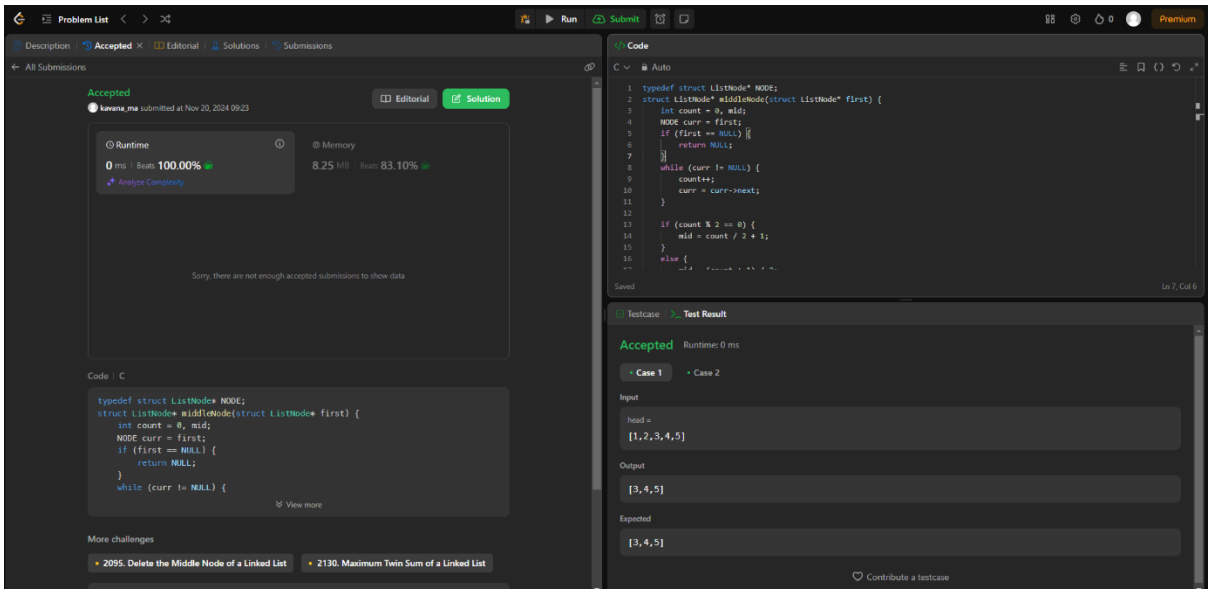
```
PS D:\1BM23CS145_ds> cd "d:\1BM23CS145_ds\" ; if ($?) { gcc doubleLinkedlists.c -o doubleLinkedlists } ; if ($?) { .\doubleLinkedlists }
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 1
Enter the value to insert at beginning: 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 1
Enter the value to insert at beginning: 5
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 1
Enter the value to insert at beginning: 2
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 4
List : 2 5 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 2
Enter the value to insert: 7
Enter the key value: 5
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 4
List : 2 7 5 3
List : 2 7 5 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 3
Enter the value to delete: 5
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 4
List : 2 7 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 5
PS D:\1BM23CS145_ds>
```

b)

```
typedef struct ListNode* NODE;
struct ListNode* middleNode(struct ListNode* first) {
    int count = 0, mid;
    NODE curr = first;
    if (first == NULL) {
        return NULL;
    }
    while (curr != NULL) {
        count++;
```

```
        curr = curr->next;
    }

    if (count % 2 == 0) {
        mid = count / 2 + 1;
    }
    else {
        mid = (count + 1) / 2;
    }

    curr = first;
    count = 1;
    while (curr != NULL && count < mid) {
        curr = curr->next;
        count++;
    }
    return curr;
}
```

Output:



Lab Program 8:

a) **Program to Implement Binary Search Tree**
b) **LeetCode 4: Intersection of Two Linked List**

a)

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

struct Node {
   int value;
   struct Node *left, *right;
};
typedef struct Node *NODE;

NODE newNode(int key) {
   NODE node = (NODE)malloc(sizeof(struct Node));
   node->value = key;
   node->left = node->right = NULL;
   return node;
}

NODE insert(NODE root, int key) {
   if (root == NULL) {
      return newNode(key);
   }

   if (key < root->value) {
      root->left = insert(root->left, key);
   } else if (key > root->value) {
      root->right = insert(root->right, key);
   }

   return root;
}

void inorder(NODE root) {
   if (root != NULL) {
      inorder(root->left);
      printf("%d ", root->value);
      inorder(root->right);
   }
}

void preorder(NODE root) {
```

```
    if (root != NULL) {
        printf("%d ", root->value);
        preorder(root->left);
        preorder(root->right);
    }
}

void postorder(NODE root) {
    if (root != NULL) {
        postorder(root->left);
        postorder(root->right);
        printf("%d ", root->value);
    }
}

int main() {
    NODE root = NULL;
    int choice, value;

    do {
        printf("\nBST Operations\n");
        printf("1. Insert a node\n");
        printf("2. Display: In-order\n");
        printf("3. Display: Pre-order\n");
        printf("4. Display: Post-order\n");
        printf("5. Exit\n");

        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch(choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                root = insert(root, value);
                printf("Value inserted:%d\n",value);
                break;
            case 2:
                if (root == NULL) {
                    printf("The tree is empty!\n");
                } else {
                    inorder(root);
                }
                break;
```

```
            case 3:
                if (root == NULL) {
                    printf("The tree is empty!\n");
                } else {
                    preorder(root);
                }
                break;
            case 4:
                if (root == NULL) {
                    printf("The tree is empty!\n");
                } else {
                    postorder(root);
                }
                break;
            case 5:
                break;
            default:
                printf("Invalid choice\n");
        }
    } while (choice != 5);

    return 0;
}
```

Output:

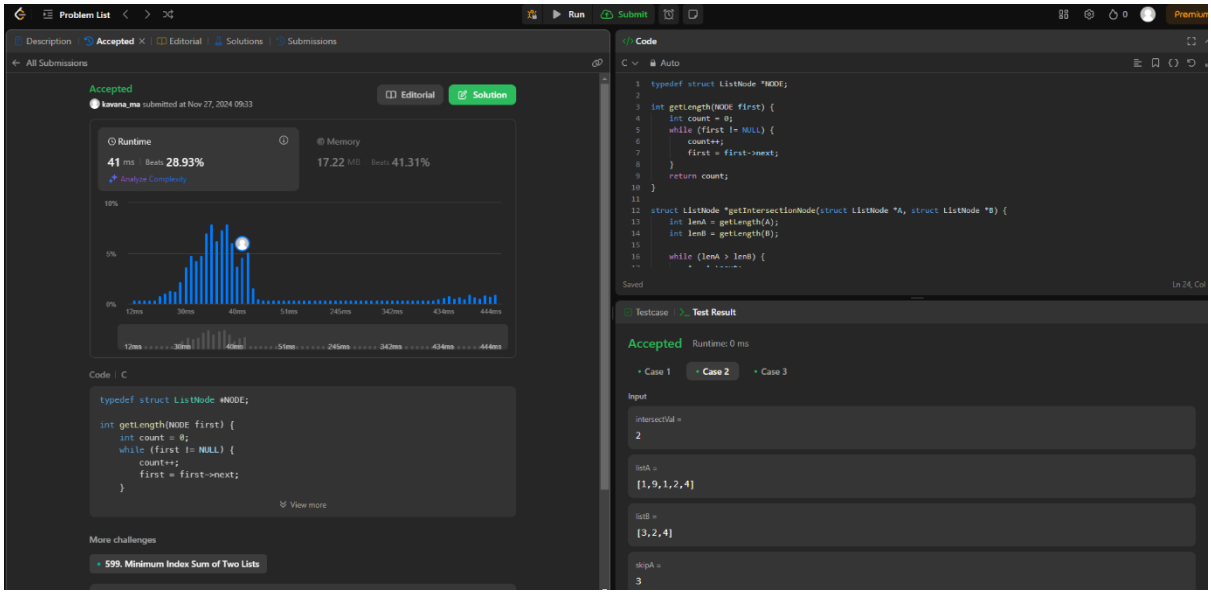
```
PS D:\1BM23CS145_ds> cd "d:\1BM23CS145_ds\" ; if ($?) { gcc BinarySearchTree.c -o BinarySearchTree } ; if ($?) { .\BinarySearchTree }

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 6
Value inserted:6

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 8
Value inserted:8

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 5
Value inserted:5

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 7
Value inserted:7

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 9
Value inserted:9

BST Operations
1. Insert a node
```

b)

```
typedef struct ListNode *NODE;

int getLength(NODE first) {
    int count = 0;
    while (first != NULL) {
        count++;
        first = first->next;
    }
    return count;
}

struct ListNode *getIntersectionNode(struct ListNode *A, struct ListNode *B) {
    int lenA = getLength(A);
    int lenB = getLength(B);

    while (lenA > lenB) {
        A = A->next;
        lenA--;
    }

    while (lenB > lenA) {
        B = B->next;
        lenB--;
    }
```

```
    while (A != NULL && B != NULL) {
        if (A == B) {
            return A;
        }
        A = A->next;
        B = B->next;
    }

    return NULL;
}
```

Output:



Lab Program 9:

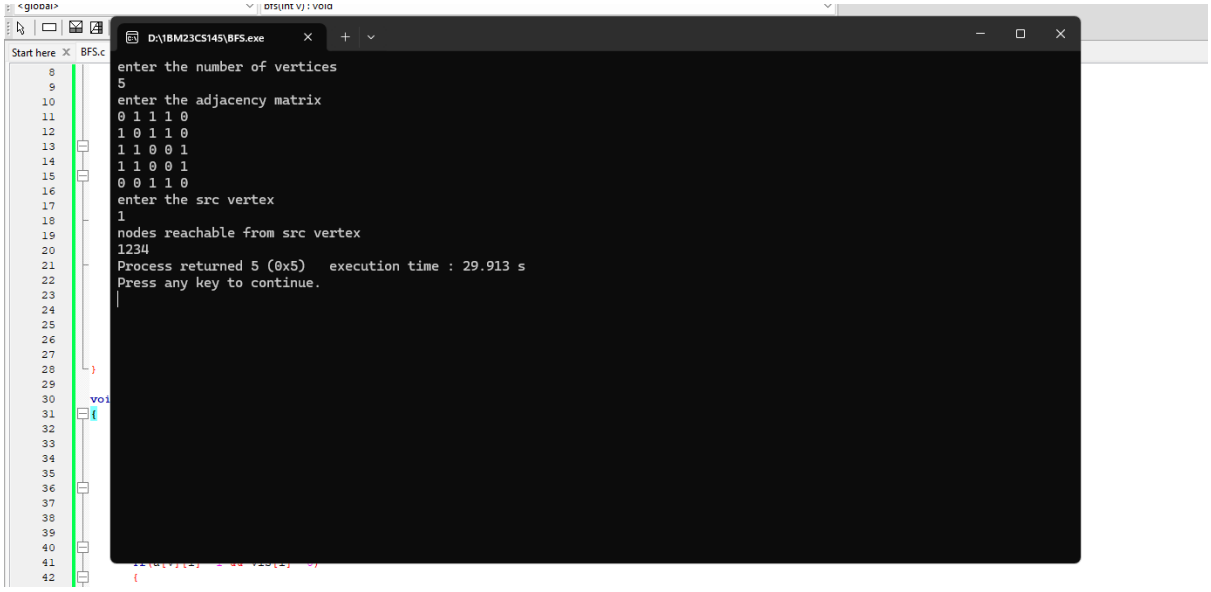
a) **BFS traversal**
b) **DFS traversal and other functions**

a)

```
#include<stdio.h>
void bfs(int);
int a[10][10],vis[10],n;

void main()
{
  int i,j,src;

  printf("enter the number of vertices\n");
  scanf("%d",&n);
  printf("enter the adjacency matrix\n");
  for(i=1;i<=n;i++)
  {
    for(j=1;j<=n;j++)
    {
   scanf("%d",&a[i][j]);

    }

    vis[i]=0;
  }

  printf("enter the src vertex\n");
  scanf("%d",&src);
  printf("nodes reachable from src vertex\n");
  bfs(src);

}

void bfs(int v)
{
   int q[10],f=1,r=1,u,i;
   q[r]=v;
   vis[v]=1;
   while(f<=r)
   {
     u=q[f];
     printf("%d",u);
     for(i=1;i<=n;i++)
```

```
    {
  if(a[v][i]==1 && vis[i]==0)
  {
    vis[i]=1;
    r=r+1;
    q[r]=i;
  }
    }
   f=f+1;
  }
}
```

Output:

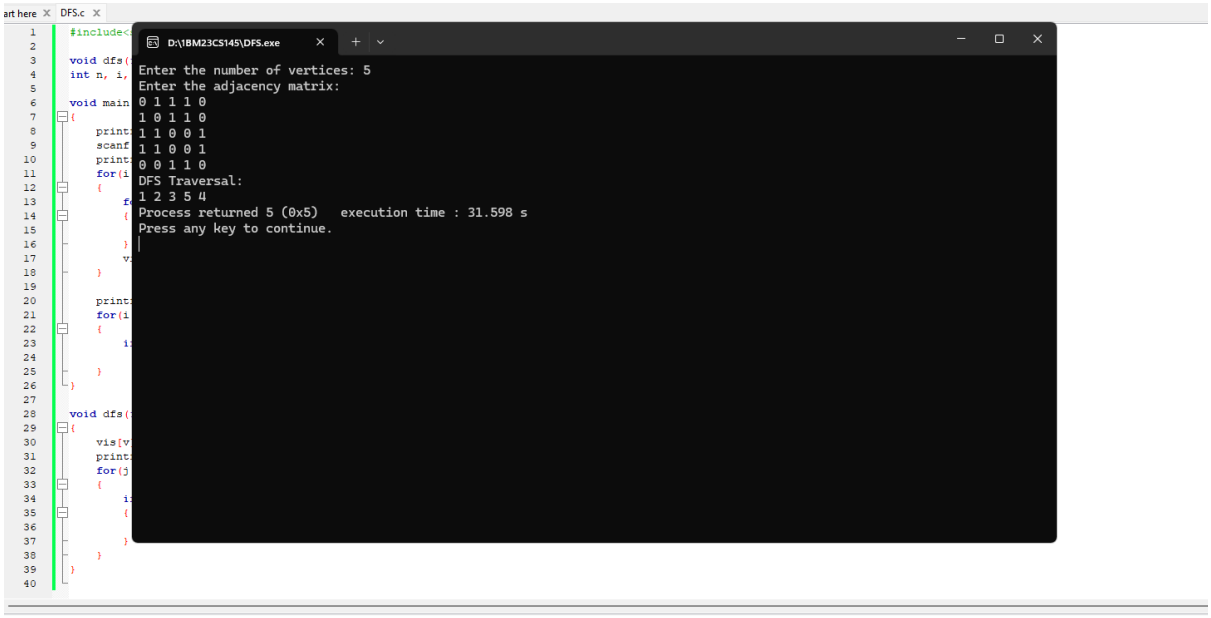


b)

```
#include<stdio.h>

void dfs(int);
int n, i, j, a[10][10], vis[10];

void main()
{
   printf("Enter the number of vertices: ");
   scanf("%d", &n);
   printf("Enter the adjacency matrix:\n");
   for(i = 0; i < n; i++)  // 0-based indexing
   {
      for(j = 0; j < n; j++)
      {
         scanf("%d", &a[i][j]);
```

```
        }
        vis[i] = 0;  // Initialize visited array
    }

    printf("DFS Traversal:\n");
    for(i = 0; i < n; i++)  // 0-based indexing
    {
        if(vis[i] == 0)
            dfs(i);
    }
}

void dfs(int v)
{
    vis[v] = 1;
    printf("%d ", v + 1);  // Print vertices as 1-based indexing
    for(j = 0; j < n; j++)  // 0-based indexing
    {
        if(a[v][j] == 1 && vis[j] == 0)
        {
            dfs(j);
        }
    }
}
```

Output:



Lab Program 10:
Design and develop a Program in C that uses Hash function H: K-> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_RECORDS 100
void displayHashTable(int HT[], int m) {
printf("\nHash Table:\n");
for (int i = 0; i < m; i++) {
if (HT[i] != -1) {
printf("Index %d: %d\n", i, HT[i]);
} else {
printf("Index %d: Empty\n", i);
}
}
}
int hashFunction(int key, int m) {
return key % m;
}
void insert(int HT[], int key, int m) {
int hash = hashFunction(key, m);
int i = 0;
while (HT[(hash + i) % m] != -1) {
i++;
if (i == m) {
printf("Hash table is full. Unable to insert key %d\n", key);
return;
}
}

HT[(hash + i) % m] = key;
printf("Inserted key %d at index %d\n", key, (hash + i) % m);
}
int main() {
int m, n;
int HT[MAX_RECORDS];
for (int i = 0; i < MAX_RECORDS; i++) {
HT[i] = -1;
}

printf("Enter the number of memory locations in the hash table (m): ");
scanf("%d", &m);
```

```
printf("Enter the number of employee records: ");
scanf("%d", &n);
for (int i = 0; i < n; i++) {
int key;
printf("Enter the 4-digit key for employee record %d: ", i + 1);
scanf("%d", &key);
if (key < 1000 || key > 9999) {
printf("Invalid key! Please enter a 4-digit number.\n");
i--;
} else {
insert(HT, key, m);
}
}
displayHashTable(HT, m);
return 0;
}
```

Output: