VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Data Structures using C

Submitted by

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

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Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Data Structures using C**" carried out by **SAMRAAT DABOLAY (1BM22CS236),** 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 academic semester December-2023 to March-2024. The Lab report has been approved as it satisfies the academic requirements in respect of a **Data Structures using C (23CS3PCDST)** work prescribed for the said degree.

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Course Outcome

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyse data structure operations for a given problem.
CO3	CO3 Design and implement operations of linear and nonlinear data structure.
CO4	Conduct practical experiments for demonstrating the operations of different data structures and sorting techniques.

LAB 1

Question

Write a program to simulate the working of stack using an array with the following: a) Push b) Pop c) Display

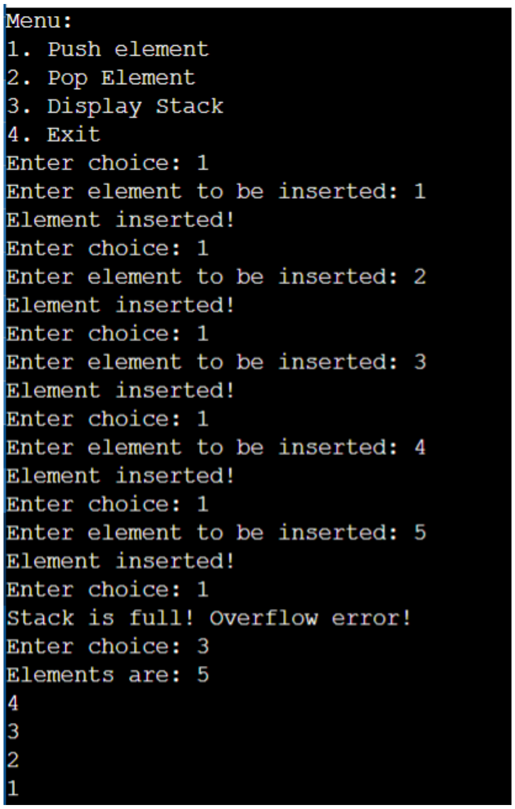
The program should print appropriate messages for stack overflow, stack underflow

Code

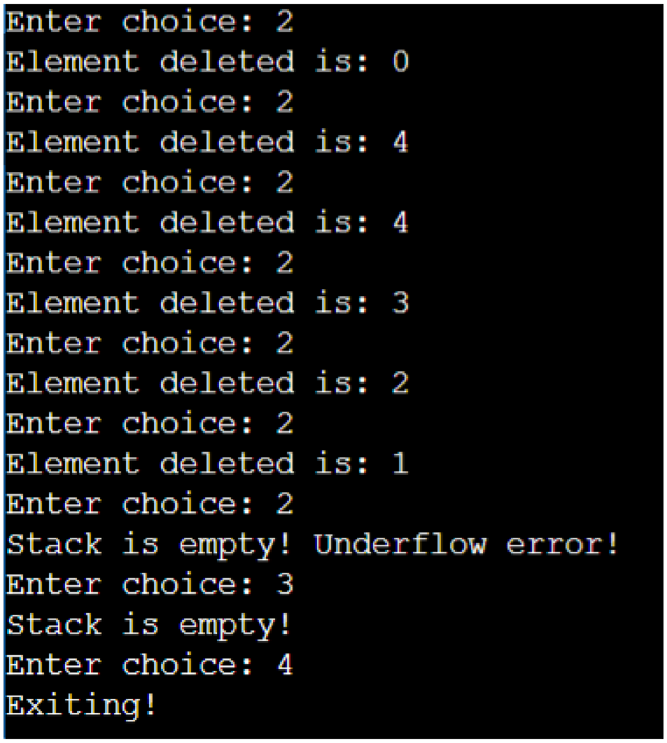
```
#include <stdio.h>

#include <stdlib.h>

#define n 4


int stack[n];

int top;


void push()

{

   if(top>=n)

   {

      printf("Stack is full! Overflow error!\n");

   }

   else

   {

      int a;

      printf("Enter element to be inserted: ");

      scanf("%d", &a);
```

```
        top++;
        stack[top] = a;
        printf("Element inserted!\n");
    }
}

void pop()
{
    if(top==-1)
    {
        printf("Stack is empty! Underflow error!\n");
    }
    else
    {
        printf("Element deleted is: %d\n", stack[top]);
        top--;
    }
}

void display()
{
    int i;
    if(top==-1)
    {
        printf("Stack is empty!\n");
    }
    else
    {
        printf("Elements are: ");
        for(i=n;i>=0;i--)
        {
            printf("%d\n", stack[i]);
        }
    }
}

int main()
{
    int ch;
    top = -1;
    printf("Menu:\n1. Push element\n2. Pop Element\n3. Display Stack\n4. Exit\n");
    printf("Enter choice: ");
    scanf("%d", &ch);
    while(1)
    {
        switch(ch)
        {
            case 1:
                push();
            break;
         case 2:
            pop();
            break;
         case 3:
            display();
            break;
         case 4:
            printf("Exiting!");
            exit(0);
         default:
            printf("Please enter valid choice!\n");
      }
      printf("Enter choice: ");
      scanf("%d", &ch);
   }
   return 0;
}
```

Output



```
Menu:
1. Push element
2. Pop Element
3. Display Stack
4. Exit
Enter choice: 1
Enter element to be inserted: 1
Element inserted!
Enter choice: 1
Enter element to be inserted: 2
Element inserted!
Enter choice: 1
Enter element to be inserted: 3
Element inserted!
Enter choice: 1
Enter element to be inserted: 4
Element inserted!
Enter choice: 1
Enter element to be inserted: 5
Element inserted!
Enter choice: 1
Stack is full! Overflow error!
Enter choice: 3
Elements are: 5
4
3
2
1
```



```
Enter choice: 2
Element deleted is: 0
Enter choice: 2
Element deleted is: 4
Enter choice: 2
Element deleted is: 4
Enter choice: 2
Element deleted is: 3
Enter choice: 2
Element deleted is: 2
Enter choice: 2
Element deleted is: 1
Enter choice: 2
Stack is empty! Underflow error!
Enter choice: 3
Stack is empty!
Enter choice: 4
Exiting!
```

LAB 2

Question

a) WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)

b) Demonstration of account creation on LeetCode platform Program - Leetcode platform

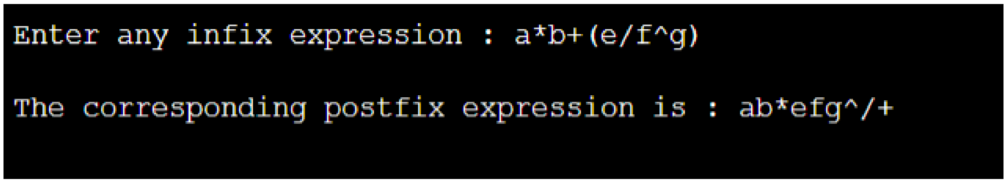
Code

```
#include <stdio.h>

#include <ctype.h>

#include <string.h>

#include <stdlib.h>


#define MAX 100

char st[MAX];

int top = -1;


void push(char st[], char);

char pop(char st[]);

void InfixtoPostfix(char source[], char target[]);

int getpri(char);


int main()

{

   char infix[100], postfix[100];
```

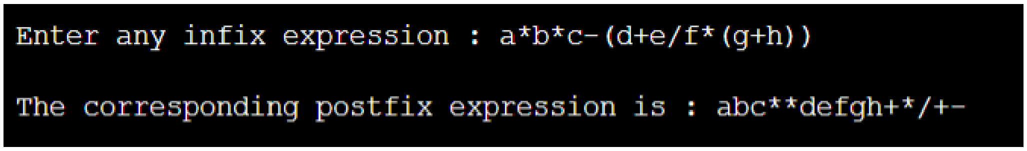
```
    printf("\n Enter any infix expression : ");
    scanf("%s", infix);
    strcpy(postfix, "");
    InfixtoPostfix(infix, postfix);
    printf("\n The corresponding postfix expression is : ");
    puts(postfix);
}

void InfixtoPostfix(char source[], char target[])
{
    int i = 0, j = 0;
    char temp;
    strcpy(target, "");
    while (source[i] != '\0')
    {
        if (source[i] == '(')
        {
            push(st, source[i]);
            i++;
        }
        else if (source[i] == ')')
        {
            while ((top != -1) && (st[top] != '('))
            {
                target[j] = pop(st);
                j++;
            }
            if (top == -1)
            {
                printf("\n INCORRECT EXPRESSION");
                exit(1);
            }
            temp = pop(st);
            i++;
        }
        else if (isdigit(source[i]) || isalpha(source[i]))
        {
            target[j] = source[i];
            j++;
            i++;
        }
        else if (source[i] == '+' || source[i] == '-' || source[i] == '*' || source[i] == '/' ||
source[i] == '%' || source[i] == '^')
        {
            while ((top != -1) && (st[top] != '(') && (getpri(st[top]) > getpri(source[i])))
            {
                target[j] = pop(st);
                j++;
            }
            push(st, source[i]);
            i++;
        }
        else
        {
            printf("\n INCORRECT ELEMENT IN EXPRESSION");
            exit(1);
        }
    }
    while ((top != -1) && (st[top] != '('))
    {
        target[j] = pop(st);
        j++;
    }
    target[j] = '\0';
}

int getpri(char op)
{
    if (op == '^')
        return 2;
    else if (op == '/' || op == '*' || op == '%')
        return 1;
    else if (op == '+' || op == '-')
        return 0;
}
```

```
void push(char st[], char val)
{
   if (top == MAX - 1)
      printf("\n STACK OVERFLOW");
   else
   {
      top++;
      st[top] = val;
   }
}

char pop(char st[])
{
   char val = ' ';
   if (top == -1)
      printf("\n STACK UNDERFLOW");
   else
   {
      val = st[top];
      top--;
   }
   return val;
}
```

Output



```
Enter any infix expression : a*b+(e/f^g)

The corresponding postfix expression is : ab*efg^/+
```



```
Enter any infix expression : a*b*c-(d+e/f*(g+h))

The corresponding postfix expression is : abc**defgh+*/+-
```

LAB 3

Question

a) WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display

The program should print appropriate messages for queue empty and queue overflow conditions

b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display

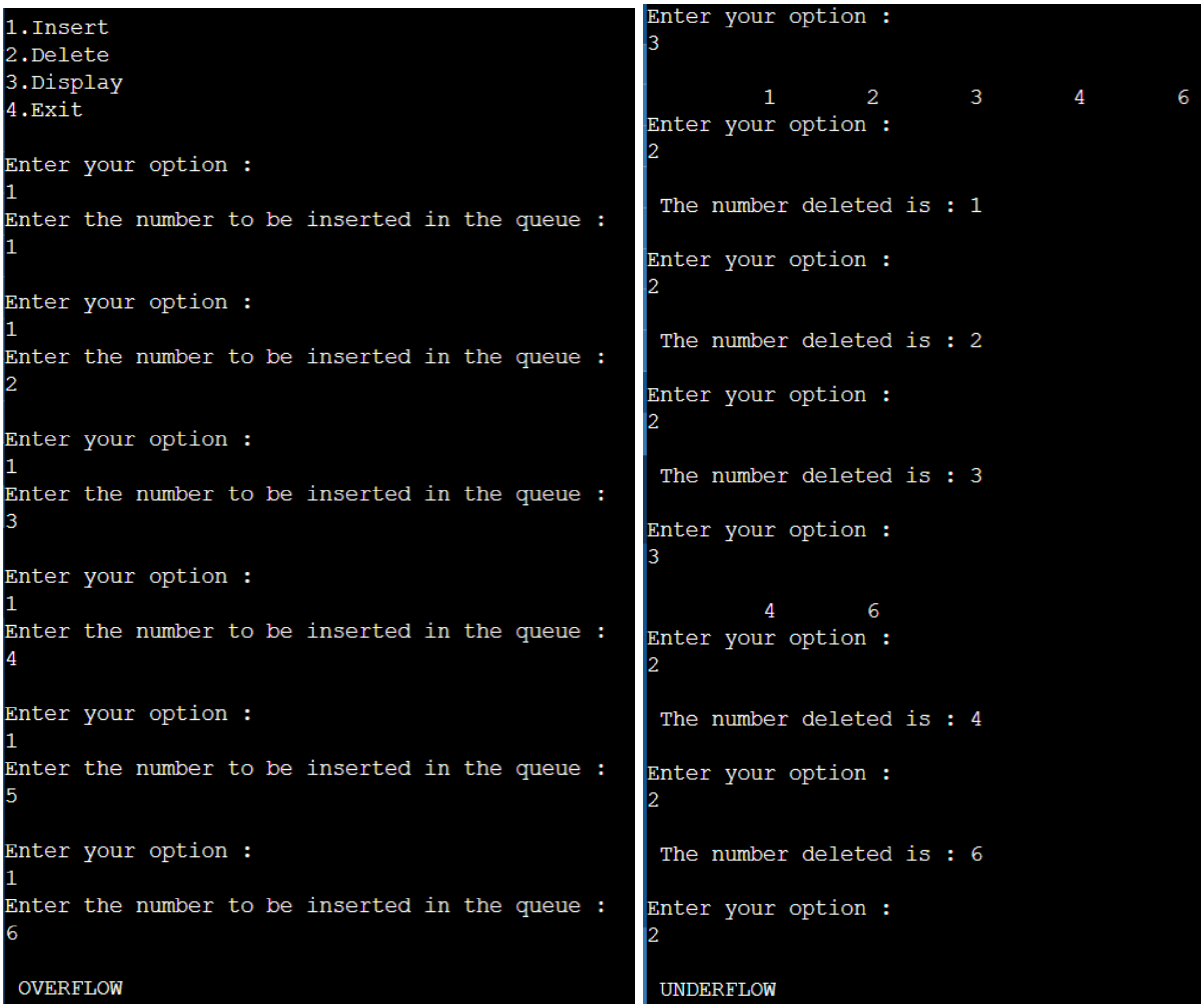
The program should print appropriate messages for queue empty and queue overflow conditions

Code (a)

```
#include <stdio.h>

#include <stdlib.h>

#define N 5


int q[N];

int front = -1, rear = -1;


void insert(int);

int deleteq();

void display();


int main()

{

   int n, choice;
```

```
printf("\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");


do
{
   printf("\nEnter your option : \n");
   scanf("%d", &choice);
   switch (choice)
   {
      case 1:
         printf("Enter the number to be inserted in the queue : \n");
         scanf("%d", &n);
         insert(n);
         break;
      case 2:
         n = deleteq();
         if (n != -1)
            printf("\n The number deleted is : %d\n", n);
         break;
      case 3:
         display();
         break;
      case 4:
         exit(0);
         break;
      default:
            printf("Invalid option\n");
            exit(0);
            break;
        }
    } while (choice != 4);
}

void insert(int num)
{
    if (rear == N - 1)
        printf("\n OVERFLOW");
    else if (front == -1 && rear == -1)
        front = rear = 0;
    else
        rear++;
    q[rear] = num;
}

int deleteq()
{
    int val;
    if (front == -1 || front > rear)
    {
        printf("\n UNDERFLOW");
        return -1;
    }
    else
    {
        val = q[front];
        front++;
        if (front > rear)
            front = rear = -1;
        return val;
    }
}

void display()
{
    int i;
    printf("\n");
    if (front == -1 || front > rear)
        printf("\n QUEUE IS EMPTY");
    else
    {
        for (i = front; i <= rear; i++)
            printf("\t %d", q[i]);
    }
}
```

Output (a)



```
1.Insert
2.Delete
3.Display
4.Exit

Enter your option :
1
Enter the number to be inserted in the queue :
1

Enter your option :
1
Enter the number to be inserted in the queue :
2

Enter your option :
1
Enter the number to be inserted in the queue :
3

Enter your option :
1
Enter the number to be inserted in the queue :
4

Enter your option :
1
Enter the number to be inserted in the queue :
5

Enter your option :
1
Enter the number to be inserted in the queue :
6

 OVERFLOW
```

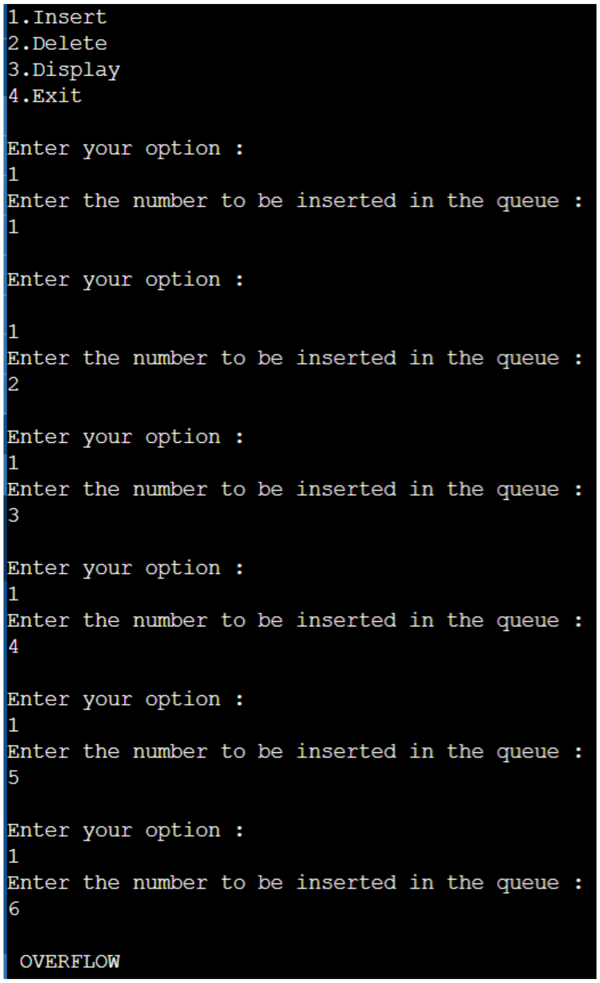
```
Enter your option :
3

         1       2       3       4       6
Enter your option :
2

 The number deleted is : 1

Enter your option :
2

 The number deleted is : 2

Enter your option :
2

 The number deleted is : 3

Enter your option :
3

         4       6
Enter your option :
2

 The number deleted is : 4

Enter your option :
2

 The number deleted is : 6

Enter your option :
2

 UNDERFLOW
```

Code (b)

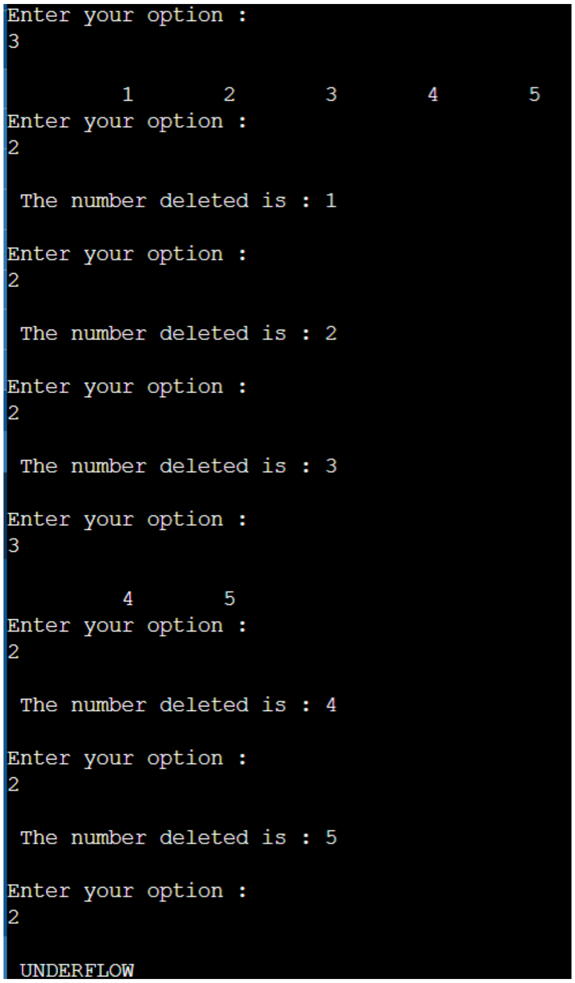
```
#include <stdio.h>

#include <stdlib.h>

#define N 5


int q[N];
int front = -1, rear = -1;

void insert(int);
int deleteq();
void display();

int main()
{
   int n, choice;
   printf("\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
   do
   {
      printf("\nEnter your option : \n");
      scanf("%d", &choice);
      switch (choice)
      {
         case 1:
            printf("Enter the number to be inserted in the queue : \n");
            scanf("%d", &n);
            insert(n);
            break;
         case 2:
            n = deleteq();
            if (n != -1)
               printf("\n The number deleted is : %d\n", n);
            break;
          case 3:
            display();
            break;
          case 4:
            exit(0);
            break;
          default:
            printf("Invalid option\n");
            exit(0);
            break;
        }
    } while (choice != 4);
}

void insert(int num)
{
    if ((front == 0 && rear == N - 1) || (rear == (front - 1)))
        printf("\n OVERFLOW");
    else if (front == -1 && rear == -1)
    {
        front = rear = 0;
        q[rear] = num;
    }
    else if (rear == N - 1 && front != 0)
    {
        rear = 0;
        q[rear] = num;
    }
    else
    {
        rear++;
        q[rear] = num;
    }
}

int deleteq()
{
    int val;
    if (front == -1 && rear == -1)
    {
        printf("\n UNDERFLOW");
        return -1;
    }
    val = q[front];
    if (front == rear)
        front = rear = -1;
    else
    {
        if (front == N - 1)
```

```
            front = 0;
        else
            front++;
    }
    return val;
}

void display()
{
    int i;
    printf("\n");
    if (front == -1 && rear == -1)
        printf("\n QUEUE IS EMPTY");
    else
    {
        if (front < rear)
        {
            for (i = front; i <= rear; i++)
                printf("\t %d", q[i]);
        }
        else
        {
            for (i = front; i < N; i++)
                printf("\t %d", q[i]);
            for (i = 0; i <= rear; i++)
            printf("\t %d", q[i]);
        }
    }
}
```

Output (b)



```
1.Insert
2.Delete
3.Display
4.Exit

Enter your option :
1
Enter the number to be inserted in the queue :
1

Enter your option :

1
Enter the number to be inserted in the queue :
2

Enter your option :
1
Enter the number to be inserted in the queue :
3

Enter your option :
1
Enter the number to be inserted in the queue :
4

Enter your option :
1
Enter the number to be inserted in the queue :
5

Enter your option :
1
Enter the number to be inserted in the queue :
6

 OVERFLOW
```



```
Enter your option :
3

         1       2       3       4       5
Enter your option :
2

 The number deleted is : 1

Enter your option :
2

 The number deleted is : 2

Enter your option :
2

 The number deleted is : 3

Enter your option :
3

         4       5
Enter your option :
2

 The number deleted is : 4

Enter your option :
2

 The number deleted is : 5

Enter your option :
2

 UNDERFLOW
```

LAB 4

Question

a) WAP to Implement Singly Linked List with following operations

Create a linked list.

Insertion of a node at first position, at any position and at end of list.

Display the contents of the linked list.

b) Program - Leetcode platform

Code

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

typedef struct Node
{
   int data;
   struct Node *next;
} Node;

void InsertAtBeginning(Node **head_ref, int new_data);
void InsertAtEnd(Node **head_ref, int new_data);
void Insert(Node **head_ref, int new_data, int pos);
void PrintList(Node *next);

void InsertAtBeginning(Node **head_ref, int new_data)
```

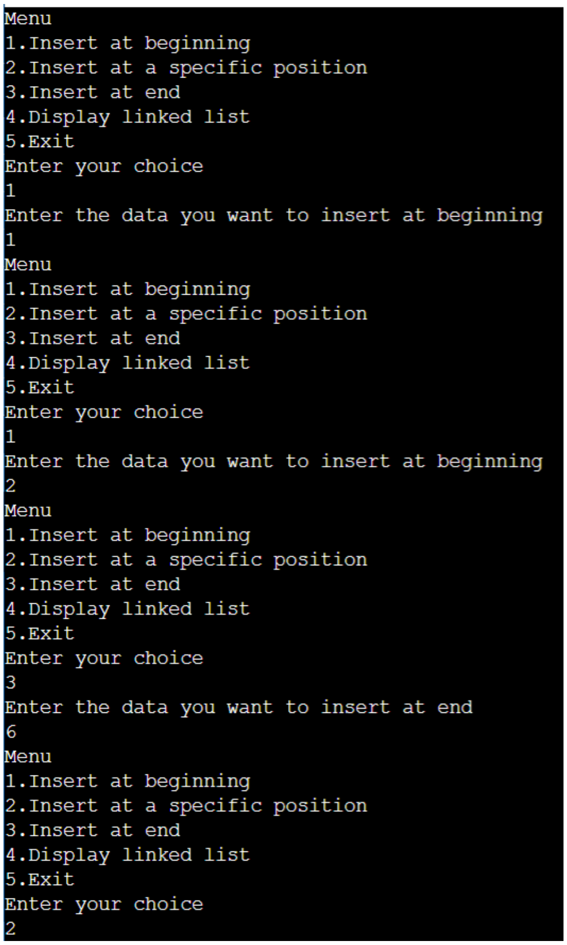
```
{
   Node *new_node = (struct Node *)malloc(sizeof(Node));
   new_node->data = new_data;
   new_node->next = *head_ref;
   *head_ref = new_node;
}

void InsertAtEnd(Node **head_ref, int new_data)
{
   Node *new_node = (struct Node *)malloc(sizeof(Node));
   Node *last = *head_ref;
   new_node->data = new_data;
   new_node->next = NULL;
   if (*head_ref == NULL)
   {
      *head_ref = new_node;
      return;
   }
   while (last->next != NULL)
      last = last->next;
   last->next = new_node;
}

void Insert(Node **head_ref, int new_data, int pos)
{
   if (*head_ref == NULL)
   {
      printf("Cannot be NULL\n");
      return;
   }
   Node *temp = *head_ref;
   Node *newNode = (Node *)malloc(sizeof(Node));
   newNode->data = new_data;
   newNode->next = NULL;
   while (--pos > 0)
   {
      temp = temp->next;
   }
   newNode->next = temp->next;
   temp->next = newNode;
}

void PrintList(Node *node)
{
   while (node != NULL)
   {
      printf("%d\n", node->data);
      node = node->next;
   }
}
```

```
int main()
{
   int ch, new, pos;
   Node *head = NULL;
   while (ch != 5)
   {
      printf("Menu\n");
      printf("1.Insert at beginning\n");
      printf("2.Insert at a specific position\n");
      printf("3.Insert at end\n");
      printf("4.Display linked list\n");
      printf("5.Exit\n");

      printf("Enter your choice\n");
      scanf("%d", &ch);
      switch (ch)
      {
      case 1:
      {
         printf("Enter the data you want to insert at beginning\n");
         scanf("%d", &new);
         InsertAtBeginning(&head, new);
         break;
      }
```

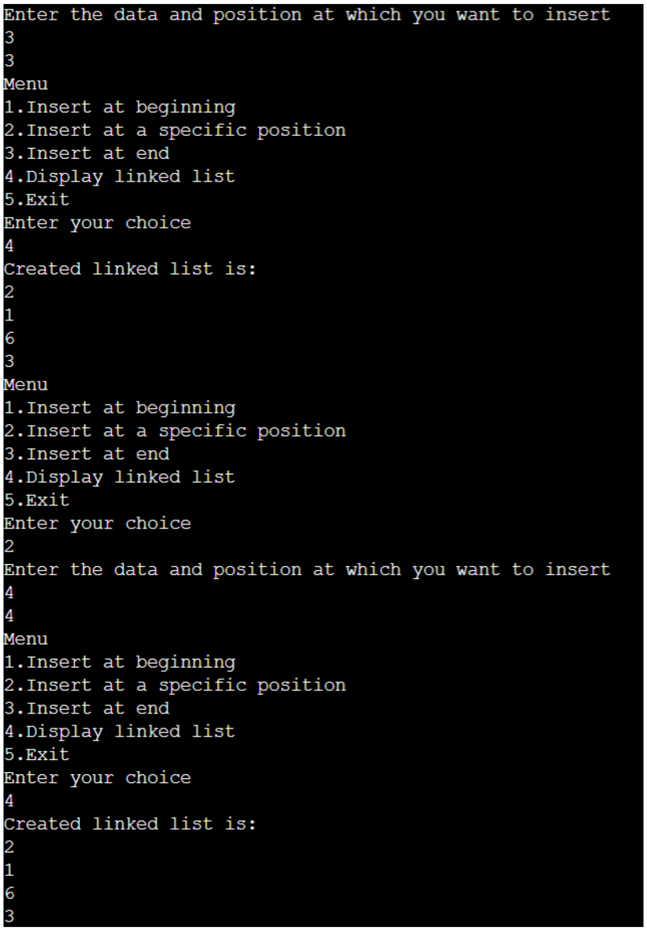
```
case 2:

{

   printf("Enter the data and position at which you want to insert \n");

   scanf("%d%d", &new, &pos);

   Insert(&head, new, pos);

   break;

}

case 3:

{

   printf("Enter the data you want to insert at end\n");

   scanf("%d", &new);

   InsertAtEnd(&head, new);

   break;

}

case 4:

{

   printf("Created linked list is:\n");

   PrintList(head);

   break;

}

case 5:

{

   return 0;

   break;

}
```

```
        case 6:

        {

           printf("Invalid data!");

           break;

        }

        }

    }

    return 0;

}
```

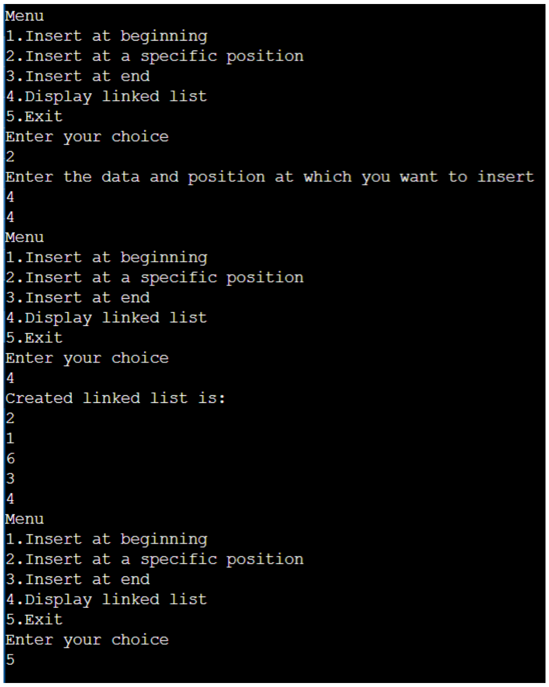
Output



```
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
1
Enter the data you want to insert at beginning
1
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
1
Enter the data you want to insert at beginning
2
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
3
Enter the data you want to insert at end
6
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
2
```



```
Enter the data and position at which you want to insert
3
3
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
4
Created linked list is:
2
1
6
3
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
2
Enter the data and position at which you want to insert
4
4
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
4
Created linked list is:
2
1
6
3
```



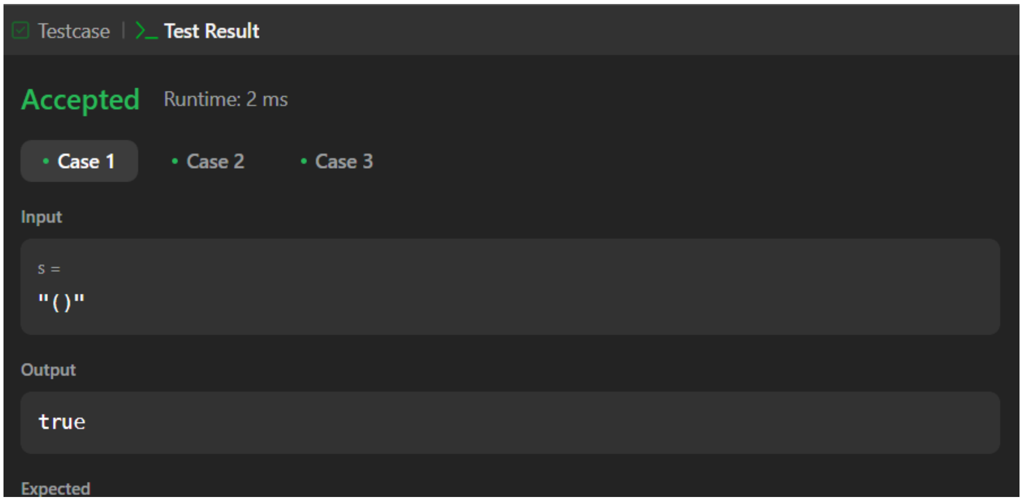
```
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
2
Enter the data and position at which you want to insert
4
4
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
4
Created linked list is:
2
1
6
3
4
Menu
1.Insert at beginning
2.Insert at a specific position
3.Insert at end
4.Display linked list
5.Exit
Enter your choice
5
```

Leetcode - Valid Parentheses

```
struct sNode {
   char data;
   struct sNode* next;
};

// Function to push an item to stack
void push(struct sNode** top_ref, int new_data);

// Function to pop an item from stack
int pop(struct sNode** top_ref);

// Returns 1 if character1 and character2 are matching left
// and right Brackets
bool isMatchingPair(char character1, char character2)
{
    if (character1 == '(' && character2 == ')')
        return 1;
    else if (character1 == '{' && character2 == '}')
        return 1;
    else if (character1 == '[' && character2 == ']')
        return 1;
    else
        return 0;
}

bool isValid(char* exp)
{
    int i = 0;

    struct sNode* stack = NULL;

    while (exp[i]) {

        if (exp[i] == '{' || exp[i] == '(' || exp[i] == '[')
            push(&stack, exp[i]);

        if (exp[i] == '}' || exp[i] == ')'
```

```
            || exp[i] == ']') {

            if (stack == NULL)
                return 0;

            // Pop the top element from stack, if it is not
            // a pair bracket of character then there is a
            // mismatch.
            // his happens for expressions like {(})
            else if (!isMatchingPair(pop(&stack), exp[i]))
                return 0;
        }
        i++;
    }

    // If there is something left in expression then there
    // is a starting bracket without a closing
    // bracket
    if (stack == NULL)
        return 1; // balanced
    else
        return 0; // not balanced
}

// Function to push an item to stack
```

```
void push(struct sNode** top_ref, int new_data)
{
   // allocate node
   struct sNode* new_node
      = (struct sNode*)malloc(sizeof(struct sNode));

   if (new_node == NULL) {
      printf("Stack overflow n");
      getchar();
      exit(0);
   }

   // put in the data
   new_node->data = new_data;

   // link the old list of the new node
   new_node->next = (*top_ref);

   // move the head to point to the new node
   (*top_ref) = new_node;
}

// Function to pop an item from stack
int pop(struct sNode** top_ref)
{
    char res;
    struct sNode* top;

    // If stack is empty then error
    if (*top_ref == NULL) {
        printf("Stack overflow n");
        getchar();
        exit(0);
    }
    else {
        top = *top_ref;
        res = top->data;
        *top_ref = top->next;
        free(top);
        return res;
    }
}
```



Accepted Runtime: 2 ms

Input

```
s =
"()"
```

Output

```
true
```

Expected

LAB 5

Question

a) WAP to Implement Singly Linked List with following operations
   i) Create a linked list.
   ii) Deletion of the first element, specified element and last element in the list.
   iii) Display the contents of the linked list.

b) Program - Leetcode platform

Code

```
#include <stdio.h>

#include <stdlib.h>


typedef struct Node

{

   int data;

   struct Node *next;

} Node;


void InsertAtBeginning(Node **head_ref, int new_data);

void DeleteAtBeginning(Node **head_ref);

void DeleteAtEnd(Node **head_ref);

void Delete(Node **head_ref, int pos);

void PrintList(Node *next);


void InsertAtBeginning(Node **head_ref, int new_data)
```

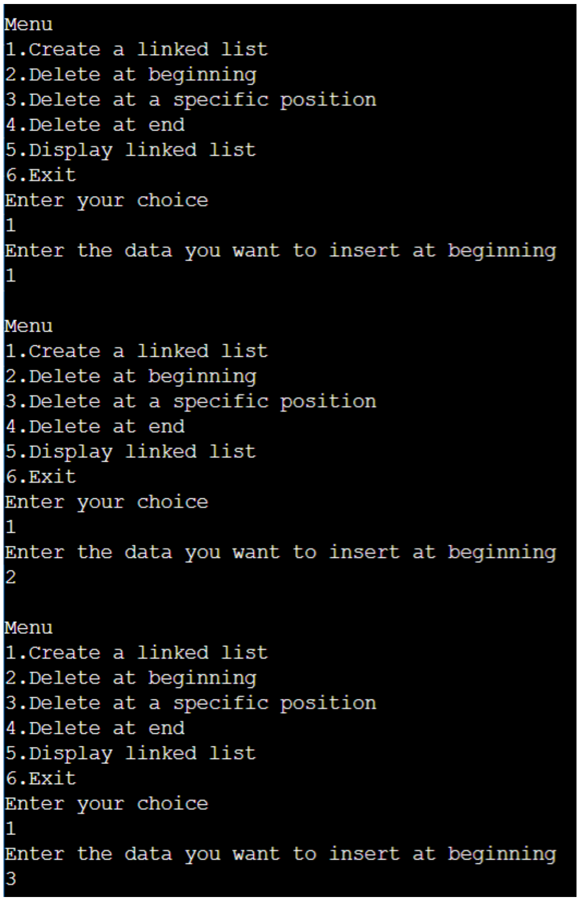
```
{
   Node *new_node = (struct Node *)malloc(sizeof(Node));
   new_node->data = new_data;
   new_node->next = *head_ref;
   *head_ref = new_node;
}

void DeleteAtBeginning(Node **head_ref)
{
   Node *ptr;
   if (*head_ref == NULL)
   {
      printf("\nList is empty");
   }
   else
   {
      ptr = *head_ref;
      *head_ref = ptr->next;
      free(ptr);
      printf("\n Node deleted from the beginning ...");
   }
}

void DeleteAtEnd(Node **head_ref)
{
   Node *ptr, *ptr1;
   if (*head_ref == NULL)
   {
      printf("\nlist is empty");
   }
   else if ((*head_ref)->next == NULL)
   {
      free(*head_ref);
      *head_ref = NULL;
      printf("\nOnly node of the list deleted ...");
   }
   else
   {
      ptr = *head_ref;
      while (ptr->next != NULL)
      {
          ptr1 = ptr;
          ptr = ptr->next;
      }
      ptr1->next = NULL;
      free(ptr);
      printf("\n Deleted Node from the last ...");
   }
}
```

```
void Delete(Node **head_ref, int pos)
{
    Node *temp = *head_ref, *prev;

    if (temp == NULL)
    {
        printf("\nList is empty");
        return;
    }

    if (pos == 1)
    {
        *head_ref = temp->next;
        free(temp);
        printf("\nDeleted node with position %d", pos);
        return;
    }

    for (int i = 0; temp != NULL && i < pos - 1; i++)
    {
        prev = temp;
        temp = temp->next;
    }

    if (temp == NULL)
    {
        printf("\nPosition out of range");
        return;
    }

    prev->next = temp->next;
    free(temp);
    printf("\nDeleted node with position %d", pos);
}

void PrintList(Node *node)
{
    while (node != NULL)
    {
        printf("%d\n", node->data);
        node = node->next;
    }
}

int main()
{
    int ch, new, pos;
    Node *head = NULL;
    while (ch != 6)
    {
```

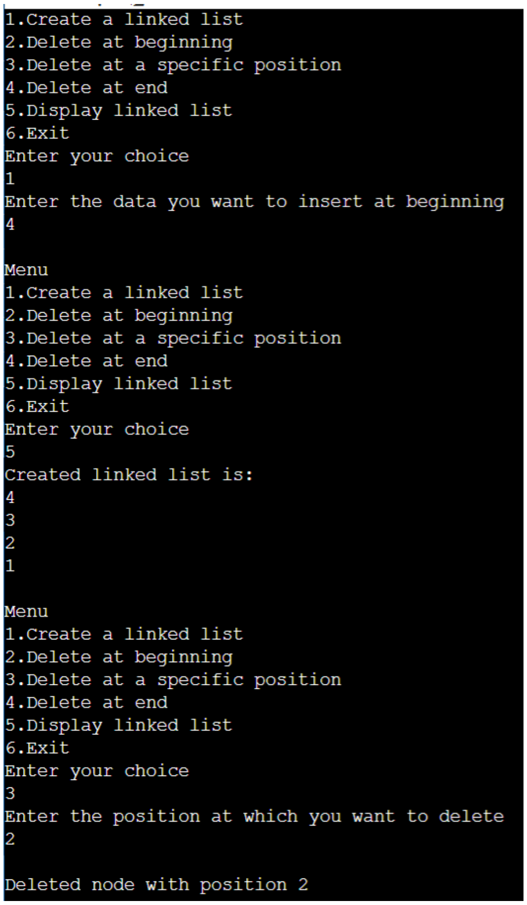
```
printf("\nMenu\n");
printf("1.Create a linked list\n");
printf("2.Delete at beginning\n");
printf("3.Delete at a specific position\n");
printf("4.Delete at end\n");
printf("5.Display linked list\n");
printf("6.Exit\n");
printf("Enter your choice\n");
scanf("%d", &ch);
switch (ch)
{
case 1:
{
   printf("Enter the data you want to insert at beginning\n");
   scanf("%d", &new);
   InsertAtBeginning(&head, new);
   break;
}
case 2:
{
   DeleteAtBeginning(&head);
   break;
}
case 3:
{
    printf("Enter the position at which you want to delete \n");
    scanf("%d", &pos);
    Delete(&head, pos);
    break;
}
case 4:
{

    DeleteAtEnd(&head);
    break;
}
case 5:
{
    printf("Created linked list is:\n");
    PrintList(head);
    break;
}
case 6:
{
    return 0;
    break;
}
default:
{
    printf("Invalid data!");
```

```
            break;
         }
         }
      }
      return 0;
}
```

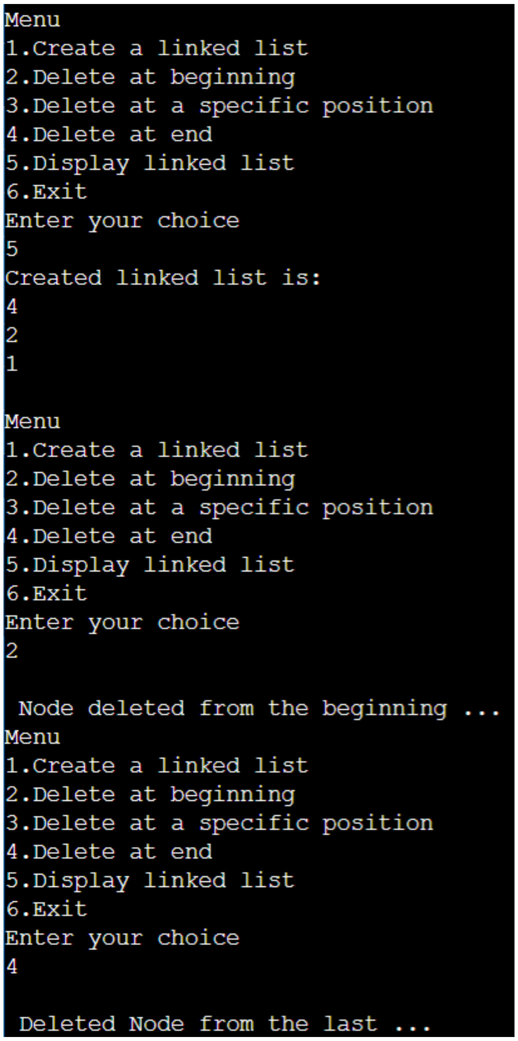
Output



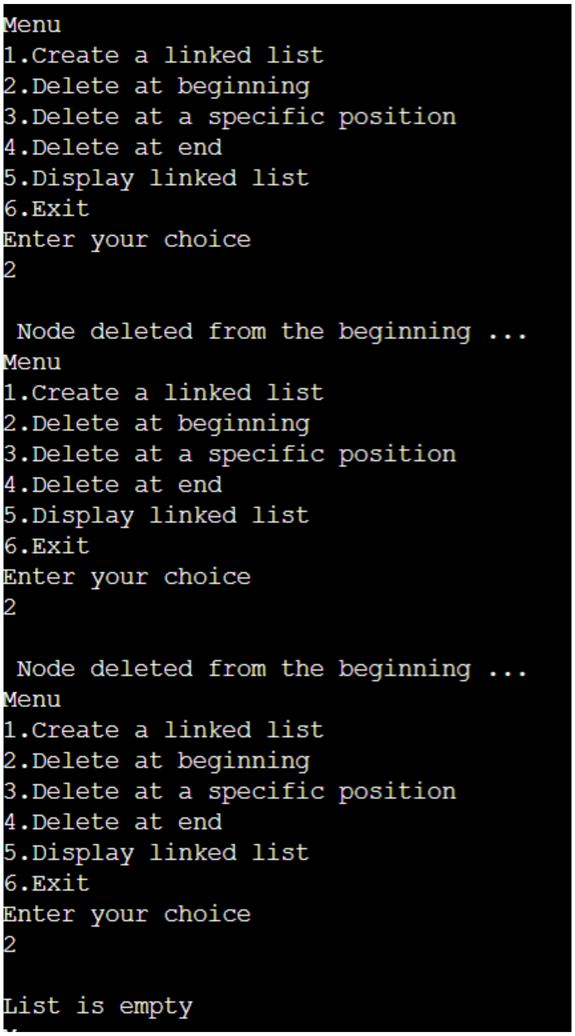
```
Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
1
Enter the data you want to insert at beginning
1

Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
1
Enter the data you want to insert at beginning
2

Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
1
Enter the data you want to insert at beginning
3
```



```
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
1
Enter the data you want to insert at beginning
4

Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
5
Created linked list is:
4
3
2
1

Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
3
Enter the position at which you want to delete
2

Deleted node with position 2
```

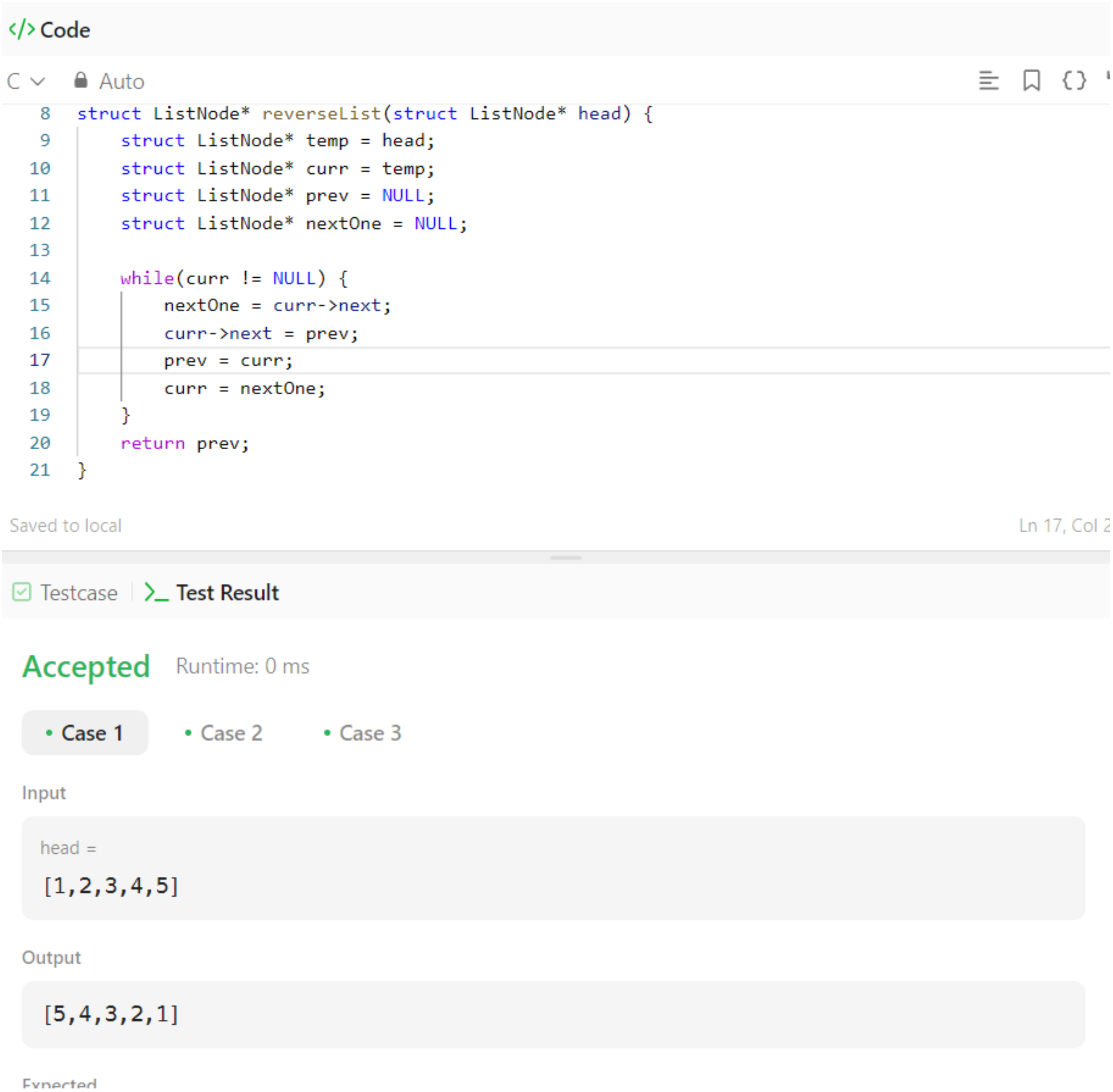


```
Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
5
Created linked list is:
4
2
1

Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
2

 Node deleted from the beginning ...
Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
4

 Deleted Node from the last ...
```



```
Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
2

 Node deleted from the beginning ...
Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
2

 Node deleted from the beginning ...
Menu
1.Create a linked list
2.Delete at beginning
3.Delete at a specific position
4.Delete at end
5.Display linked list
6.Exit
Enter your choice
2

List is empty
```

Leetcode - Reversing a Linked List



```c
struct ListNode* reverseList(struct ListNode* head) {
    struct ListNode* temp = head;
    struct ListNode* curr = temp;
    struct ListNode* prev = NULL;
    struct ListNode* nextOne = NULL;

    while(curr != NULL) {
        nextOne = curr->next;
        curr->next = prev;
        prev = curr;
        curr = nextOne;
    }
    return prev;
}
```

Accepted Runtime: 0 ms

Input

head =

```
[1,2,3,4,5]
```

Output

```
[5,4,3,2,1]
```

Expected

LAB 6

Question

a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

b) WAP to Implement Single Link List to simulate Stack & Queue Operations.

Code (a)

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

struct Node {
   int val;
   struct Node* next;
};

void sortList(struct Node** node);
void create(struct Node** node);
void display(struct Node* node);
void insert(struct Node** node, int value);
void reverse(struct Node** node);
void concat(struct Node** node1, struct Node** node2);

int main() {
   struct Node* head1 = NULL;
```

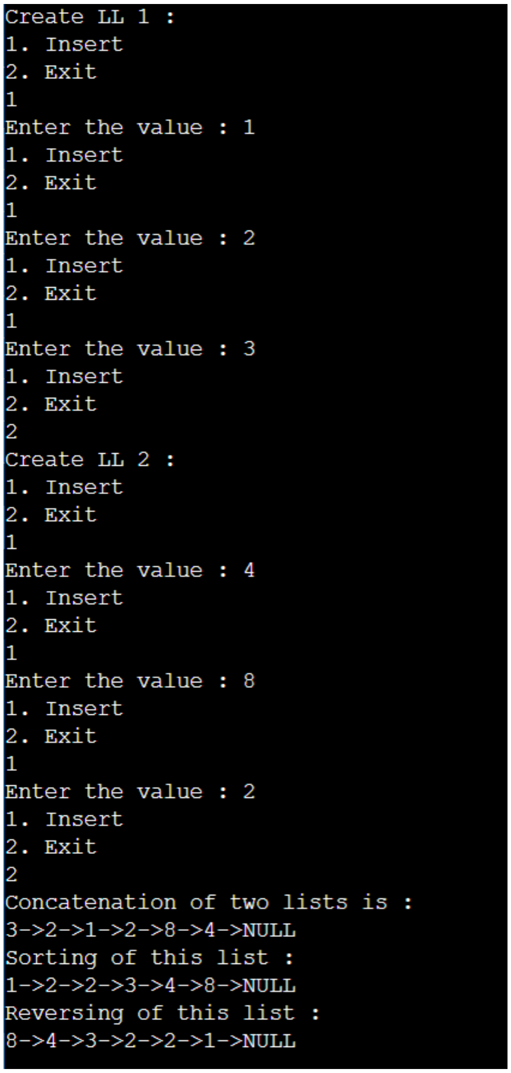
```
    struct Node* head2 = NULL;

    printf("Create LL 1 : \n");
    create(&head1);
    printf("Create LL 2 : \n");
    create(&head2);

    printf("Concatenation of two lists is : \n");
    concat(&head1, &head2);
    display(head1);

    printf("Sorting of this list : \n");
    sortList(&head1);
    display(head1);

    printf("Reversing of this list : \n");
    reverse(&head1);
    display(head1);

    // Free memory
    struct Node* temp;
    while (head1 != NULL) {
        temp = head1;
        head1 = head1->next;
        free(temp);
    }
    while (head2 != NULL) {
        temp = head2;
        head2 = head2->next;
        free(temp);
    }

    return 0;
}

void create(struct Node** node) {
    int ch, val;
    while (1) {
        printf("1. Insert\n2. Exit\n");
        scanf("%d", &ch);

        switch (ch) {
            case 1:
                printf("Enter the value : ");
                scanf("%d", &val);
                insert(node, val);
                break;
            case 2:
                return;
            default:
```

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

void insert(struct Node** node, int value) {
    struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
    new_node->val = value;
    new_node->next = *node;
    *node = new_node;
}

void sortList(struct Node** node) {
    struct Node *temp, *i;
    for (temp = *node; temp != NULL; temp = temp->next) {
        for (i = *node; i != NULL; i = i->next) {
            if (i->val > temp->val) {
                int tem = i->val;
                i->val = temp->val;
                temp->val = tem;
            }
        }
    }
}
```

```
void display(struct Node* node) {
   while (node != NULL) {
      printf("%d->", node->val);
      node = node->next;
   }
   printf("NULL\n");
}

void reverse(struct Node** node) {
   struct Node* curr = *node;
   struct Node* prev = NULL;
   struct Node* nextOne = NULL;

   while (curr != NULL) {
      nextOne = curr->next;
      curr->next = prev;
      prev = curr;
      curr = nextOne;
   }

   *node = prev;
}

void concat(struct Node** node1, struct Node** node2) {
   struct Node* temp1 = *node1;
```

```
    while (temp1->next != NULL) {
        temp1 = temp1->next;
    }
    temp1->next = *node2;
    *node2 = NULL;
}
```

Output (a)



```
Create LL 1 :
1. Insert
2. Exit
1
Enter the value : 1
1. Insert
2. Exit
1
Enter the value : 2
1. Insert
2. Exit
1
Enter the value : 3
1. Insert
2. Exit
2
Create LL 2 :
1. Insert
2. Exit
1
Enter the value : 4
1. Insert
2. Exit
1
Enter the value : 8
1. Insert
2. Exit
1
Enter the value : 2
1. Insert
2. Exit
2
Concatenation of two lists is :
3->2->1->2->8->4->NULL
Sorting of this list :
1->2->2->3->4->8->NULL
Reversing of this list :
8->4->3->2->2->1->NULL
```

Code (b)

Stacks:

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

typedef struct Node {
   int data;
   struct Node *next;
} Node;

typedef Node* Stack;

Stack head = NULL;

void push(int val) {
   Node *newNode = malloc(sizeof(Node));
   if (newNode == NULL) {
      printf("Memory allocation failed\n");
      exit(1);
   }
   newNode->data = val;
   newNode->next = head;
   head = newNode;
}
```

```
void pop() {
   if (head == NULL) {
      printf("Stack is Empty\n");
   } else {
      printf("Popped element = %d\n", head->data);
      Node *temp = head;
      head = head->next;
      free(temp);
   }
}

void printList() {
   Node *temp = head;
   while (temp != NULL) {
      printf("%d->", temp->data);
      temp = temp->next;
   }
   printf("NULL\n");
}

void freeStack() {
   Node *temp;
   while (head != NULL) {
      temp = head;
      head = head->next;
```

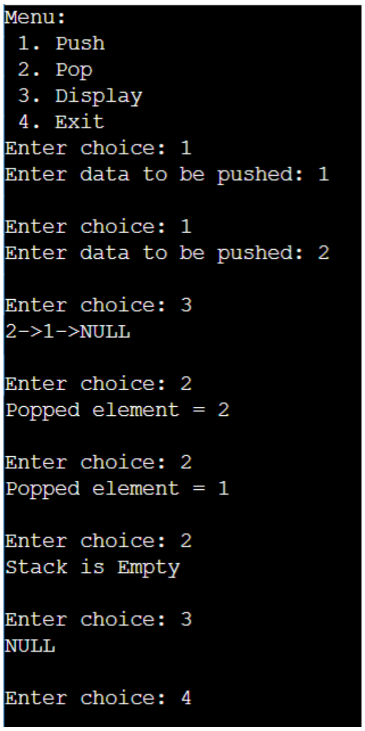
```
        free(temp);
    }
}

int main() {
    int data, ch;
    printf("Menu:\n 1. Push\n 2. Pop\n 3. Display\n 4. Exit\n");
    printf("Enter choice: ");
    scanf("%d", &ch);
    while (ch != 4) {
        switch (ch) {
            case 1:
                printf("Enter data to be pushed: ");
                scanf("%d", &data);
                push(data);
                break;
            case 2:
                pop();
                break;
            case 3:
                printList();
                break;
            default:
                printf("Invalid choice\n");
        }
        printf("\nEnter choice: ");
        scanf("%d", &ch);
    }
    freeStack();
    return 0;
}
```

Queues:

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

struct node {
    int data;
    struct node *next;
};

struct node *front = NULL, *rear = NULL;

void enqueue(int val) {
    struct node *newNode = malloc(sizeof(struct node));
    if (newNode == NULL) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = val;
    newNode->next = NULL;

    if (front == NULL && rear == NULL) {
        front = rear = newNode;
    } else {
        rear->next = newNode;
        rear = newNode;
    }
}

void dequeue() {
    if (front == NULL) {
        printf("Queue is Empty. Unable to perform dequeue\n");
    } else {
        struct node *temp = front;
        front = front->next;
        free(temp);

        if (front == NULL) {
            rear = NULL;
        }
    }
}

void printList() {
    struct node *temp = front;
    while (temp) {
        printf("%d->", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}

int main() {
    int data, ch;
    printf("Menu:\n 1. Enqueue\n 2. Dequeue\n 3. Display\n 4. Exit\n");
    printf("Enter choice: ");
    scanf("%d", &ch);
    while (ch != 4) {
        switch (ch) {
            case 1:
                printf("Enter data to be enqueued: ");
                scanf("%d", &data);
                enqueue(data);
                break;
            case 2:
                dequeue();
                break;
            case 3:
                printList();
            break;
          default:
            printf("Invalid choice\n");
        }
        printf("\nEnter choice: ");
        scanf("%d", &ch);
    }

    return 0;
}
```

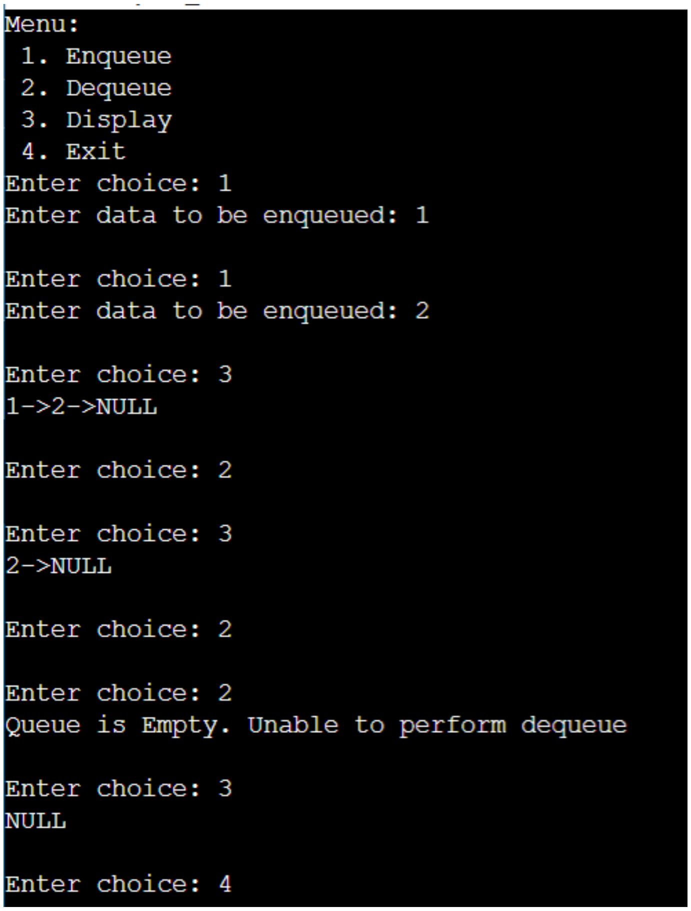
Output (b)

Stacks:



```
Menu:
 1. Push
 2. Pop
 3. Display
 4. Exit
Enter choice: 1
Enter data to be pushed: 1

Enter choice: 1
Enter data to be pushed: 2

Enter choice: 3
2->1->NULL

Enter choice: 2
Popped element = 2

Enter choice: 2
Popped element = 1

Enter choice: 2
Stack is Empty

Enter choice: 3
NULL

Enter choice: 4
```

Queues:



```
Menu:
 1. Enqueue
 2. Dequeue
 3. Display
 4. Exit
Enter choice: 1
Enter data to be enqueued: 1

Enter choice: 1
Enter data to be enqueued: 2

Enter choice: 3
1->2->NULL

Enter choice: 2

Enter choice: 3
2->NULL

Enter choice: 2

Enter choice: 2
Queue is Empty. Unable to perform dequeue

Enter choice: 3
NULL

Enter choice: 4
```

LAB 7

Question

a) WAP to Implement doubly link list with primitive operations
   i) Create a doubly linked list.
   ii) Insert a new node to the left of the node.
   iii) Delete the node based on a specific value
   iv) Display the contents of the list

b) Program - Leetcode platform

Code

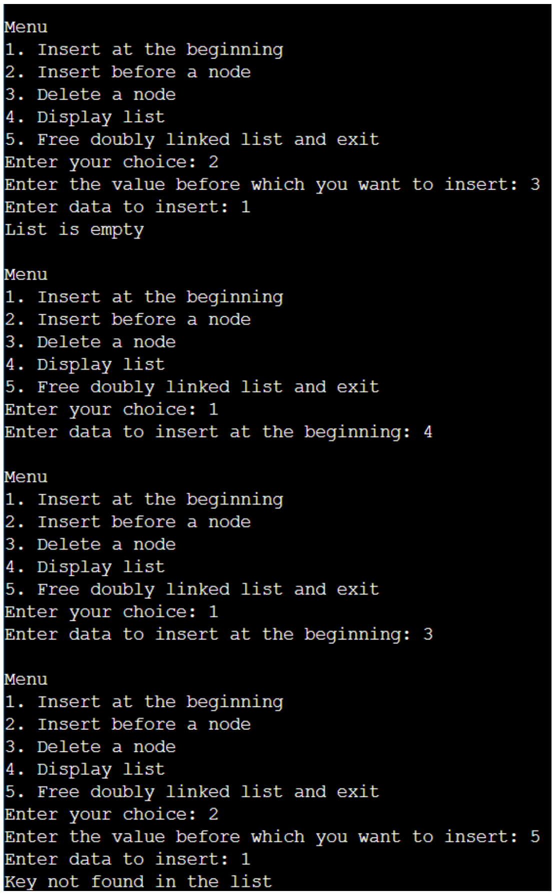
```
#include <stdio.h>

#include <stdlib.h>


struct Node {

   int data;

   struct Node* prev;

   struct Node* next;

};


struct Node* createNode(int data) {

   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));

   if (newNode == NULL) {

      printf("Memory allocation failed\n");

      return NULL;

   }
```

```
    newNode->data = data;
    newNode->prev = NULL;
    newNode->next = NULL;
    return newNode;
}

void insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = createNode(data);

    if (*head == NULL) {
        *head = newNode;
    } else {
        newNode->next = *head;
        (*head)->prev = newNode;
        *head = newNode;
    }
}

void insertBeforeNode(struct Node** head, int key, int data) {
    if (*head == NULL) {
        printf("List is empty\n");
        return;
    }

    struct Node* newNode = createNode(data);
    struct Node* current = *head;

    while (current) {
        if (current->data == key) {
            if (current->prev) {
                current->prev->next = newNode;
                newNode->prev = current->prev;
            } else {
                *head = newNode;
            }

            newNode->next = current;
            current->prev = newNode;
            return;
        }
        current = current->next;
    }

    printf("Key not found in the list\n");
}

void deleteNode(struct Node** head, int pos) {
    if (*head == NULL) {
        printf("List is empty\n");
        return;
    }

    struct Node* current = *head;
    int count = 1;

    while (current && count < pos) {
        current = current->next;
        count++;
    }

    if (current == NULL) {
        printf("Position %d is beyond the length of the list\n", pos);
        return;
    }

    if (current->prev) {
        current->prev->next = current->next;
    } else {
        *head = current->next;
    }

    if (current->next) {
        current->next->prev = current->prev;
    }
```

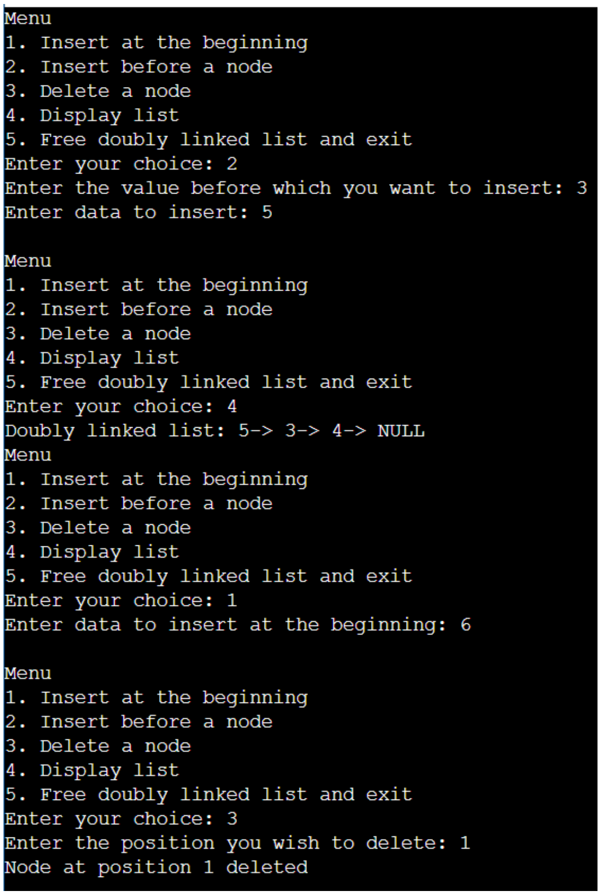
```
    free(current);
    printf("Node at position %d deleted\n", pos);
}

void displayList(struct Node* head) {
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }

    struct Node* current = head;

    while (current) {
        printf("%d-> ", current->data);
        current = current->next;
    }
    printf("NULL\n");
}

void freeList(struct Node** head) {
    struct Node* current = *head;
    struct Node* nextNode;

    while (current) {
        nextNode = current->next;
        free(current);
        current = nextNode;
    }

    *head = NULL; // Set head to NULL after freeing all nodes
}

int main() {
    struct Node* head = NULL;
    int ch, newData, pos, key;

    while (1) {
        printf("\nMenu\n");
        printf("1. Insert at the beginning\n");
        printf("2. Insert before a node\n");
        printf("3. Delete a node\n");
        printf("4. Display list\n");
        printf("5. Free doubly linked list and exit\n");
        printf("Enter your choice: ");
        scanf("%d", &ch);

        switch (ch) {
            case 1:
                printf("Enter data to insert at the beginning: ");
                scanf("%d", &newData);
                insertAtBeginning(&head, newData);
                break;

            case 2:
                printf("Enter the value before which you want to insert: ");
                scanf("%d", &key);
                printf("Enter data to insert: ");
                scanf("%d", &newData);
                insertBeforeNode(&head, key, newData);
                break;

            case 3:
                printf("Enter the position you wish to delete: ");
                scanf("%d", &pos);
                deleteNode(&head, pos);
                break;

            case 4:
                printf("Doubly linked list: ");
                displayList(head);
                break;

            case 5:
                freeList(&head);
                printf("Exiting the program\n");
```

```
        return 0;

      default:
        printf("Invalid choice. Please enter a valid choice.\n");
    }
  }

  return 0;
}
```

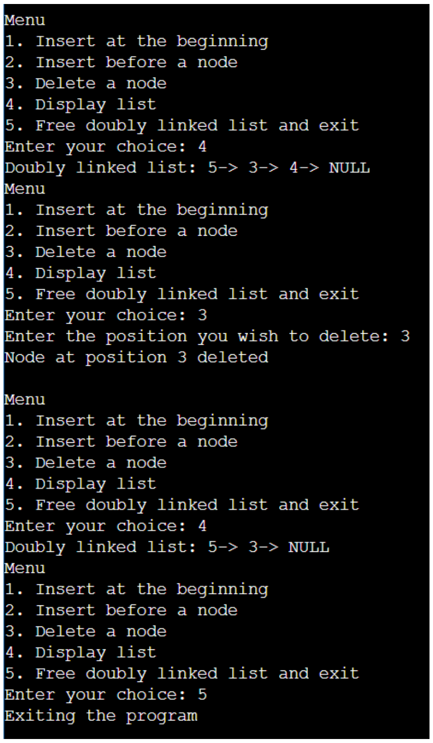
Output



```
Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 2
Enter the value before which you want to insert: 3
Enter data to insert: 1
List is empty

Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 1
Enter data to insert at the beginning: 4

Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 1
Enter data to insert at the beginning: 3

Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 2
Enter the value before which you want to insert: 5
Enter data to insert: 1
Key not found in the list
```



```
Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 2
Enter the value before which you want to insert: 3
Enter data to insert: 5

Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 4
Doubly linked list: 5-> 3-> 4-> NULL
Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 1
Enter data to insert at the beginning: 6

Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 3
Enter the position you wish to delete: 1
Node at position 1 deleted
```

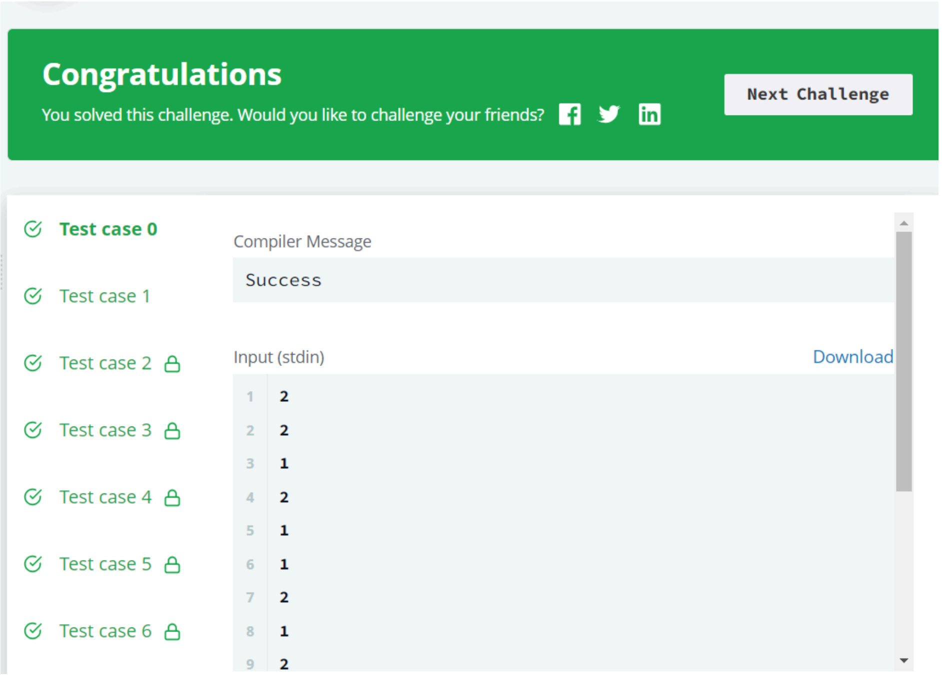


```
Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 4
Doubly linked list: 5-> 3-> 4-> NULL
Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 3
Enter the position you wish to delete: 3
Node at position 3 deleted

Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 4
Doubly linked list: 5-> 3-> NULL
Menu
1. Insert at the beginning
2. Insert before a node
3. Delete a node
4. Display list
5. Free doubly linked list and exit
Enter your choice: 5
Exiting the program
```

Leetcode - Compare Linked Lists

```
/*
 * For your reference:
 *
 * SinglyLinkedListNode {
 *     int data;
 *     SinglyLinkedListNode* next;
 * };
 *
 */
bool compare_lists(SinglyLinkedListNode* head1, SinglyLinkedListNode* head2) {
    struct SinglyLinkedListNode *t1;
    struct SinglyLinkedListNode *t2;
    t1=head1;t2 = head2;
    if(t1==NULL && t2==NULL)
        return 1;
    if(t1 != NULL && t2 == NULL)
        return 0;
     if(t1 == NULL && t2 != NULL)
        return 0;
    else
    {
        while(t1->next != NULL && t2->next != NULL)
        {
            if(t1->data == t2->data)
            {
                t1 = t1->next;
                t2 = t2->next;
            }
            else return 0;
        }
        if(t1->next == NULL && t2->next == NULL)
```

```
            return 1;
         else return 0;
      }

}
```



Congratulations

You solved this challenge. Would you like to challenge your friends?

Compiler Message

```
Success
```

Input (stdin)

```
2
2
1
2
1
1
2
1
2
```

LAB 8

Question

a) Write a program
   i) To construct a binary Search tree.
   ii) To traverse the tree using all the methods i.e., in-order, preorder and post order
   iii) To display the elements in the tree.

b) Program - Leetcode platform

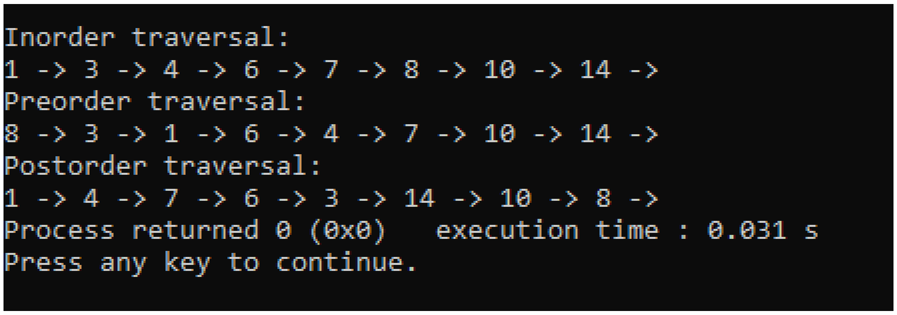
Code

```
#include <stdio.h>

#include <stdlib.h>


struct node {

   int key;

   struct node *left, *right;

};


// Create a node

struct node *newNode(int item) {

   struct node *temp = (struct node *)malloc(sizeof(struct node));

   if (temp == NULL) {

      printf("Memory allocation failed\n");

      exit(1);
```

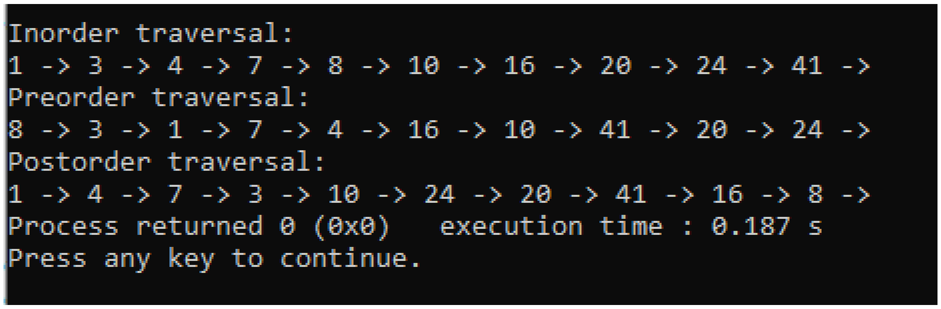
```
    }
    temp->key = item;
    temp->left = temp->right = NULL;
    return temp;
}

// Inorder Traversal
void inorder(struct node *root) {
    if (root != NULL) {
        inorder(root->left);
        printf("%d -> ", root->key);
        inorder(root->right);
    }
}

// Preorder Traversal
void preorder(struct node *root) {
    if (root != NULL) {
        printf("%d -> ", root->key);
        preorder(root->left);
        preorder(root->right);
    }
}

// Postorder Traversal
```

```
void postorder(struct node *root) {
    if (root != NULL) {
        postorder(root->left);
        postorder(root->right);
        printf("%d -> ", root->key);
    }
}

// Insert a node
struct node *insert(struct node *node, int key) {
    if (node == NULL)
        return newNode(key);

    if (key < node->key)
        node->left = insert(node->left, key);
    else if (key > node->key)
        node->right = insert(node->right, key);

    return node;
}

// Free the memory allocated for the tree
void freeTree(struct node *root) {
    if (root != NULL) {
        freeTree(root->left);
        freeTree(root->right);
        free(root);
    }
}

// Driver code
int main() {
    struct node *root = NULL;
    root = insert(root, 8);
    insert(root, 3);
    insert(root, 1);
    insert(root, 6);
    insert(root, 7);
    insert(root, 10);
    insert(root, 14);
    insert(root, 4);

    printf("\nInorder traversal: \n");
    inorder(root);

    printf("\nPreorder traversal: \n");
    preorder(root);

    printf("\nPostorder traversal: \n");
    postorder(root);
    // Free memory

    freeTree(root);


    return 0;

}
```

Output



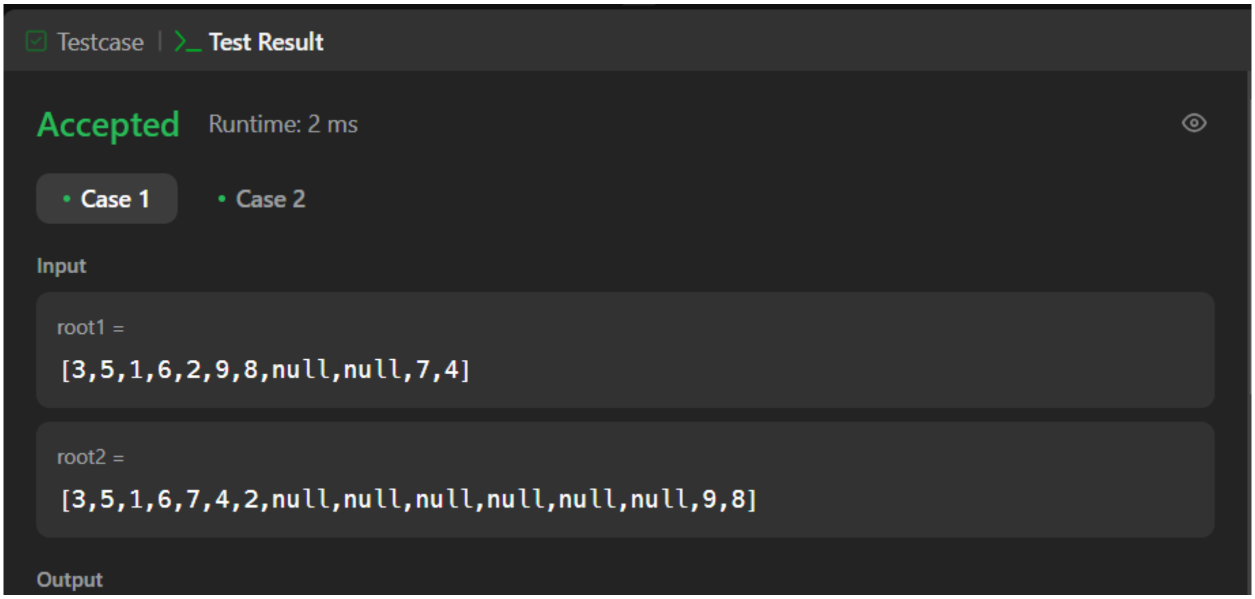
```
Inorder traversal:
1 -> 3 -> 4 -> 6 -> 7 -> 8 -> 10 -> 14 ->
Preorder traversal:
8 -> 3 -> 1 -> 6 -> 4 -> 7 -> 10 -> 14 ->
Postorder traversal:
1 -> 4 -> 7 -> 6 -> 3 -> 14 -> 10 -> 8 ->
Process returned 0 (0x0)   execution time : 0.031 s
Press any key to continue.
```



```
Inorder traversal:
1 -> 3 -> 4 -> 7 -> 8 -> 10 -> 16 -> 20 -> 24 -> 41 ->
Preorder traversal:
8 -> 3 -> 1 -> 7 -> 4 -> 16 -> 10 -> 41 -> 20 -> 24 ->
Postorder traversal:
1 -> 4 -> 7 -> 3 -> 10 -> 24 -> 20 -> 41 -> 16 -> 8 ->
Process returned 0 (0x0)   execution time : 0.187 s
Press any key to continue.
```

Leetcode

```
/**

 * Definition for a binary tree node.

 * struct TreeNode {

 *     int val;

 *     struct TreeNode *left;

 *     struct TreeNode *right;

 * };
 */

void findLeaves(struct TreeNode* node, int** leafValues, int* size, int* capacity) {
    if (node == NULL) {
        return;
    }

    if (node->left == NULL && node->right == NULL) {
        if (*size >= *capacity) {
            *capacity *= 2;
            *leafValues = (int*) realloc(*leafValues, *capacity * sizeof(int));
        }
        (*leafValues)[(*size)++] = node->val;
    }

    findLeaves(node->left, leafValues, size, capacity);
    findLeaves(node->right, leafValues, size, capacity);
}

bool leafSimilar(struct TreeNode* root1, struct TreeNode* root2) {
    int *leaves1 = (int*) malloc(sizeof(int) * 10);
    int size1 = 0, capacity1 = 10;

    int *leaves2 = (int*) malloc(sizeof(int) * 10);
    int size2 = 0, capacity2 = 10;
    findLeaves(root1, &leaves1, &size1, &capacity1);
    findLeaves(root2, &leaves2, &size2, &capacity2);

    if (size1 != size2) {
        free(leaves1);
        free(leaves2);
        return false;
    }

    for (int i = 0; i < size1; i++) {
        if (leaves1[i] != leaves2[i]) {
            free(leaves1);
            free(leaves2);
            return false;
        }
    }

    free(leaves1);
    free(leaves2);
    return true;
}
```



Accepted Runtime: 2 ms

Input

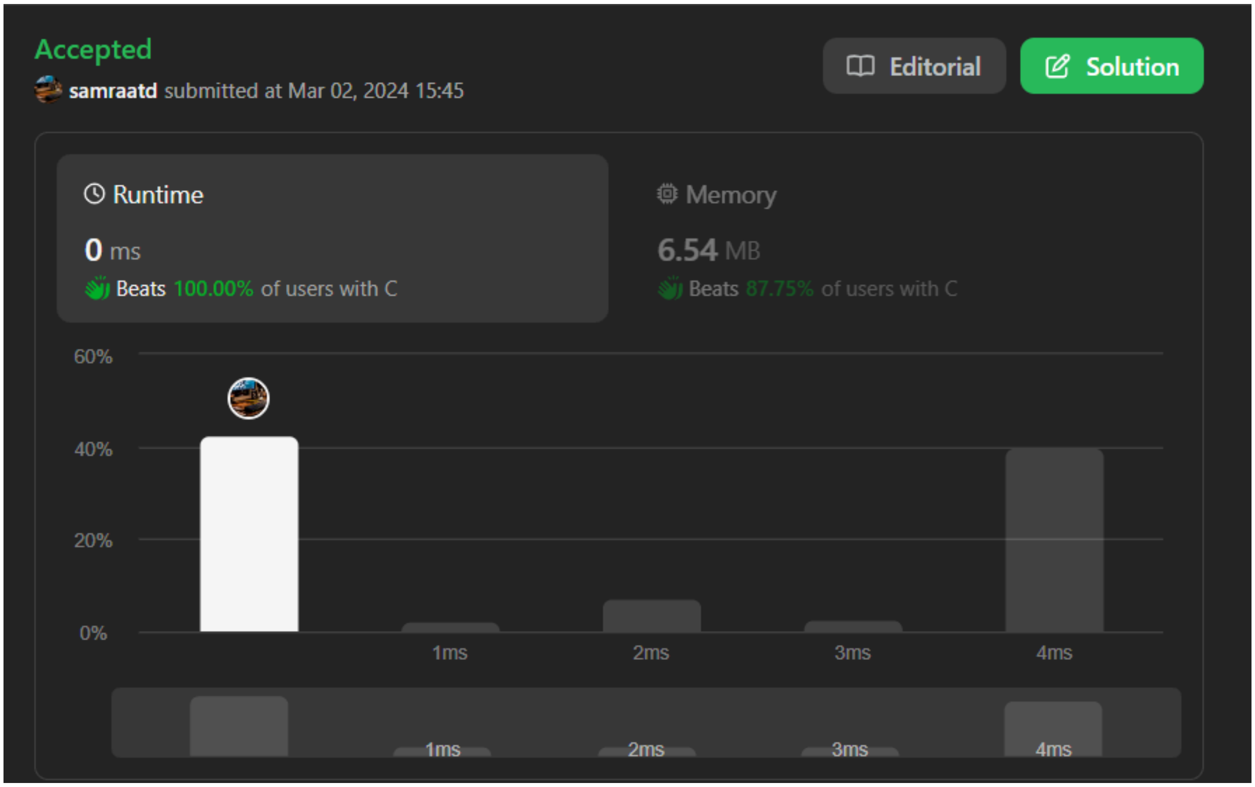
root1 =

```
[3,5,1,6,2,9,8,null,null,7,4]
```

root2 =

```
[3,5,1,6,7,4,2,null,null,null,null,null,null,9,8]
```

Output



Accepted

samraatd submitted at Mar 02, 2024 15:45

Runtime

0 ms

Beats 100.00% of users with C

Memory

6.54 MB

Beats 87.75% of users with C

LAB 9

Question

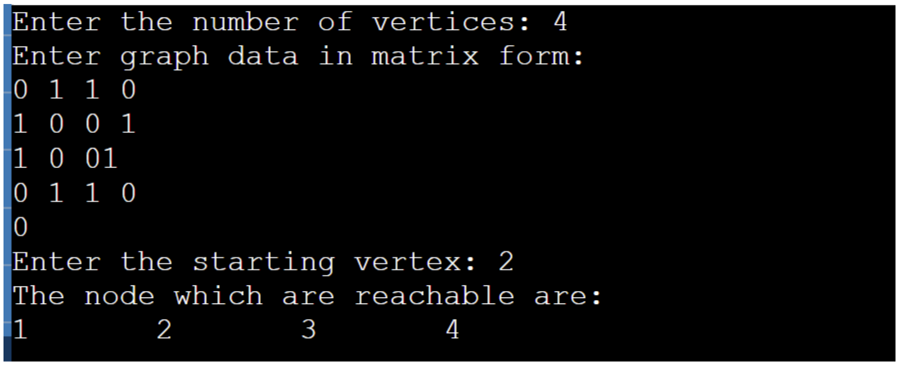
a) Write a program to traverse a graph using BFS method.
b) Write a program to check whether given graph is connected or not using DFS method.

Code (a)

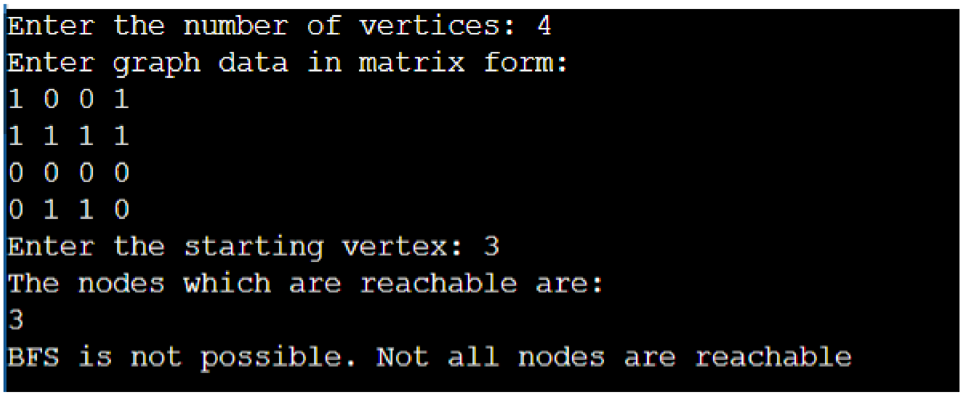
```
#include <stdio.h>


int n, i, j, visited[10], queue[10], front = -1, rear = -1;

int adj[10][10];


void bfs(int v)

{

   for (i = 1; i <= n; i++)

   {

      if (adj[v][i] && !visited[i])

      {

         queue[++rear] = i;

         visited[i] = 1;

      }

   }


   if (front <= rear)

   {

      bfs(queue[++front]);
```

```
    }
}

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

    for (i = 1; i <= n; i++)
    {
        queue[i] = 0;
        visited[i] = 0;
    }

    printf("Enter graph data in matrix form:\n");
    for (i = 1; i <= n; i++)
    {
        for (j = 1; j <= n; j++)
        {
            scanf("%d", &adj[i][j]);
        }
    }

    printf("Enter the starting vertex: ");
    scanf("%d", &v);
    visited[v] = 1;
    bfs(v);

    printf("The nodes which are reachable are:\n");
    for (i = 1; i <= n; i++)
    {
        if (visited[i])
        {
            printf("%d\t", i);
        }
    }

    for (i = 1; i <= n; i++)
    {
        if (!visited[i])
        {
            printf("\nBFS is not possible. Not all nodes are reachable\n");
            break;
        }
    }

    return 0;
}
```

Output (a)



```
Enter the number of vertices: 4
Enter graph data in matrix form:
0 1 1 0
1 0 0 1
1 0 01
0 1 1 0
0
Enter the starting vertex: 2
The node which are reachable are:
1       2       3       4
```

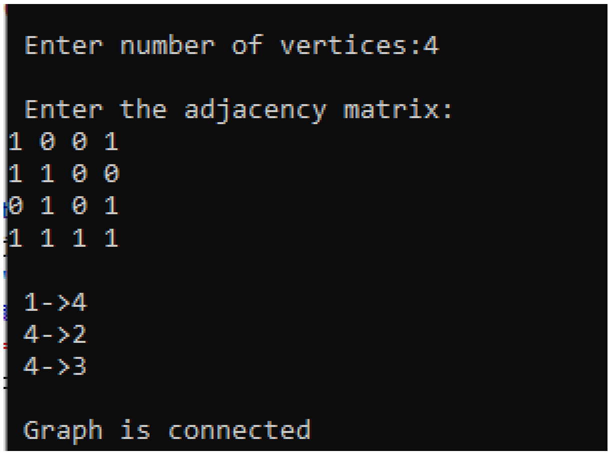


```
Enter the number of vertices: 4
Enter graph data in matrix form:
1 0 0 1
1 1 1 1
0 0 0 0
0 1 1 0
Enter the starting vertex: 3
The nodes which are reachable are:
3
BFS is not possible. Not all nodes are reachable
```

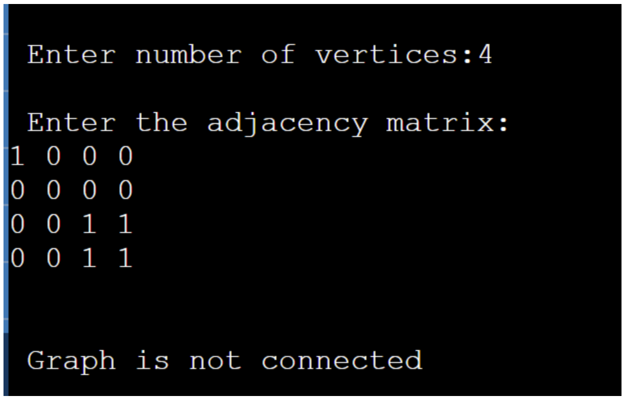
Code (b)

```
#include<stdio.h>


int a[20][20], reach[20], n;


void dfs(int v) {
   int i;
   reach[v] = 1;
   for (i = 1; i <= n; i++) {
       if (a[v][i] && !reach[i]) {
           printf("\n %d->%d", v, i);
           dfs(i);
       }
   }
}

int main() {
   int i, j, count = 0;
   printf("\n Enter number of vertices:");
   scanf("%d", &n);
   for (i = 1; i <= n; i++) {
       reach[i] = 0;
       for (j = 1; j <= n; j++) {
           a[i][j] = 0;
       }
   }
   printf("\n Enter the adjacency matrix:\n");
   for (i = 1; i <= n; i++) {
       for (j = 1; j <= n; j++) {
           scanf("%d", &a[i][j]);
       }
   }
   dfs(1);
   printf("\n");
   for (i = 1; i <= n; i++) {
       if (reach[i]) {
           count++;
       }
   }
   if (count == n) {
       printf("\n Graph is connected");
   } else {
       printf("\n Graph is not connected");
   }
   return 0;
}
```

Output (b)



```
 Enter number of vertices:4

 Enter the adjacency matrix:
1 0 0 1
1 1 0 0
0 1 0 1
1 1 1 1

 1->4
 4->2
 4->3

 Graph is connected
```



```
 Enter number of vertices:4

 Enter the adjacency matrix:
1 0 0 0
0 0 0 0
0 0 1 1
0 0 1 1


 Graph is not connected
```