VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
September 2024-January 2025

B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by Ritesh Mohan Nayak **(1BM23CS350)**, 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.

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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.

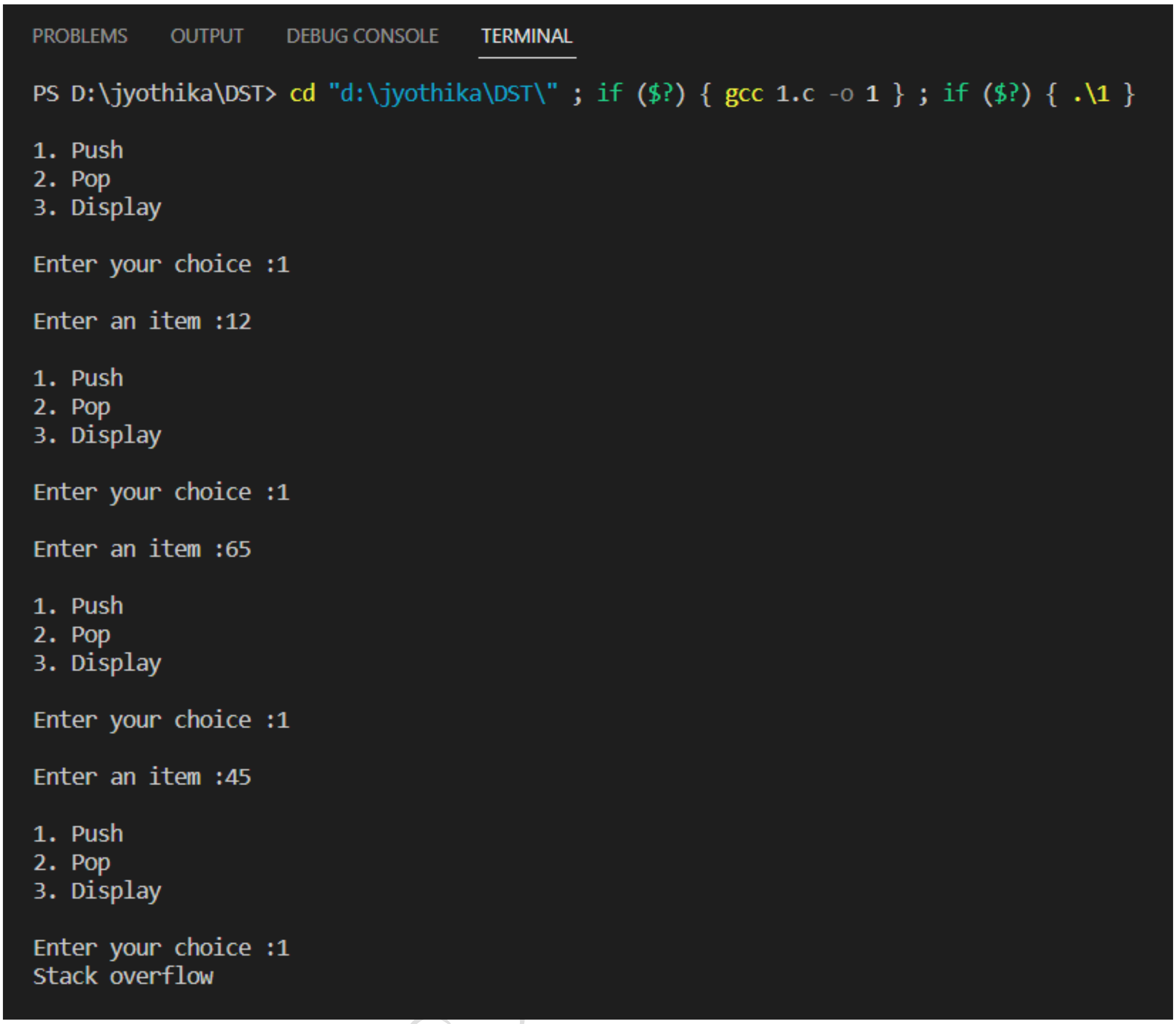
Lab program 1:

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.

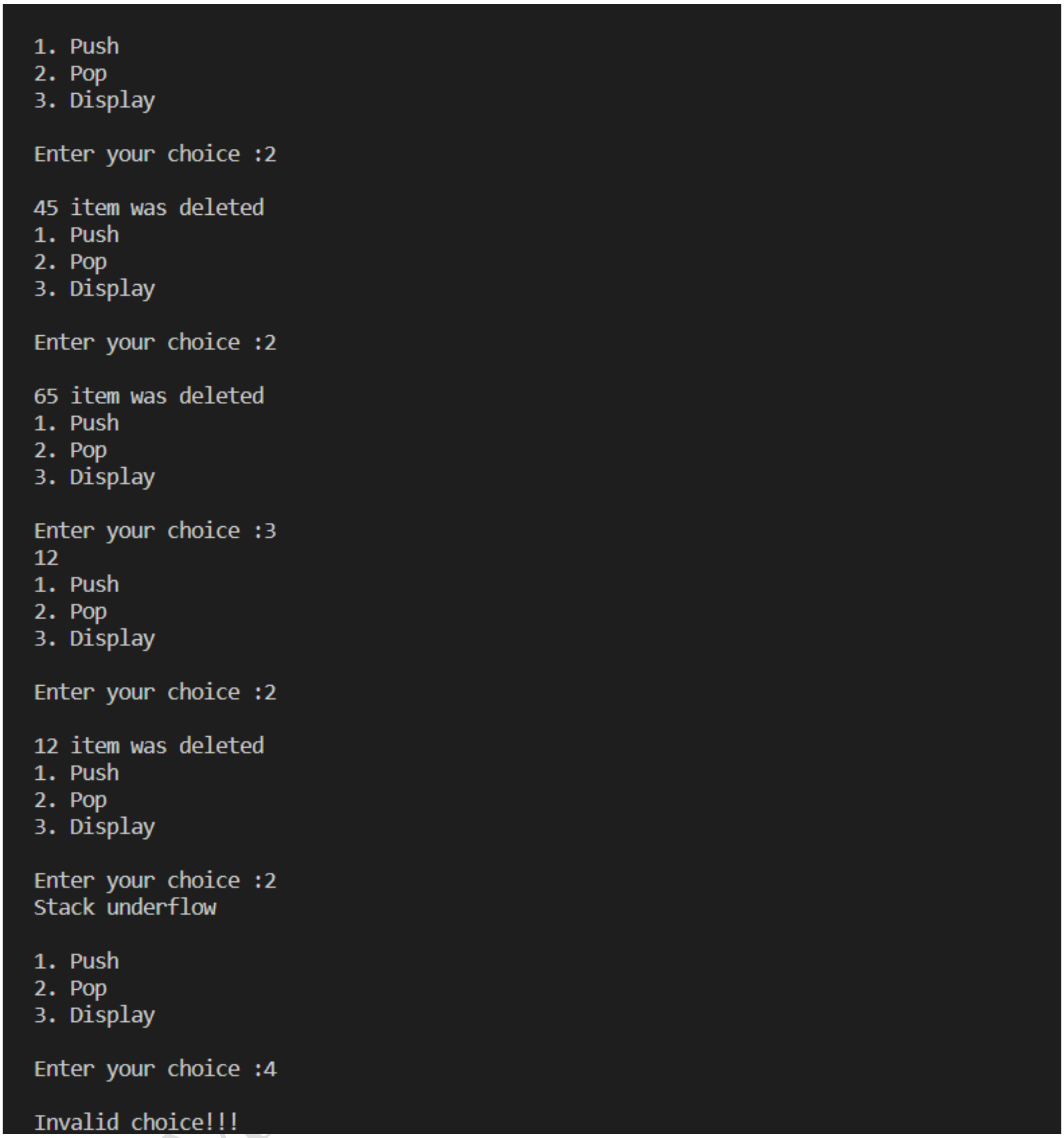
```
#include <stdio.h>
#include<stdlib.h>
#define STACK_SIZE 5
void push(int st[],int *top)
{
        int item;
        if(*top==STACK_SIZE-1)
                printf("Stack overflow\n");
        else
        {
                printf("\nEnter an item :");
                scanf("%d",&item);
                (*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:



```
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
```



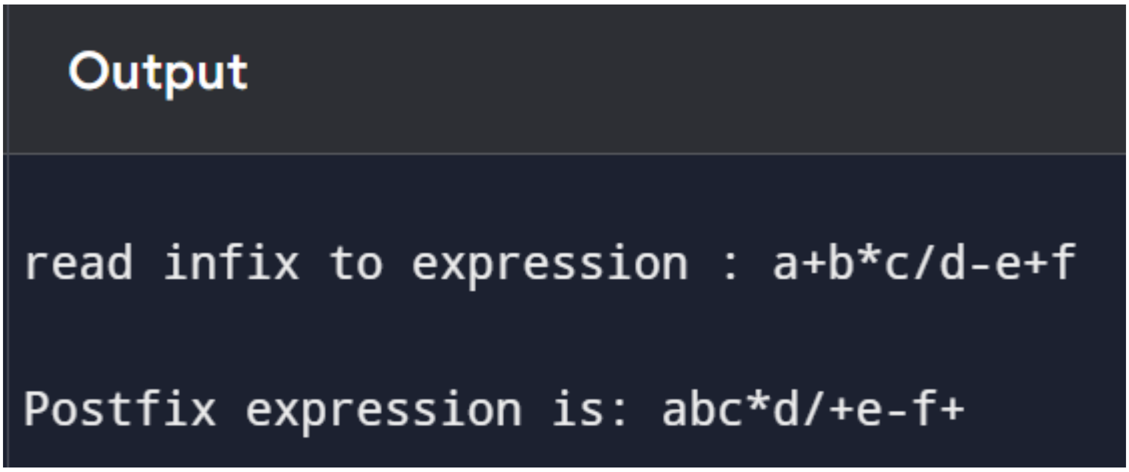
```
1. Push
2. Pop
3. Display

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!!!
```

2.Infix to Postfix Conversions

Code:

```
#include<stdio.h>
#include<string.h>
#include<ctype.h>
#define size 20

struct stack
{
   int top;
   char data[size];
};

typedef struct stack STACK;

void push(STACK*S, char item)
{
   S-> data[++(S-> top)]=item;
}

char pop(STACK*S)
{
   return S-> data[(S->top)--];
}

int preced(char symbol)
{
   switch (symbol)
```

```
    {
        case '^' : return 3;
        case'*' :
        case'/' : return 2;
        case'+' :
        case'-' : return 1;
        default : return 0;
    }
}

void infixtopostfix(char infix[10], STACK*S)
{
    char postfix[10],symbol,temp;
    int a,b=0;
    for(a=0;infix[a]!='\0';a++)
    {
        symbol=infix[a];
        if(isalnum(symbol)){
            postfix[b++]=symbol;
        }else{
            switch(symbol){
                case'(': push(S,symbol);
                        break;
                case')': temp = pop(S);
                        while(temp!='(')
                        {
                            postfix[b++]=temp;
                            temp=pop(S);
                        }
                    break;
                case '+' :
                case '-' :
                case '*' :
                case '/' :
                case '^' : while (S->top != -1 && preced(S->data[S->top]) >= preced(symbol) && S->data[S->top] != '('){
                        postfix[b++] = pop(S);
                    }
                    push(S, symbol);
                    break;
            }
        }
    }
        while (S->top != -1) {
        postfix[b++] = pop(S);
    }
    postfix[b] = '\0';
    printf("\nPostfix expression is: %s\n", postfix);
}
int main ()
{
    char infix[10];
    STACK S;
    S.top=-1;
    printf("\nread infix to expression : ");
    scanf("%s",infix);
    infixtopostfix(infix,&S);

    return 0;

}
```



```
read infix to expression : a+b*c/d-e+f

Postfix expression is: abc*d/+e-f+
```

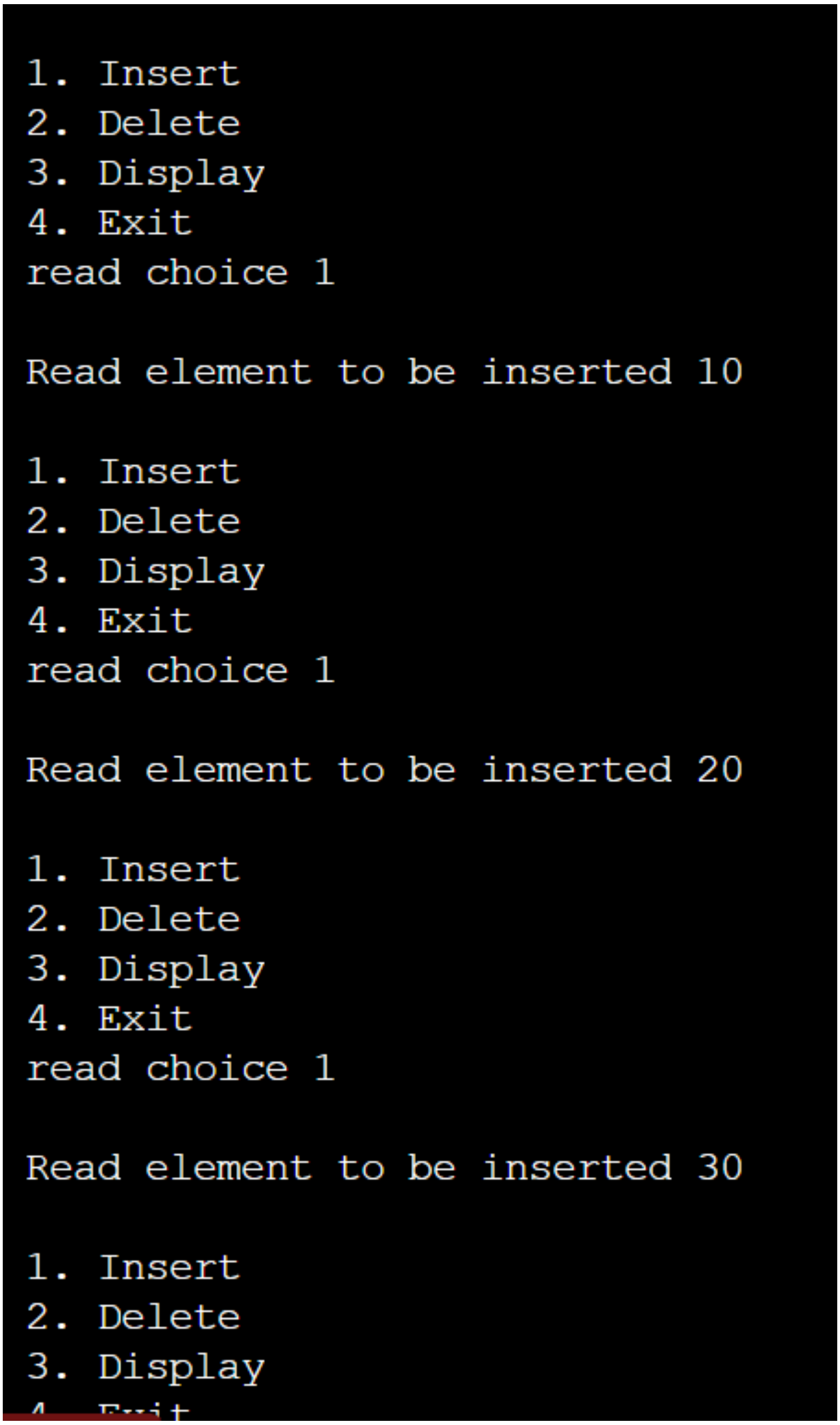
3.Queue Implementation

Code:

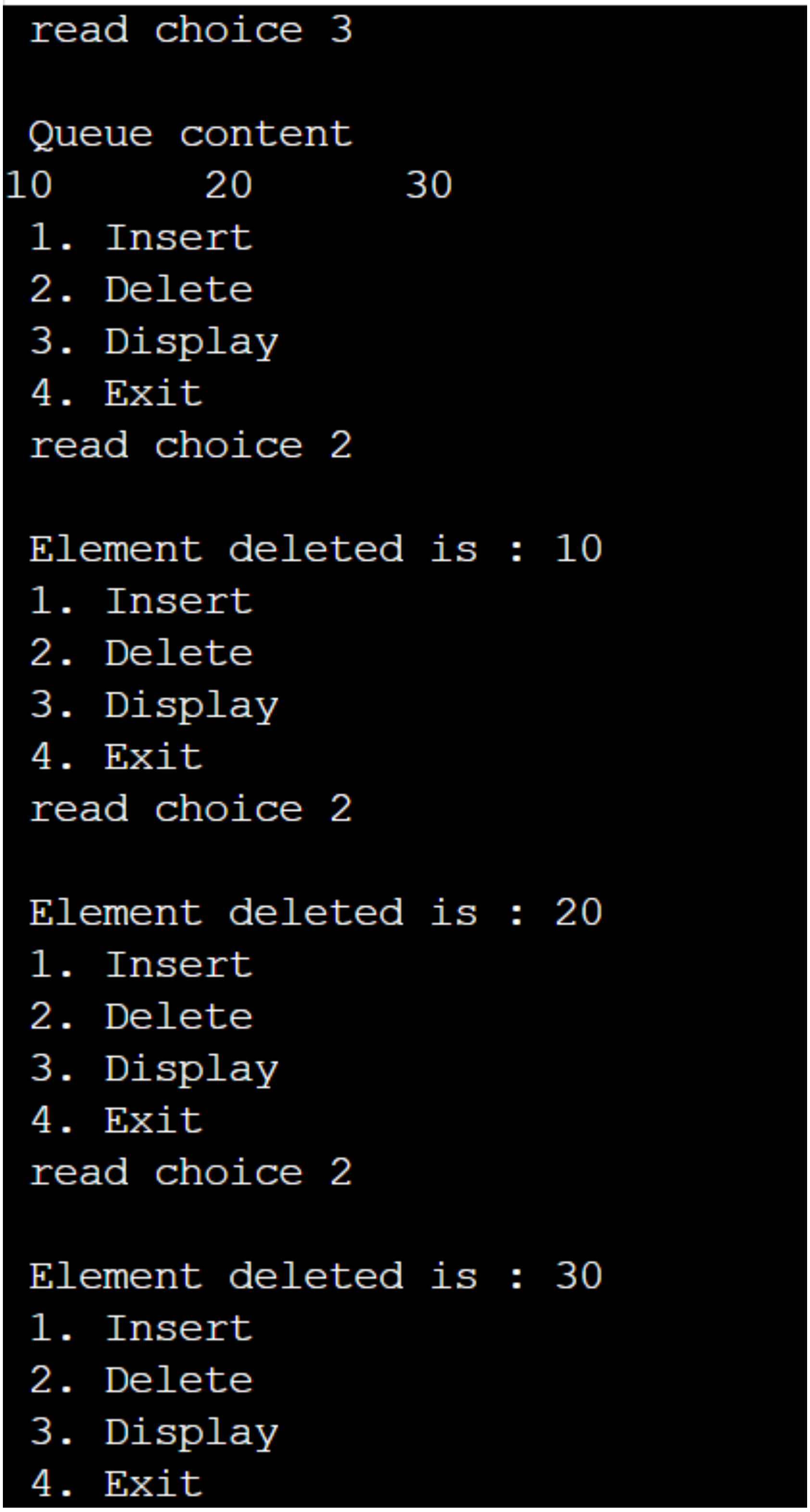
```
#include <stdio.h>

#include <stdlib.h>

#define SIZE 5


int front = -1 , rear = -1 ;

int q[SIZE];


void enqueue (int item)

{

    if(rear==SIZE-1)

    printf("\n Queue is full ");

    else{

        rear=rear+1;
        q[rear]=item;
        if(front==-1)
        front=front+1;
    }
}

void dequeue()
{
    int del;
    if(front==-1)
    printf("\n Queue is empty");
    else{
        del=q[front];
        printf("\n Element deleted is : %d",del);
        if(front==rear)
        {
            front=-1;rear=-1;
        }
        else{
            front=front+1;
        }
    }
}

void display()
{
    int i;
    if(front==-1)
    printf("\n Queue is empty");
    else{
        printf("\n Queue content \n");
        for (i=front;i<=rear;i++)
        printf("%d\t",q[i]);
    }
}

int main()
{
    int item,ch;
    for(;;)
    {
        printf("\n 1. Insert");
        printf("\n 2. Delete");
        printf("\n 3. Display");
        printf("\n 4. Exit");
        printf("\n read choice ");
        scanf("%d",&ch);

        switch(ch)
        {
            case 1 : printf("\n Read element to be inserted ");
                    scanf("%d", & item);
                    enqueue(item);
                    break;

            case 2 : dequeue();
```

```
                break;

            case 3 : display();
                break;

            default : exit (0);
        }
    }
    return 0;
}
```

OUTPUT:



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

Read element to be inserted 10

1. Insert
2. Delete
3. Display
4. Exit
read choice 1

Read element to be inserted 20

1. Insert
2. Delete
3. Display
4. Exit
read choice 1

Read element to be inserted 30

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



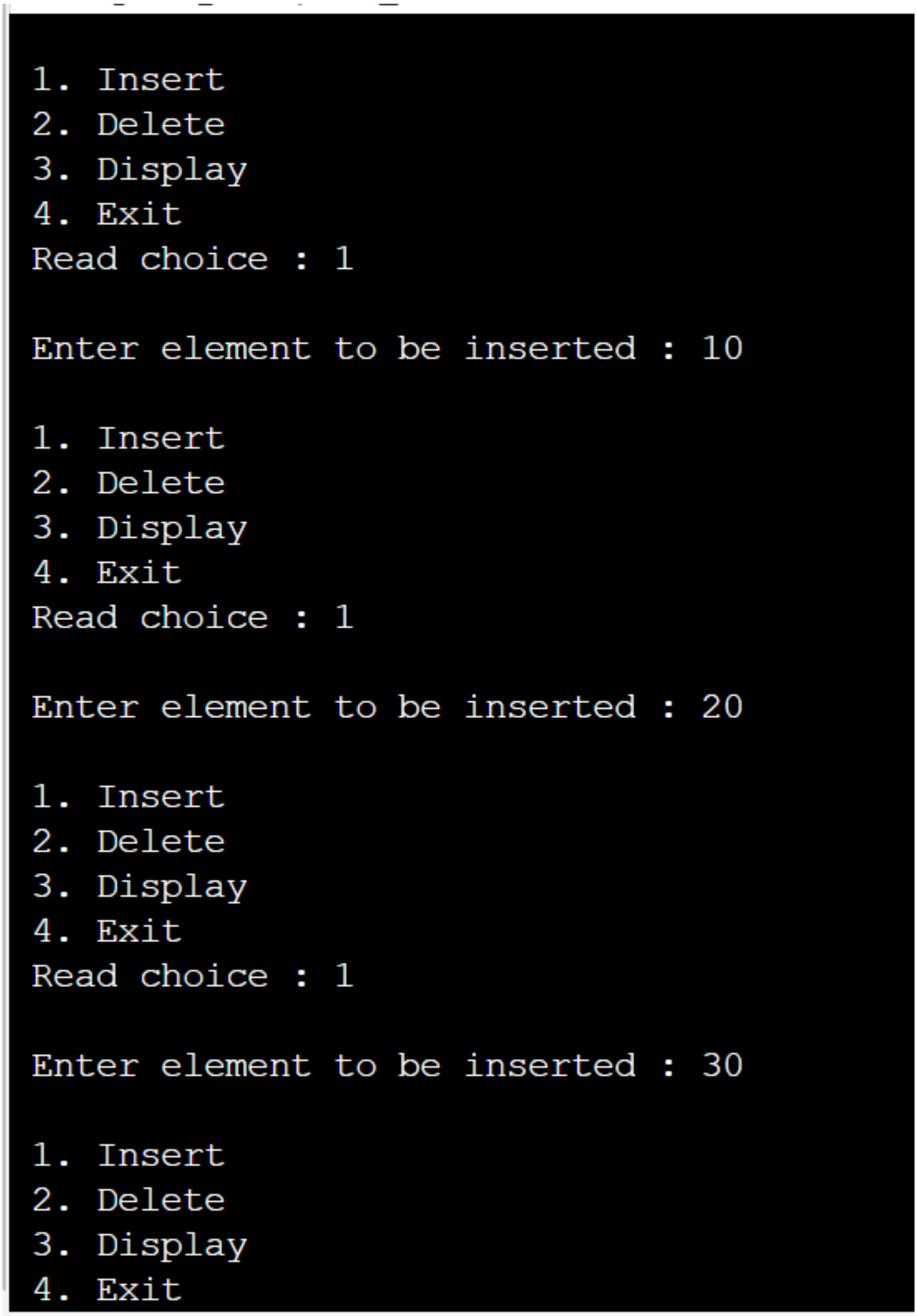
```
 read choice 3

 Queue content
10      20      30
 1. Insert
 2. Delete
 3. Display
 4. Exit
 read choice 2

 Element deleted is : 10
 1. Insert
 2. Delete
 3. Display
 4. Exit
 read choice 2

 Element deleted is : 20
 1. Insert
 2. Delete
 3. Display
 4. Exit
 read choice 2

 Element deleted is : 30
 1. Insert
 2. Delete
 3. Display
 4. Exit
```

4.Circular Queue Implementation

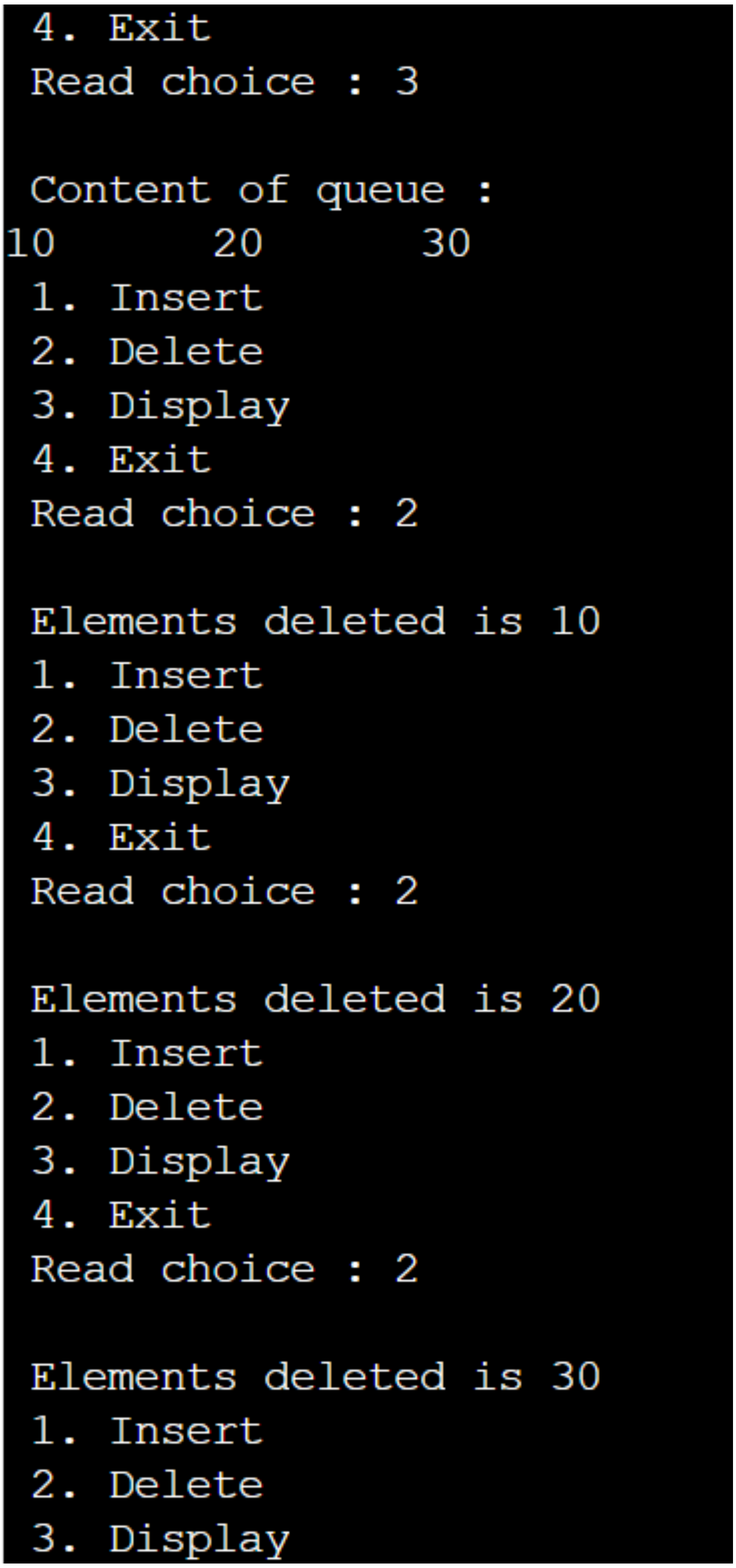
Code:

```
#include <stdio.h>
#include <stdlib.h>
#define size 5

int f=-1;
int r=-1;
int q[size];

void enqueue(int item)
{
   if(f==(r+1)%size)
   printf("Queue is full");
   else{
      r=(r+1)%size;
      q[r]=item;
      if(f==-1)
         f=f+1;
   }
}

void dequeue()
{
   if(f==-1)
   printf("Queue is empty");
   else{
      printf("\n Elements deleted is %d ",q[f]);
      if(f==r)
      {
            f=-1;
            r=-1;
        }
        else{
            f=(f+1)%size;
        }
    }
}

void display()
{
    int i;
    if(f==-1)
        printf("Queue is empty");
    else{
        printf("\n Content of queue : \n");
        for(i=f ; i!=r ; i=(i+1)%size)
        printf("%d \t",q[i]);
        printf("%d \t", q[r]);
    }
}

int main()
{
    int ch , item;
    for(;;)
    {
        printf("\n 1. Insert");
        printf("\n 2. Delete");

        printf("\n 3. Display");

        printf("\n 4. Exit");

        printf("\n Read choice : ");

        scanf("%d",&ch);


        switch(ch)

        {

          case 1 : printf("\n Enter element to be inserted : ");

                  scanf("%d",&item);

                  enqueue(item);

                  break;


          case 2 : dequeue();

                  break;


          case 3 : display();

                  break;


          default : exit(0);

        }

    }

    return 0;

}
```

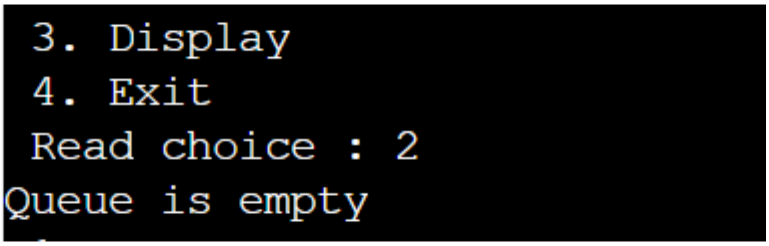
OUTPUT:



```
1. Insert
2. Delete
3. Display
4. Exit
Read choice : 1

Enter element to be inserted : 10

1. Insert
2. Delete
3. Display
4. Exit
Read choice : 1

Enter element to be inserted : 20

1. Insert
2. Delete
3. Display
4. Exit
Read choice : 1

Enter element to be inserted : 30

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



```
 4. Exit
 Read choice : 3

 Content of queue :
10      20      30
 1. Insert
 2. Delete
 3. Display
 4. Exit
 Read choice : 2

 Elements deleted is 10
 1. Insert
 2. Delete
 3. Display
 4. Exit
 Read choice : 2

 Elements deleted is 20
 1. Insert
 2. Delete
 3. Display
 4. Exit
 Read choice : 2

 Elements deleted is 30
 1. Insert
 2. Delete
 3. Display
```



```
 3. Display
 4. Exit
 Read choice : 2
Queue is empty
```

5.1) WAP to Implement Singly Linked List with following operations

(10 Marks)

a) Create a linked list.

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

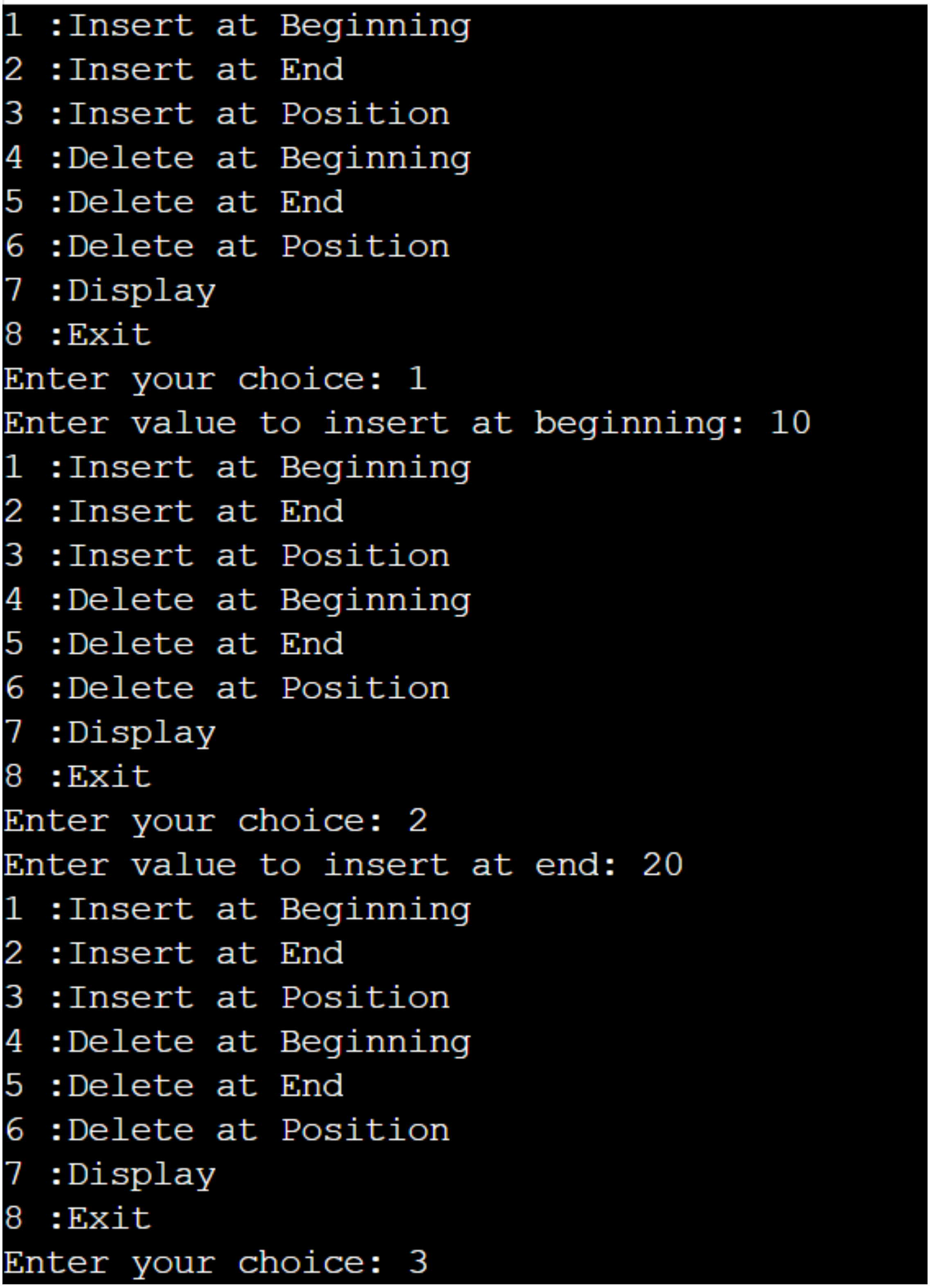
c) Display the contents of the linked list.

Code:

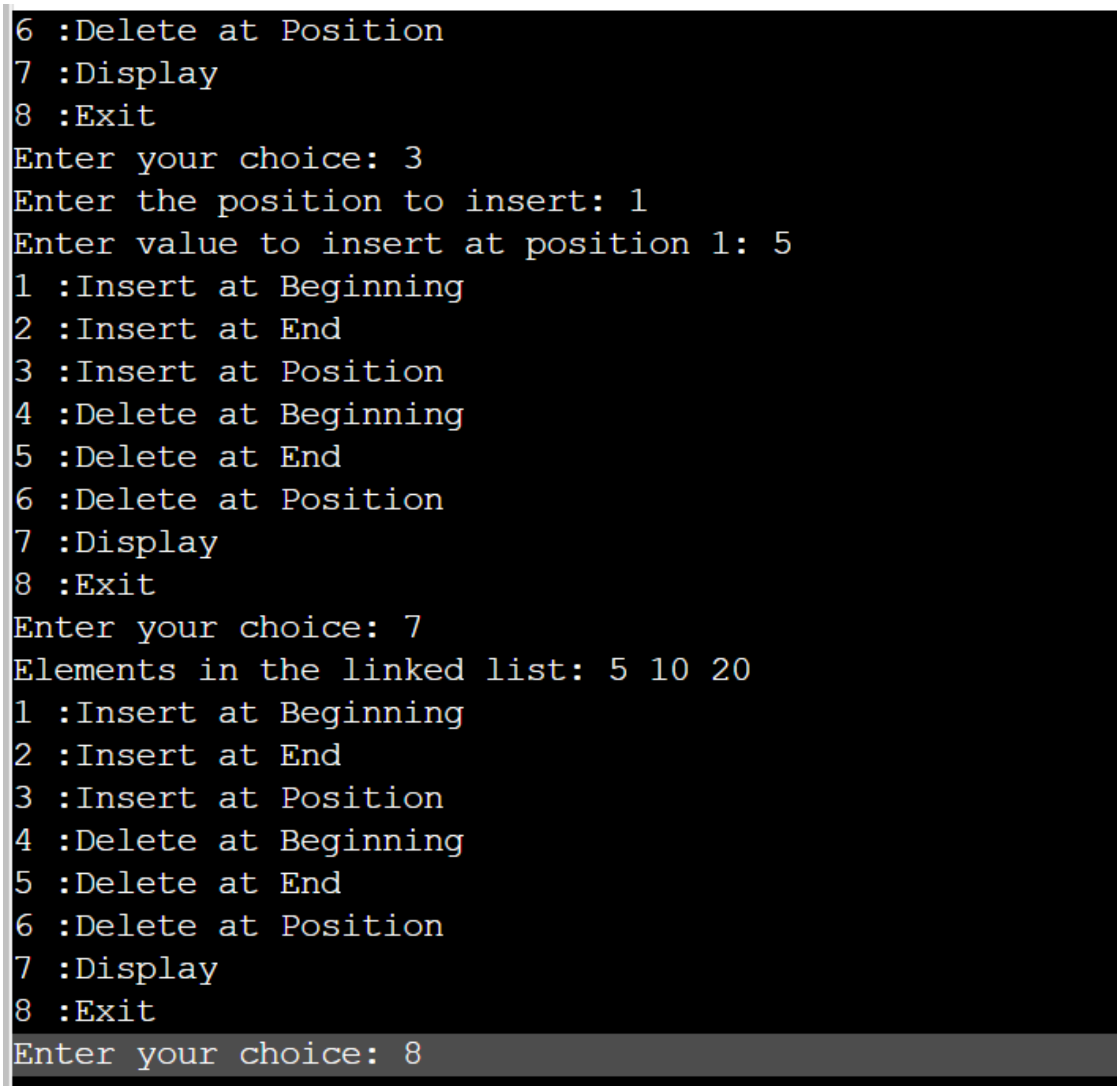
```
#include <stdio.h>

#include <stdlib.h>


struct Node {

    int data;

    struct Node *link;

};


typedef struct Node node;

node *start = NULL;


void insertAtBeginning() {

    node *new1 = (node*)malloc(sizeof(node));

    if (new1 == NULL) {

        printf("Memory allocation failed.\n");

        return;

    }


    printf("Enter value to insert at beginning: ");

    scanf("%d", &new1->data);


    new1->link = start;

    start = new1;
```

```
}

void insertAtEnd() {
    node *new1 = (node*)malloc(sizeof(node));
    if (new1 == NULL) {
        printf("Memory allocation failed.\n");
        return;
    }

    printf("Enter value to insert at end: ");
    scanf("%d", &new1->data);

    new1->link = NULL;

    if (start == NULL) {
        start = new1;
    } else {
        node *temp = start;
        while (temp->link != NULL) {
            temp = temp->link;
        }
        temp->link = new1;
    }
}

void insertAtPosition() {
    int pos;
    printf("Enter the position to insert: ");
    scanf("%d", &pos);

    if (pos < 1) {
        printf("Invalid position. Position should be >= 1.\n");
        return;
    }

    node *new1 = (node*)malloc(sizeof(node));
    if (new1 == NULL) {
        printf("Memory allocation failed.\n");
        return;
    }

    printf("Enter value to insert at position %d: ", pos);
    scanf("%d", &new1->data);

    if (pos == 1) {
        new1->link = start;
        start = new1;
    } else {
        node *temp = start;
        for (int i = 1; i < pos - 1; i++) {
            if (temp == NULL) {
                printf("Position out of range.\n");
                free(new1);
                return;
            }
            temp = temp->link;
        }

        new1->link = temp->link;
        temp->link = new1;
    }
}

void deleteAtBeginning() {
    if (start == NULL) {
        printf("The list is empty, nothing to delete.\n");
        return;
    }

    node *temp = start;
    start = start->link;
    free(temp);

    printf("Node deleted from the beginning.\n");
}

void deleteAtEnd() {
    if (start == NULL) {
        printf("The list is empty, nothing to delete.\n");
        return;
    }

    if (start->link == NULL) {
        free(start);
        start = NULL;
        printf("Node deleted from the end.\n");
        return;
    }

    node *temp = start;
    while (temp->link != NULL && temp->link->link != NULL) { // Traverse to the second last node
        temp = temp->link;
    }

    free(temp->link);
    temp->link = NULL;
    printf("Node deleted from the end.\n");
}

void deleteAtPosition() {
    int pos;
    printf("Enter the position to delete: ");
    scanf("%d", &pos);



    if (pos < 1 || start == NULL) {
        printf("Invalid position or list is empty.\n");
        return;
    }

    if (pos == 1) {
        node *temp = start;
        start = start->link;
        free(temp);
        printf("Node deleted from position 1.\n");
        return;
    }

    node *temp = start;
    for (int i = 1; i < pos - 1; i++) {
        if (temp == NULL || temp->link == NULL) {
            printf("Position out of range.\n");
            return;
        }
        temp = temp->link;
    }
    node *delNode = temp->link;
    temp->link = temp->link->link;
    free(delNode);

    printf("Node deleted from position %d.\n", pos);
}

void display() {
    node *temp;
    if (start == NULL) {
        printf("Linked list is empty.\n");
        return;
    }

    printf("Elements in the linked list: ");
    temp = start;
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->link;
    }
    printf("\n");
}

int main() {
    int ch;

    while (1) {
        printf("1 :Insert at Beginning  \n2 :Insert at End  \n3 :Insert at Position  \n4 :Delete at Beginning
\n5 :Delete at End  \n6 :Delete at Position  \n7 :Display  \n8 :Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &ch);
        switch (ch) {
            case 1:
                insertAtBeginning();
                break;
            case 2:
                insertAtEnd();
                break;
            case 3:
                insertAtPosition();
                break;
            case 4:
                deleteAtBeginning();
                break;
            case 5:
                deleteAtEnd();
                break;
            case 6:
                deleteAtPosition();
                break;
            case 7:
                display();
                break;
            case 8:
                exit(0);  // Exit the program
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }

    return 0;
}
```

OUTPUT:



```
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 1
Enter value to insert at beginning: 10
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 2
Enter value to insert at end: 20
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 3
```



```
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 3
Enter the position to insert: 1
Enter value to insert at position 1: 5
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 7
Elements in the linked list: 5 10 20
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 8
```

6.WAP to Implement Singly Linked List with following operations

(10 Marks)

a) Create a linked list.

b) Deletion of first element, specified element and last element in the list.

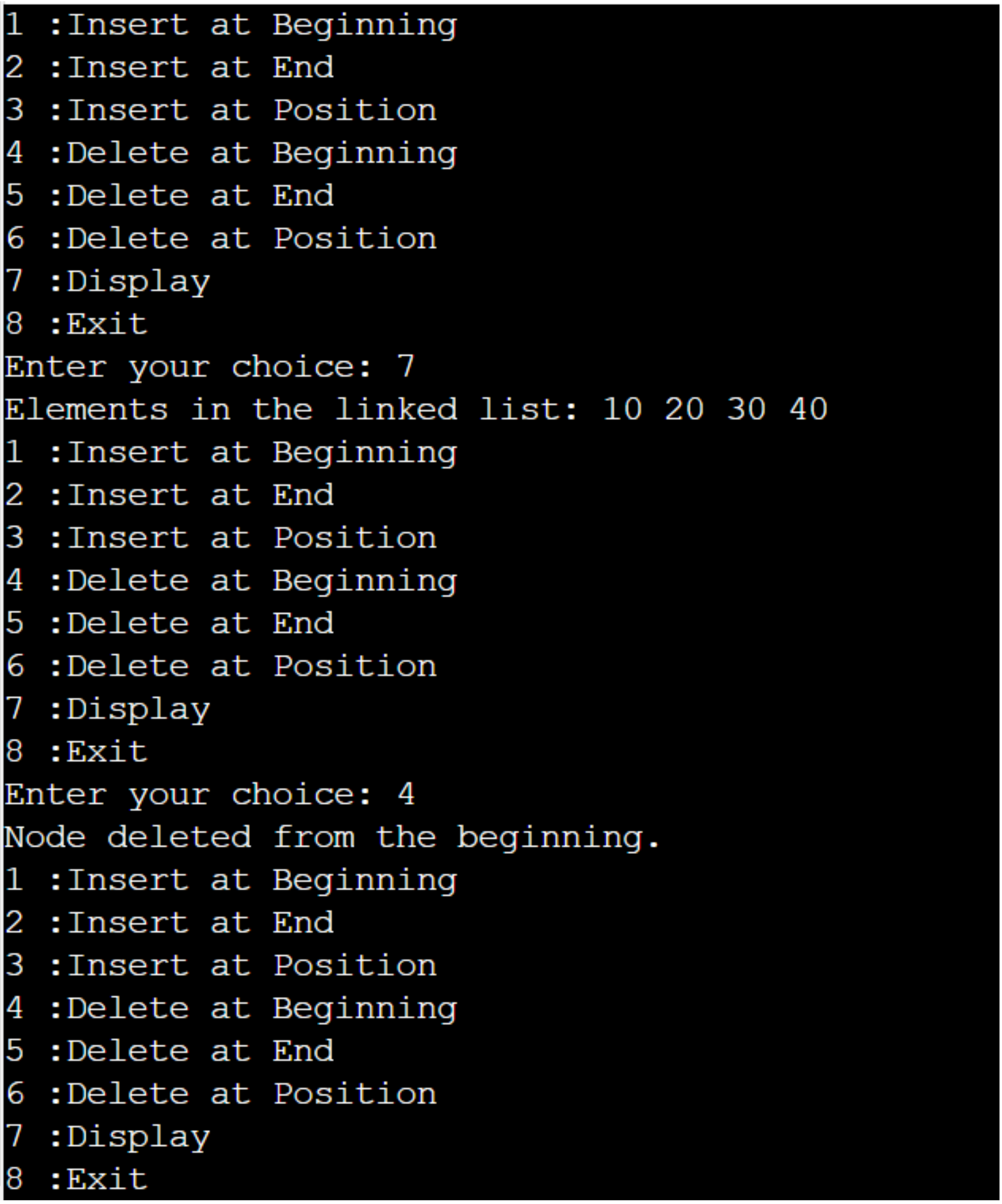
c) Display the contents of the linked list.

Code:

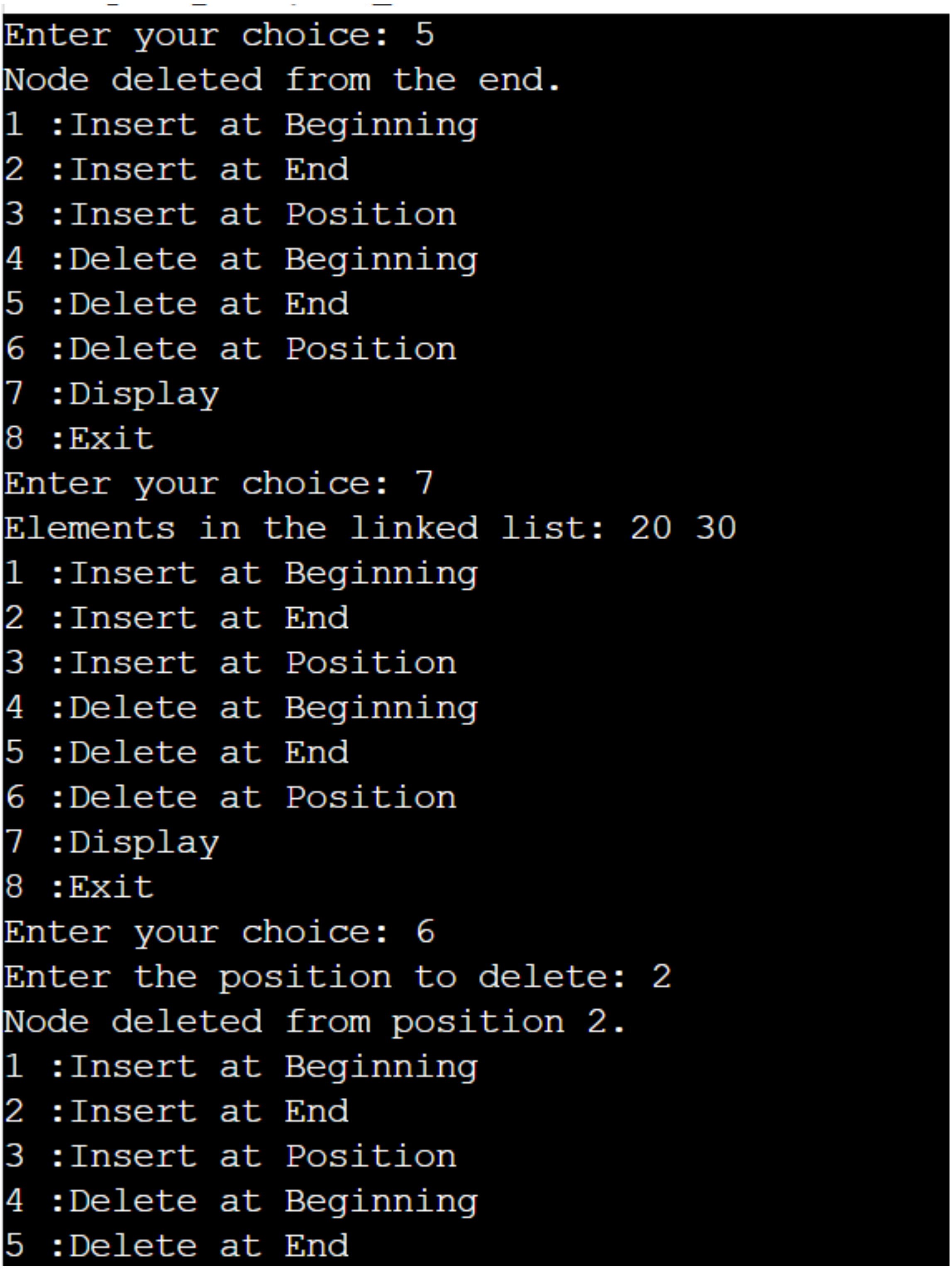
```
#include <stdio.h>

#include <stdlib.h>
```

```
struct Node {
    int data;
    struct Node *link;
};

typedef struct Node node;
node *start = NULL;

void insertAtBeginning() {
    node *new1 = (node*)malloc(sizeof(node));
    if (new1 == NULL) {
        printf("Memory allocation failed.\n");
        return;
    }

    printf("Enter value to insert at beginning: ");
    scanf("%d", &new1->data);

    new1->link = start;
    start = new1;
}

void insertAtEnd() {
    node *new1 = (node*)malloc(sizeof(node));
    if (new1 == NULL) {
        printf("Memory allocation failed.\n");
        return;
    }

    printf("Enter value to insert at end: ");
    scanf("%d", &new1->data);
    new1->link = NULL;

    if (start == NULL) {
        start = new1;
    } else {
        node *temp = start;
        while (temp->link != NULL) {
            temp = temp->link;
        }
        temp->link = new1;
    }
}

void insertAtPosition() {
    int pos;
    printf("Enter the position to insert: ");
    scanf("%d", &pos);

    if (pos < 1) {
        printf("Invalid position. Position should be >= 1.\n");
        return;
    }

    node *new1 = (node*)malloc(sizeof(node));
    if (new1 == NULL) {
        printf("Memory allocation failed.\n");
        return;
    }

    printf("Enter value to insert at position %d: ", pos);
    scanf("%d", &new1->data);
    if (pos == 1) {
        new1->link = start;
        start = new1;
    } else {
        node *temp = start;
        for (int i = 1; i < pos - 1; i++) {
            if (temp == NULL) {
                printf("Position out of range.\n");
                free(new1);
                return;
            }
            temp = temp->link;
        }

        new1->link = temp->link;
        temp->link = new1;
    }
}

void deleteAtBeginning() {
    if (start == NULL) {
        printf("The list is empty, nothing to delete.\n");
        return;
    }

    node *temp = start;
    start = start->link;
    free(temp);

    printf("Node deleted from the beginning.\n");
}
```

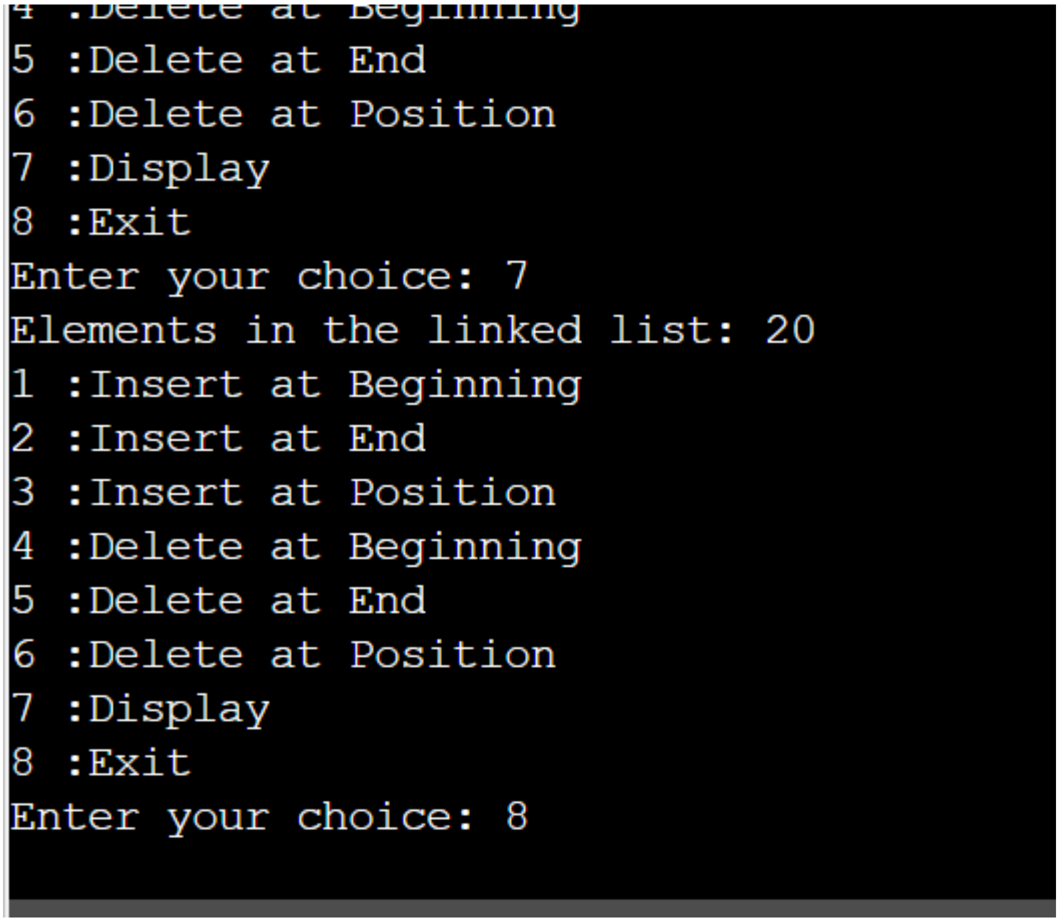
```
void deleteAtEnd() {
    if (start == NULL) {
        printf("The list is empty, nothing to delete.\n");
        return;
    }

    if (start->link == NULL) {
        free(start);
        start = NULL;
        printf("Node deleted from the end.\n");
        return;
    }

    node *temp = start;
    while (temp->link != NULL && temp->link->link != NULL) { // Traverse to the second last node
        temp = temp->link;
    }

    free(temp->link);
    temp->link = NULL;

    printf("Node deleted from the end.\n");
}

void deleteAtPosition() {
    int pos;
    printf("Enter the position to delete: ");
    scanf("%d", &pos);



    if (pos < 1 || start == NULL) {
        printf("Invalid position or list is empty.\n");
        return;
    }

    if (pos == 1) {
        node *temp = start;
        start = start->link;
        free(temp);
        printf("Node deleted from position 1.\n");
        return;
    }

    node *temp = start;
    for (int i = 1; i < pos - 1; i++) {
        if (temp == NULL || temp->link == NULL) {
            printf("Position out of range.\n");
            return;
        }
        temp = temp->link;
    }

    node *delNode = temp->link;
    temp->link = temp->link->link;
    free(delNode);

    printf("Node deleted from position %d.\n", pos);
}

void display() {
    node *temp;
    if (start == NULL) {
        printf("Linked list is empty.\n");
        return;
    }

    printf("Elements in the linked list: ");
    temp = start;
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->link;
    }
    printf("\n");
}

int main() {
    int ch;

    while (1) {
        printf("1 :Insert at Beginning  \n2 :Insert at End  \n3 :Insert at Position  \n4 :Delete at Beginning  \n5 :Delete at End  \n6 :Delete at Position  \n7 :Display  \n8 :Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &ch);

        switch (ch) {
            case 1:
                insertAtBeginning();
                break;
            case 2:
                insertAtEnd();
                break;
            case 3:
                insertAtPosition();
                break;
            case 4:
                deleteAtBeginning();
                break;
            case 5:
                deleteAtEnd();
                break;
            case 6:
                deleteAtPosition();
                break;
            case 7:
                display();
                break;
            case 8:
                exit(0);  // Exit the program
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }

    return 0;
}
```



```
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 7
Elements in the linked list: 10 20 30 40
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 4
Node deleted from the beginning.
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
```



```
Enter your choice: 5
Node deleted from the end.
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 7
Elements in the linked list: 20 30
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 6
Enter the position to delete: 2
Node deleted from position 2.
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
```



```
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 7
Elements in the linked list: 20
1 :Insert at Beginning
2 :Insert at End
3 :Insert at Position
4 :Delete at Beginning
5 :Delete at End
6 :Delete at Position
7 :Display
8 :Exit
Enter your choice: 8
```

7.)i) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists. (5 Marks)

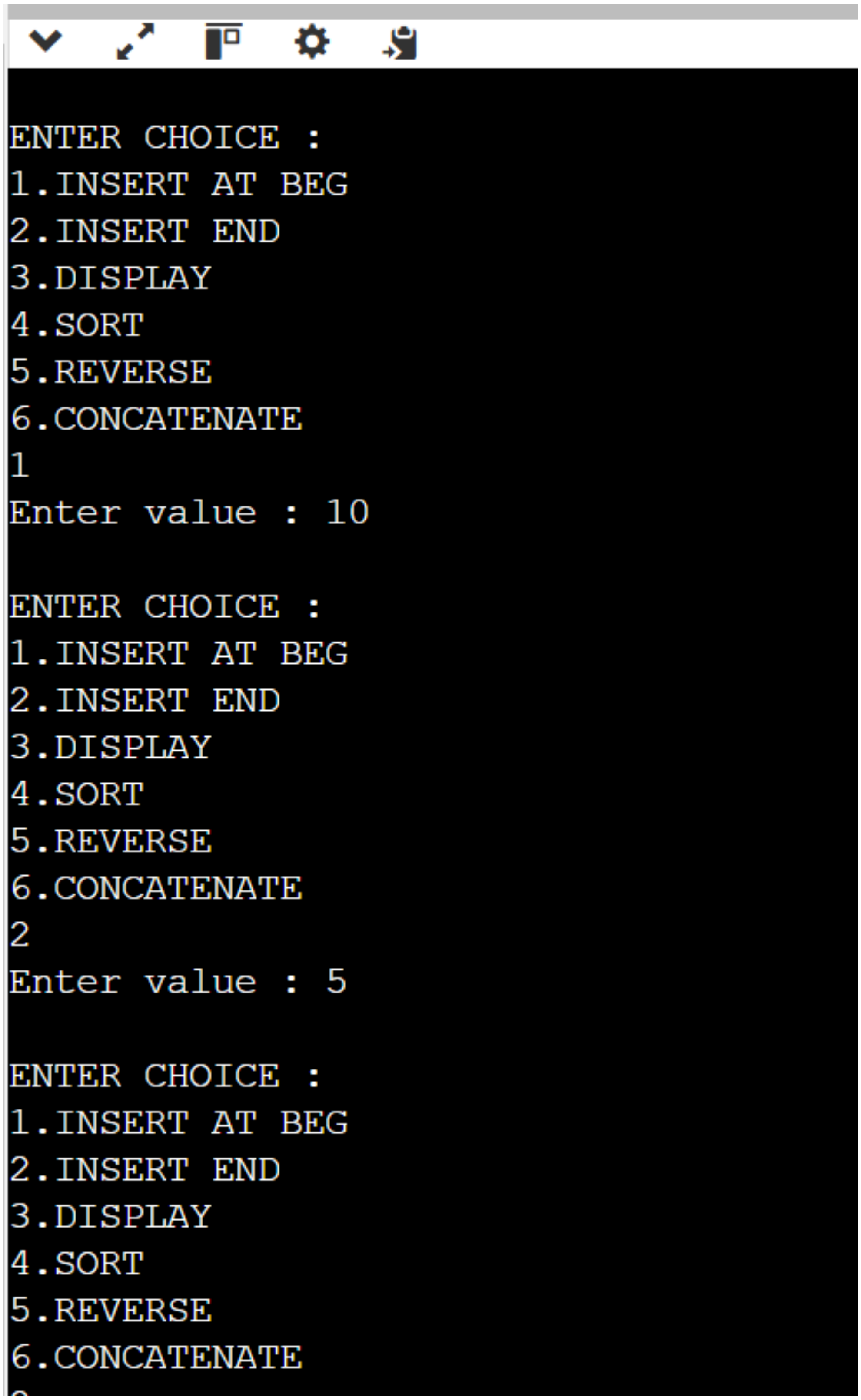
Code:

```
#include<stdio.h>

#include<stdlib.h>

typedef struct node

{

   int data;

   struct node *link;

}NODE,NODE1;

NODE *head=NULL;

NODE1 *head1=NULL;

NODE* createnode()

{

   NODE *ptr = (NODE*)malloc(sizeof(NODE));
```

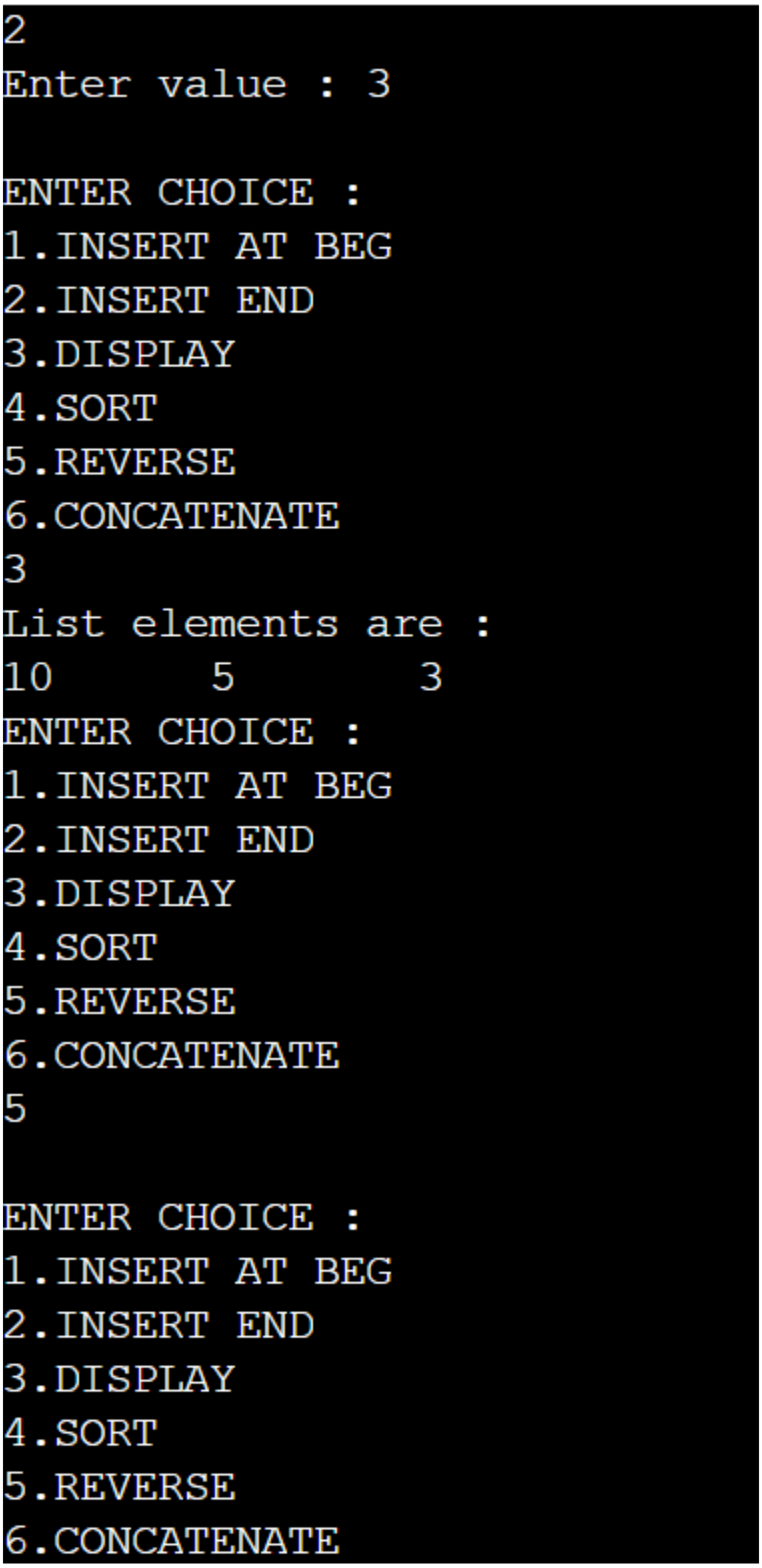
```
    int item;
    printf("Enter value : ");
    scanf("%d",&item);
    if(ptr==NULL)
    {
        printf("Memory not allocated");
    }
    else
    {
        ptr->data = item;
        ptr->link=NULL;
    }
    return ptr;

}

void insert_beg()
{
    NODE *ptr=createnode();
    if(head==NULL)
    {
        head=ptr;
    }
    else if(head!=NULL)
    {
        ptr->link=head;
        head=ptr;
    }
}
void insert_end()
{
    NODE *ptr=createnode();
    NODE *temp;
    temp = head;
    while(temp->link!=NULL)
    {
        temp=temp->link;
    }
    temp->link=ptr;
}
void display()
{
    NODE *temp;
    temp=head;
    if(head==NULL)
    {
        printf("List is empty");
        return;
    }
    else
    {
        printf("List elements are : \n");
    }
    while(temp!=NULL)
    {
        printf("%d\t",temp->data);
        temp = temp->link;
    }
}
void sort()
{
    NODE *start = head;
    while(start!=NULL)
    {
        NODE *temp=start->link;
        while(temp!=NULL)
        {
            if(start->data > temp->data)
            {
                int x=start->data;
                start->data=temp->data;
                temp->data=x;
            }
            temp=temp->link;
        }
        start=start->link;
    }

}
void reverse()
{
    NODE* prev=NULL;
    NODE* next = NULL;
    NODE* curr = head;
    while(curr!=NULL)
    {
        next=curr->link;
        curr->link=prev;
        prev = curr;
        curr=  next;
    }
    head = prev;
}
NODE1* createnode1()
{
    NODE1 *ptr = (NODE1*)malloc(sizeof(NODE1));
    int item;
    printf("Enter value FOR NODE 2 : ");
    scanf("%d",&item);
    if(ptr==NULL)
    {
        printf("Memory not allocated");
    }
    else
    {
        ptr->data = item;
        ptr->link=NULL;
    }
    return ptr;

}
void insert_beg1()
{
    NODE1 *ptr=createnode1();
    if(head1==NULL)
    {
        head1=ptr;
    }
    else if(head1!=NULL)
    {
        ptr->link=head1;
        head1=ptr;
    }
}
void insert_end1()
{
    NODE1 *ptr=createnode1();
    NODE1 *temp;
    temp = head1;
    while(temp->link!=NULL)
    {
        temp=temp->link;
    }
    temp->link=ptr;
}
void display1()
{
    NODE1 *temp;
    temp=head1;
    if(head1==NULL)
    {
        printf("List is empty");
        return;
    }
    else
    {
        printf("List elements are : \n");
    }
    while(temp!=NULL)
    {
        printf("%d\t",temp->data);
        temp = temp->link;
    }
}
void extra()
{
    int choice=0;
    while(choice<=5)
    {
        printf("\nENTER CHOICE : \n1.INSERT AT BEG\n2.INSERT END\n3.DISPLAY\n4.CONCATENATE\n");

        scanf("%d",&choice);

        switch(choice)

        {

            case 1:insert_beg1();

                    break;

            case 2:insert_end1();

                    break;

            case 3:display1();

                    break;

            case 4:concatenate();

                    break;

        }


    }

}

void concatenate()

{

   NODE *temp = head;

   NODE *temp1=head1;

    while(temp->link!=NULL)

    {

        temp=temp->link;

    }

    temp->link=head1;

    temp=head;

    while(temp!=NULL)

    {

        printf("%d\t",temp->data);

        temp=temp->link;

    }
```

```
}

void main()

{

    int choice=0;



    while(choice<=5)

    {

        printf("\nENTER CHOICE : \n1.INSERT AT BEG\n2.INSERT
END\n3.DISPLAY\n4.SORT\n5.REVERSE\n6.CONCATENATE\n");

        scanf("%d",&choice);

        switch(choice)

        {

            case 1:insert_beg();

                    break;

            case 2:insert_end();

                    break;

            case 3:display();

                    break;

            case 4:sort();

                    break;

            case 5:reverse();

                    break;

            case 6:printf("Enter node 2 \n");

                    extra();

                    break;

        }

    }

}
```

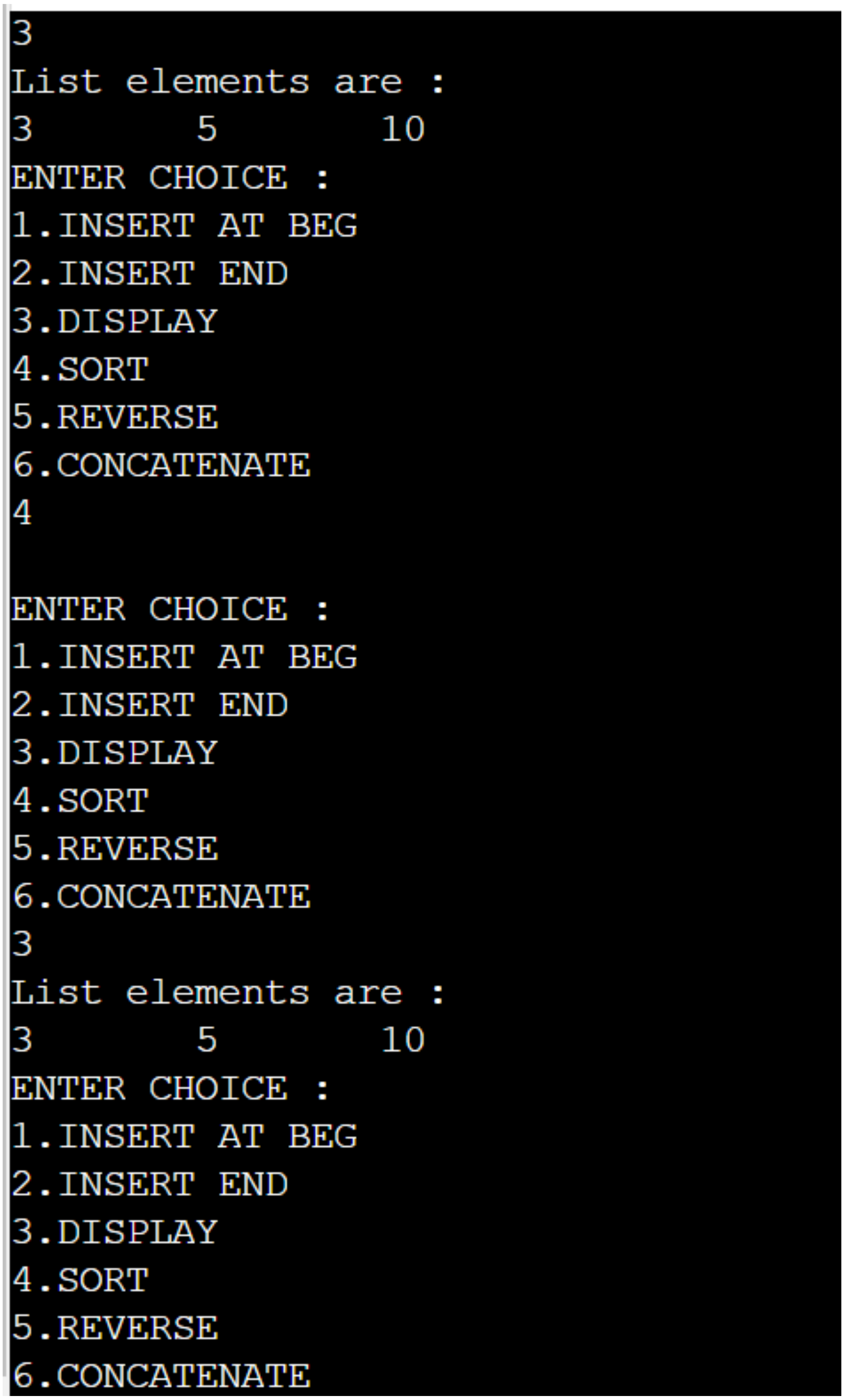
OUTPUT:



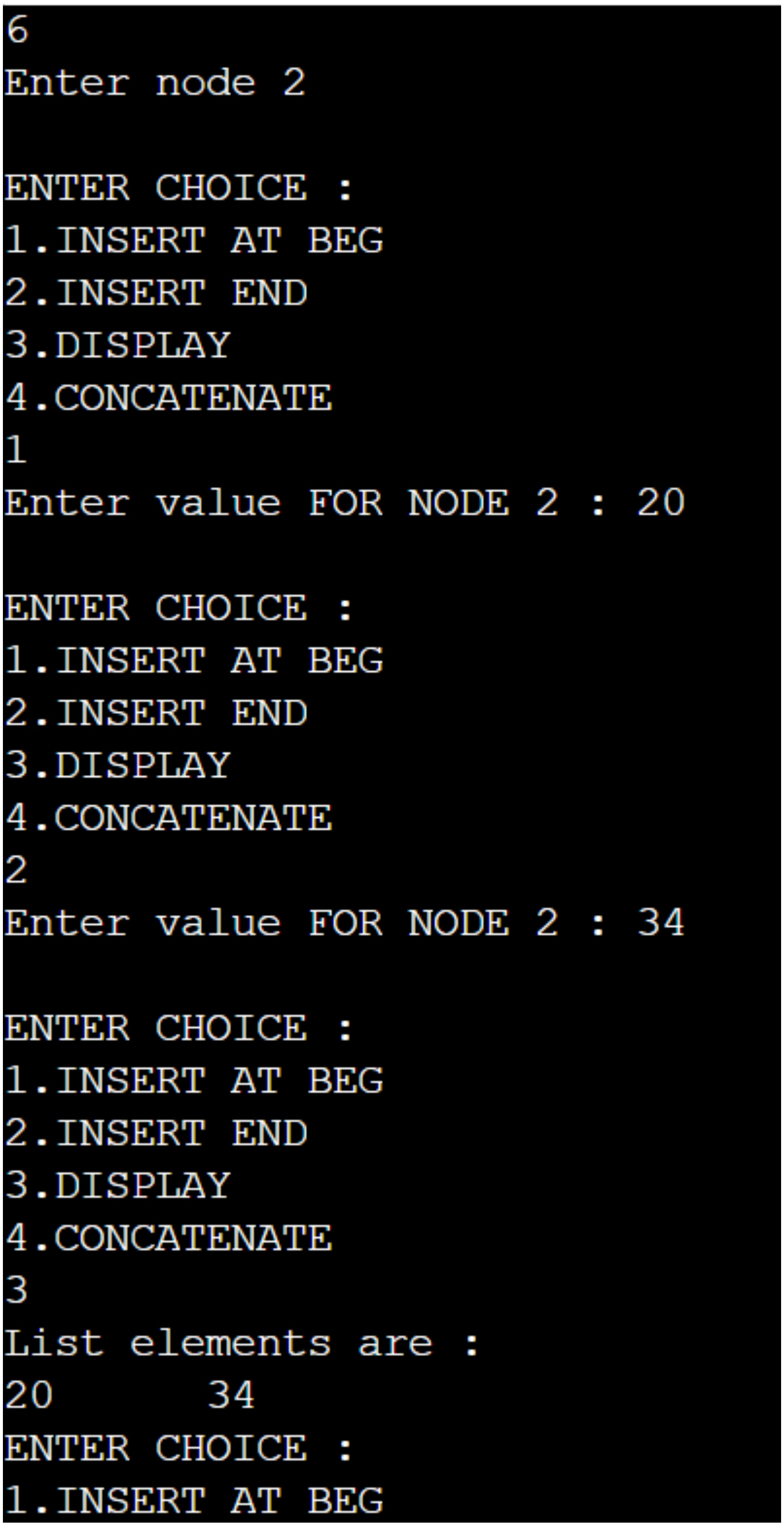
```

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
1
Enter value : 10

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
2
Enter value : 5

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
```



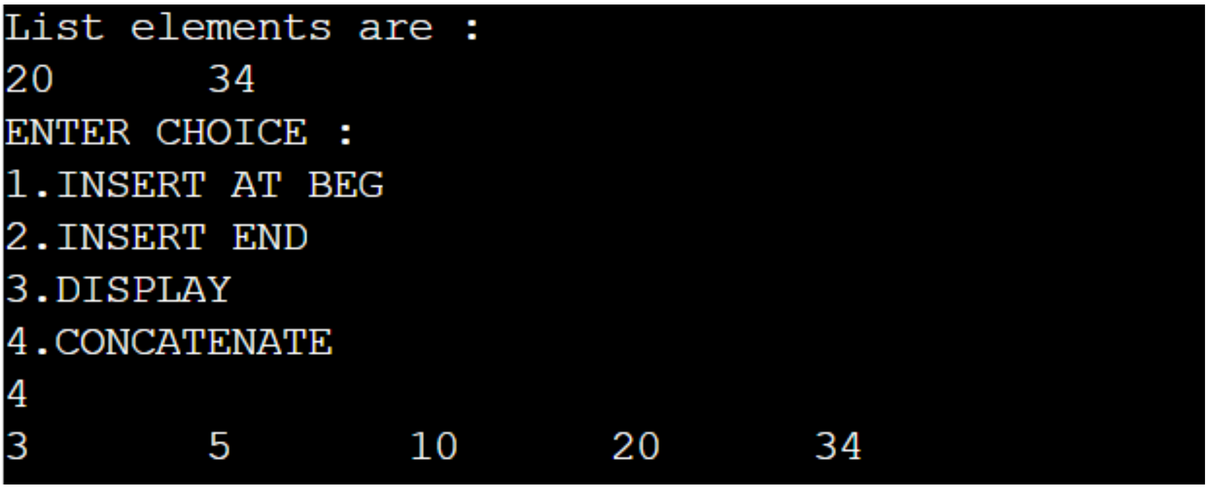
```
2
Enter value : 3

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
3
List elements are :
10      5       3
ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
5

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
```



```
3
List elements are :
3        5        10
ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
4

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
3
List elements are :
3        5        10
ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.SORT
5.REVERSE
6.CONCATENATE
```



```
6
Enter node 2

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.CONCATENATE
1
Enter value FOR NODE 2 : 20

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.CONCATENATE
2
Enter value FOR NODE 2 : 34

ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.CONCATENATE
3
List elements are :
20      34
ENTER CHOICE :
1.INSERT AT BEG
```



```
List elements are :
20        34
ENTER CHOICE :
1.INSERT AT BEG
2.INSERT END
3.DISPLAY
4.CONCATENATE
4
3         5         10        20        34
```

ii)WAP to Implement Single Link List to simulate Stack & Queue Operations.   (5 Marks)

Code:

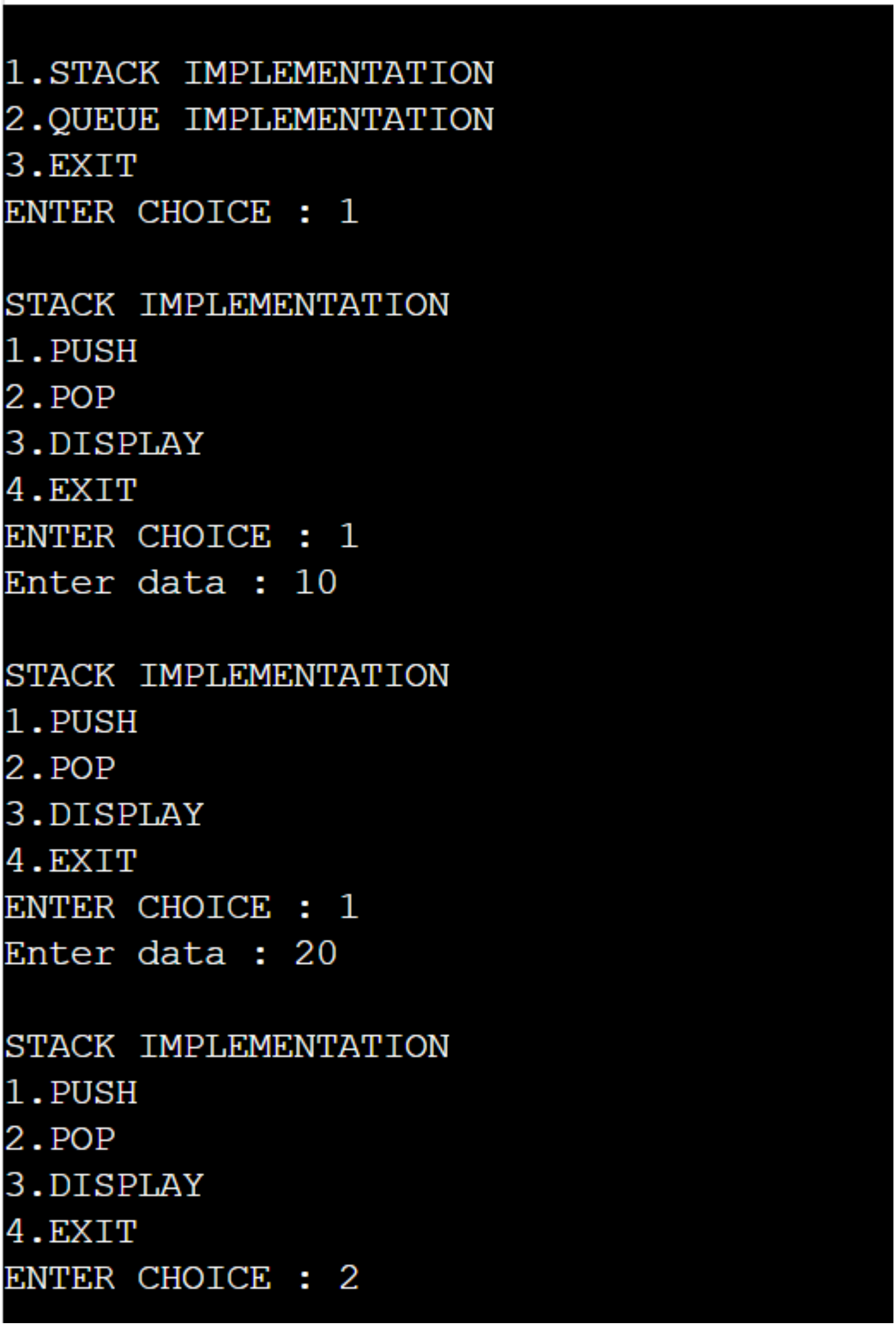
```
#include<stdio.h>

#include<stdlib.h>


int count1=0,count2=0,s=3;

typedef struct node

{

   int data;

   struct node *link;

}NODE;

NODE *head=NULL,*head1=NULL;


NODE* createnode()

{

   int a;

   NODE *ptr=  (NODE*)malloc(sizeof(NODE));

   printf("Enter data : ");

   scanf("%d",&a);

   if(ptr==NULL)

   {

      printf("Memory not allocated");

   }
```

```
    else
    {
        ptr->data=a;
        ptr->link=NULL;
    }
    return ptr;
}
void push()
{
     if(count1==s)
    {
        printf("\nStack Overflow");
        return;
    }
    NODE *ptr=createnode();
    if(head==NULL)
    {
        head=ptr;
        count1++;
        return;
    }
    NODE *temp=head;
    while(temp->link!=NULL)
    {
        temp=temp->link;
    }
    temp->link=ptr;
    count1++;
}
void pop()
{
    if(count1==0)
    {
        printf("\nStack Underflow");
        return;
    }
    NODE *temp=head;
    NODE *prev;
    if(head->link==NULL)
    {
        free(head);
        head=NULL;
        count1--;
        return;
    }
    while(temp->link!=NULL)
    {
        prev=temp;
        temp=temp->link;
    }
    free(temp);
    prev->link=NULL;
    count1--;
}
void display()
{
    NODE *temp;
    temp=head;
    if(head==NULL)
    {
        printf("List is empty\n");
        return;
    }
    else
    {
        printf("List elements are : ");
    }
    while(temp!=NULL)
    {
        printf("%d\t",temp->data);
        temp = temp->link;
    }
}
void stack()
{
    int choice=0;
    while(choice<=4)
    {
        printf("\nSTACK IMPLEMENTATION\n1.PUSH\n2.POP\n3.DISPLAY\n4.EXIT\nENTER CHOICE : ");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1: push();
                    break;
            case 2: pop();
                    break;
            case 3: display();
                    break;
            case 4: return;
        }
    }

}
void enqueue()
{
    if(count2==s)
    {
        printf("\nQueue Overflow");
        return;
    }
    NODE *ptr=createnode();
    if(head1==NULL)
    {
        head1=ptr;
        count2++;
        return;
    }
    NODE *temp=head1;
    while(temp->link!=NULL)
    {
        temp=temp->link;
    }
    temp->link=ptr;
    count2++;
}
void dequeue()
{
    if(head1==NULL)
    {
        printf("\nQueue Underflow");
        return;
    }
    NODE *prev=head1;
    head1=head1->link;
    free(prev);
    prev=head1;
    count2--;
```

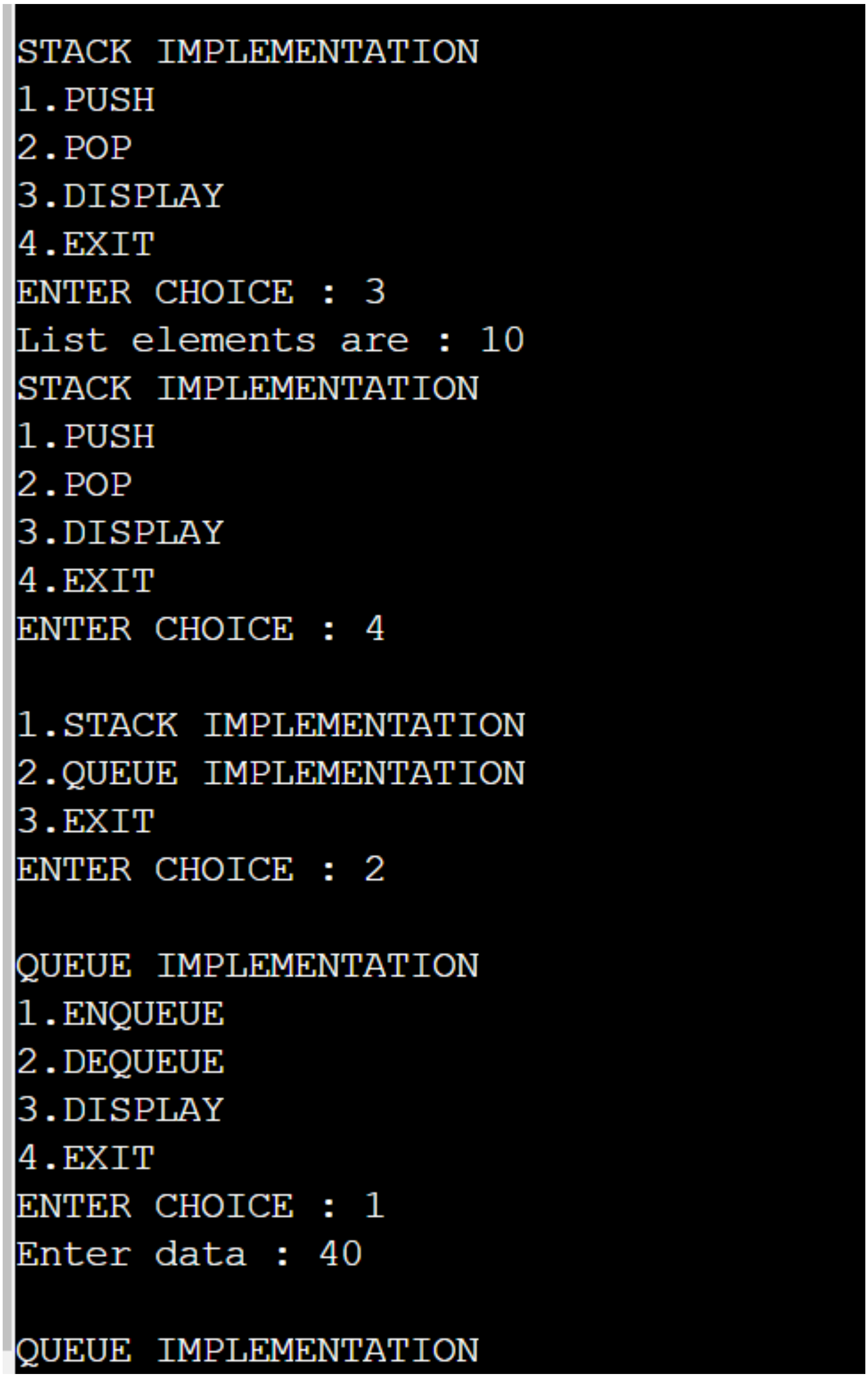
```
}
void display1()
{
   NODE *temp;
   temp=head1;
   if(head1==NULL)
   {
      printf("Queue is empty\n");
      return;
   }
   else
   {
      printf("Queue elements are : ");
   }
   while(temp!=NULL)
   {
      printf("%d\t",temp->data);
      temp = temp->link;
   }
}
void queue()
{
   int choice=0;
   while(choice<=4)
   {
      printf("\nQUEUE
IMPLEMENTATION\n1.ENQUEUE\n2.DEQUEUE\n3.DISPLAY\n4.EXIT\nENTER CHOICE : ");
      scanf("%d",&choice);
      switch(choice)
      {
         case 1: enqueue();
               break;
```

```
            case 2: dequeue();
                    break;
            case 3: display1();
                    break;
            case 4: return;
        }
    }

}
void main()
{
    int c=0;
    while(c<=3)
    {
        printf("\n1.STACK IMPLEMENTATION\n2.QUEUE IMPLEMENTATION\n3.EXIT\n");
        printf("ENTER CHOICE : ");
        scanf("%d",&c);
        switch(c)
        {
            case 1: stack();
                    break;
            case 2: queue();
                    break;
            case 3: printf("\nExiting from program");
                    exit(0);
        }
    }
}
```

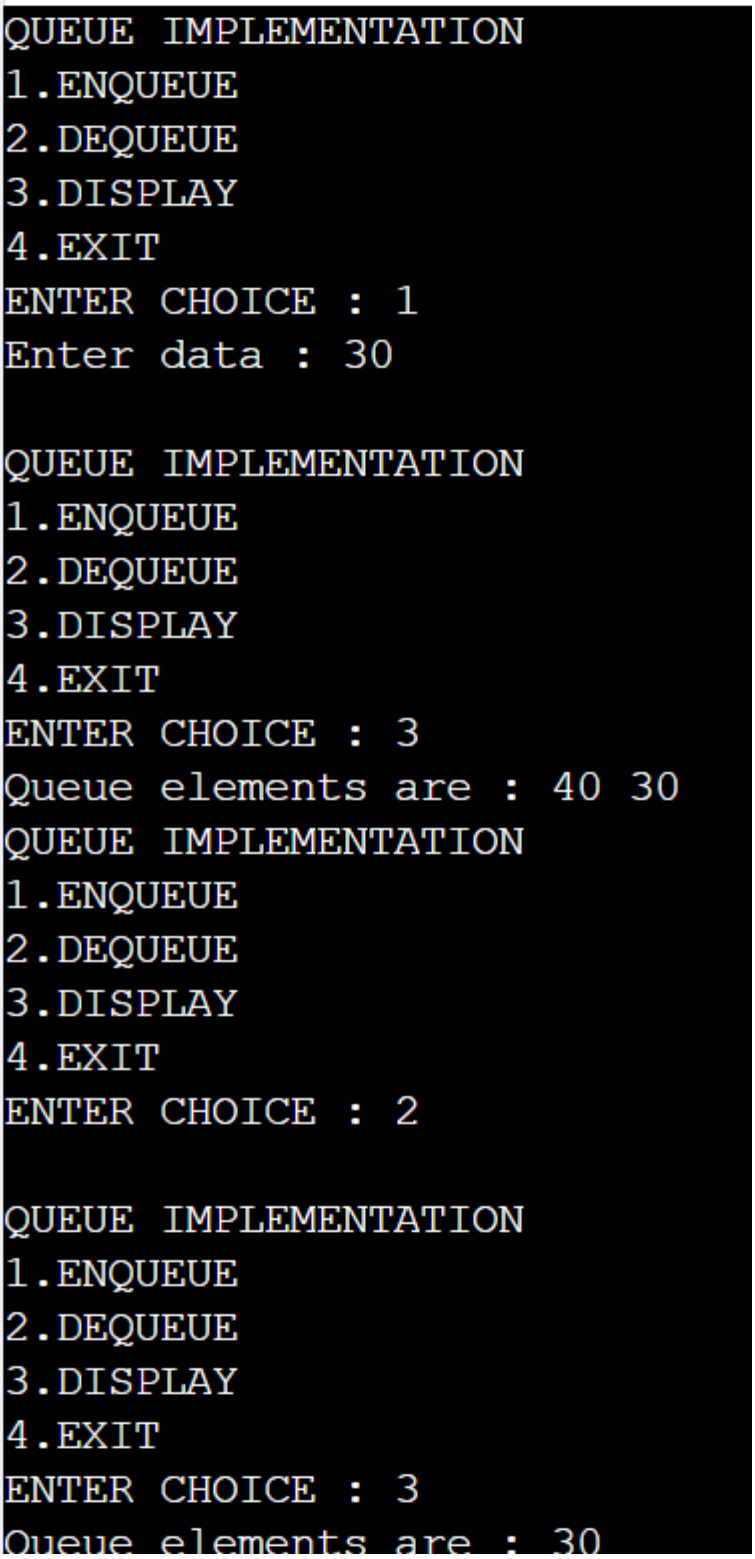
Output:



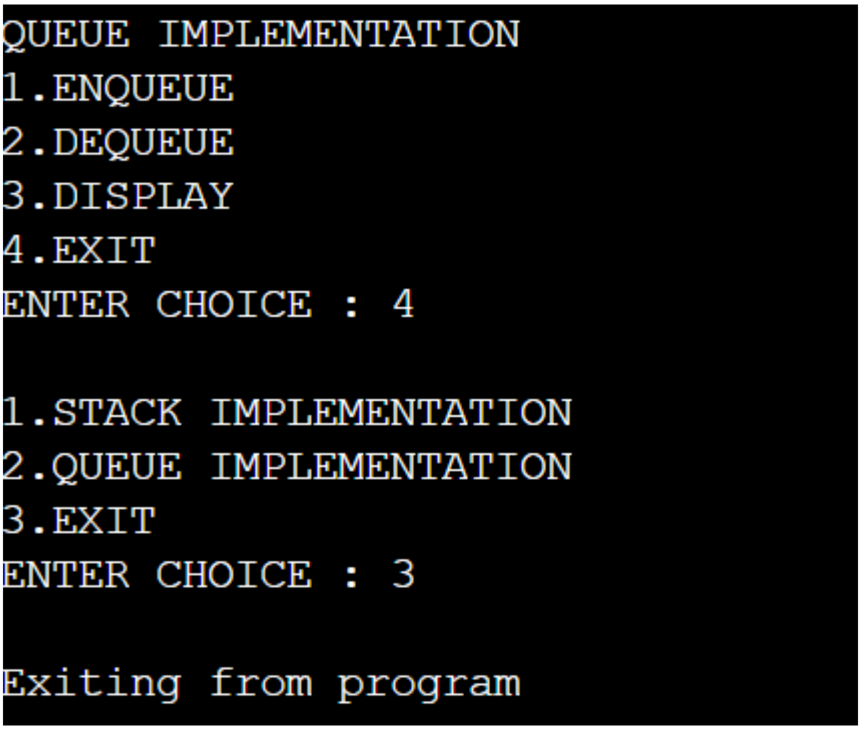
```
1.STACK IMPLEMENTATION
2.QUEUE IMPLEMENTATION
3.EXIT
ENTER CHOICE : 1

STACK IMPLEMENTATION
1.PUSH
2.POP
3.DISPLAY
4.EXIT
ENTER CHOICE : 1
Enter data : 10

STACK IMPLEMENTATION
1.PUSH
2.POP
3.DISPLAY
4.EXIT
ENTER CHOICE : 1
Enter data : 20

STACK IMPLEMENTATION
1.PUSH
2.POP
3.DISPLAY
4.EXIT
ENTER CHOICE : 2
```



```
STACK IMPLEMENTATION
1.PUSH
2.POP
3.DISPLAY
4.EXIT
ENTER CHOICE : 3
List elements are : 10
STACK IMPLEMENTATION
1.PUSH
2.POP
3.DISPLAY
4.EXIT
ENTER CHOICE : 4

1.STACK IMPLEMENTATION
2.QUEUE IMPLEMENTATION
3.EXIT
ENTER CHOICE : 2

QUEUE IMPLEMENTATION
1.ENQUEUE
2.DEQUEUE
3.DISPLAY
4.EXIT
ENTER CHOICE : 1
Enter data : 40

QUEUE IMPLEMENTATION
```



```
QUEUE IMPLEMENTATION
1.ENQUEUE
2.DEQUEUE
3.DISPLAY
4.EXIT
ENTER CHOICE : 1
Enter data : 30

QUEUE IMPLEMENTATION
1.ENQUEUE
2.DEQUEUE
3.DISPLAY
4.EXIT
ENTER CHOICE : 3
Queue elements are : 40 30
QUEUE IMPLEMENTATION
1.ENQUEUE
2.DEQUEUE
3.DISPLAY
4.EXIT
ENTER CHOICE : 2

QUEUE IMPLEMENTATION
1.ENQUEUE
2.DEQUEUE
3.DISPLAY
4.EXIT
ENTER CHOICE : 3
Queue elements are : 30
```



```
QUEUE IMPLEMENTATION
1.ENQUEUE
2.DEQUEUE
3.DISPLAY
4.EXIT
ENTER CHOICE : 4

1.STACK IMPLEMENTATION
2.QUEUE IMPLEMENTATION
3.EXIT
ENTER CHOICE : 3

Exiting from program
```

8.Doubly Linked List Implementation

Code:

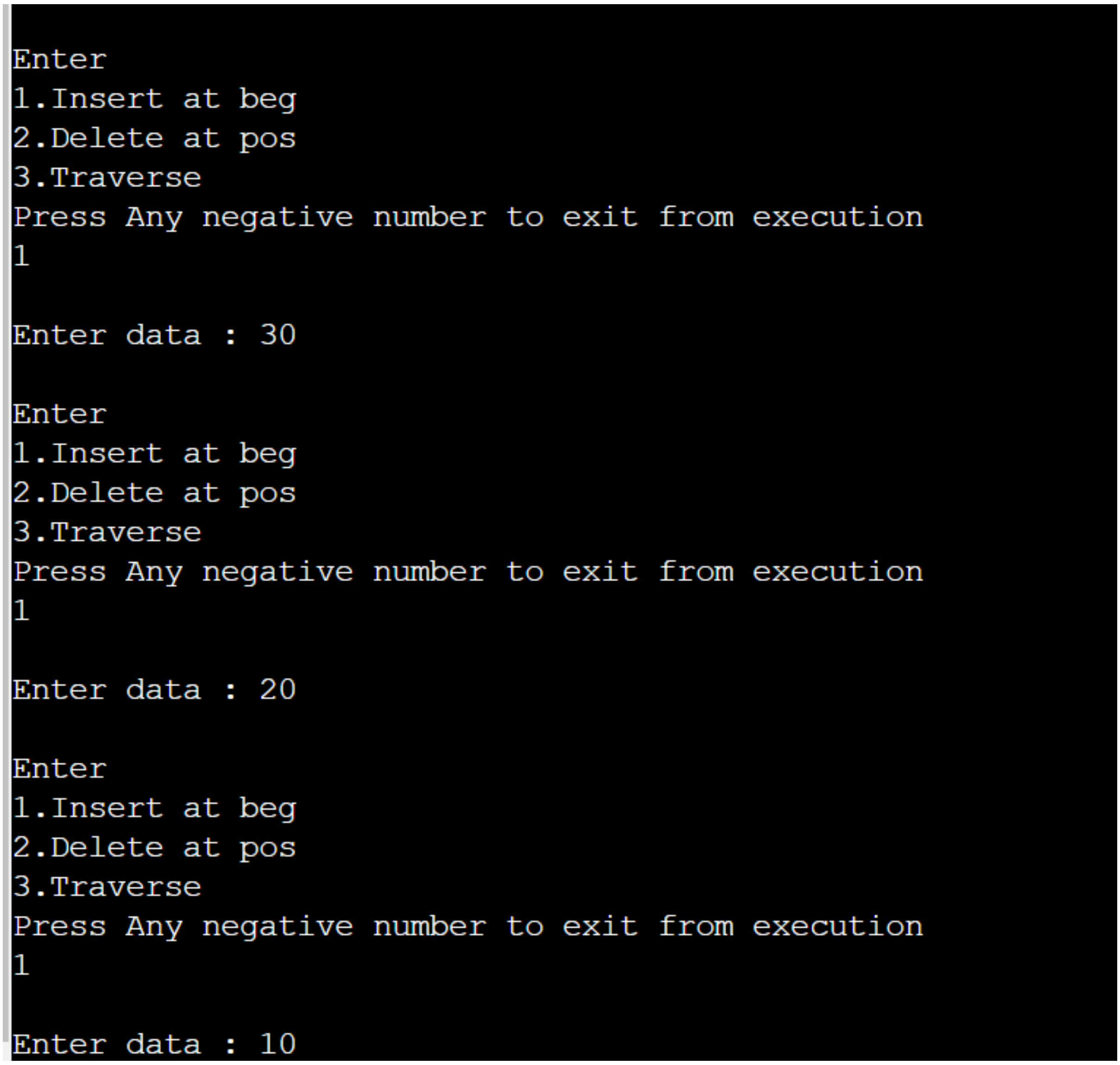
```
#include <stdio.h>
#include <stdlib.h>
typedef struct doublyList
{
   struct doublyList* llink;
   int data;
   struct doublyList* rlink;
}DNode;
DNode *first=NULL;
DNode* createNode()
{
   int item;
   DNode *ptr=(DNode*)malloc(sizeof(DNode));
   printf("\nEnter data : ");
   scanf("%d",&item);
   if( ptr!=NULL)
```

```
    {
        ptr->data=item;
        ptr->llink=NULL;
        ptr->rlink=NULL;
    }
    return ptr;
}

void insertBeg()
{
    DNode *temp=createNode();
    if(temp!=NULL && first==NULL)
        first=temp;
    else
        {
            temp->rlink=first;
            first->llink=temp;
            first=temp;
        }
}

void del_val()
{
    int item;
    printf("\nEnter the data to be deleted\n");
    scanf("%d",&item);
    DNode *temp=first;
    if(first==NULL)
    {
        printf("\nList is empty.Deletion not possible");
        return;
    }
```

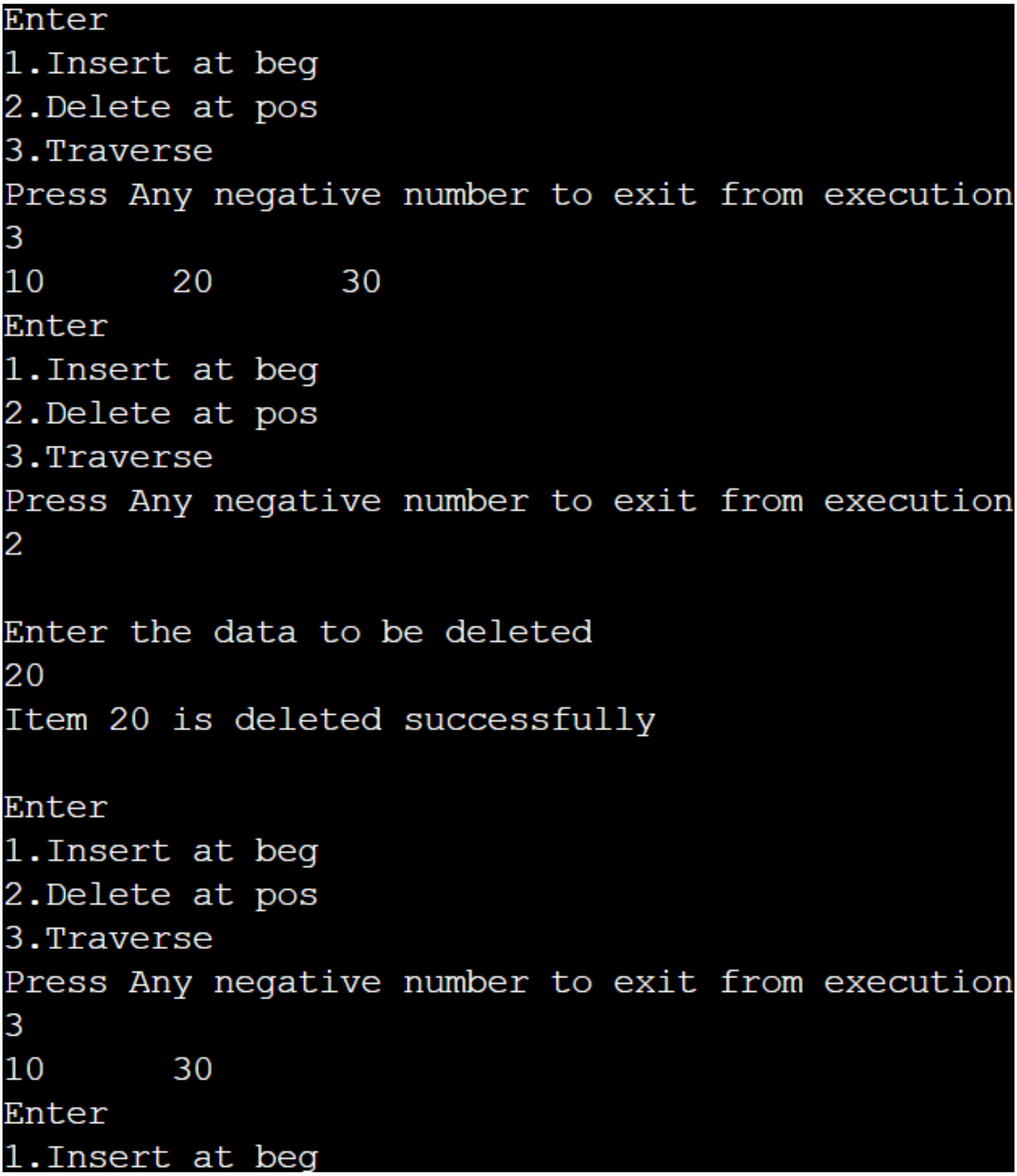
```
if(first->data==item && first->rlink==NULL)
{
    printf("Item %d is deleted successfully\n",first->data);
    first=NULL;
    free(first);
    return;
}
else if(first->data==item && first->rlink!=NULL)
{
     printf("Item %d is deleted successfully\n",first->data);
     first=first->rlink;
     free(first->llink);
     first->llink=NULL;
     return;
}
else
{
    while(temp!=NULL && temp->data!=item)
    {
          temp=temp->rlink;
    }
    if(temp==NULL)
    {
        printf("\nItem %d is not present in the list\n",item);
        return;
    }
    else if(temp->data==item && temp->rlink!=NULL)
    {
        printf("Item %d is deleted successfully\n",temp->data);
        temp->rlink->llink=temp->llink;
        temp->llink->rlink=temp->rlink;
        free(temp);
```

```
            return;
        }
        else if(temp->data==item && temp->rlink==NULL)
        {
             printf("Item %d is deleted successfully\n",temp->data);
             temp->llink->rlink=NULL;
             free(temp);
             return;

        }

    }
}

void traverse()
{
    DNode *temp=first;
    if(temp==NULL)
        printf("List is empty\n");
    else
    {
        while(temp!=NULL)
        {
            printf("%d\t",temp->data);
            temp=temp->rlink;
        }
    }
}
int main()
{

    int choice;
    while(1)

    {

        printf("\nEnter\n1.Insert at beg\n2.Delete at pos\n3.Traverse\nPress Any negative number to exit
from execution\n");

        scanf("%d",&choice);

        switch(choice)

        {

            case 1:insertBeg();

                   break;


            case 2: del_val();

                    break;

            case 3: traverse();

                    break;

            default:exit(0);

        }

    }

    return 0;

}
```

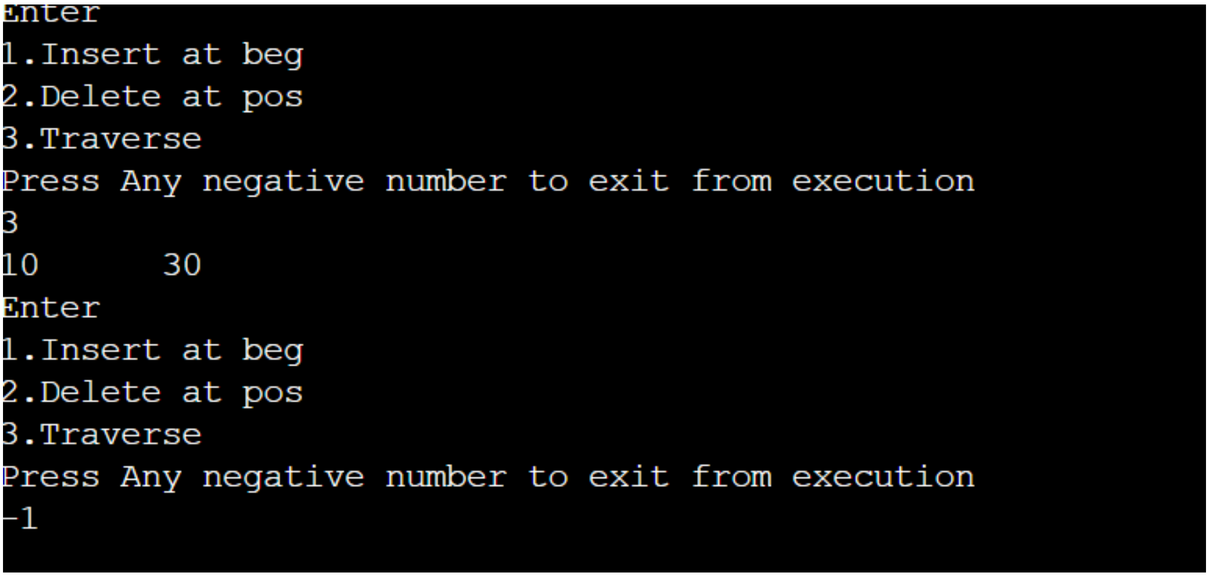
OUTPUT:



```
Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
1

Enter data : 30

Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
1

Enter data : 20

Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
1

Enter data : 10
```



```
Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
3
10      20      30
Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
2

Enter the data to be deleted
20
Item 20 is deleted successfully

Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
3
10      30
Enter
1.Insert at beg
```



```
Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
3
10      30
Enter
1.Insert at beg
2.Delete at pos
3.Traverse
Press Any negative number to exit from execution
-1
```

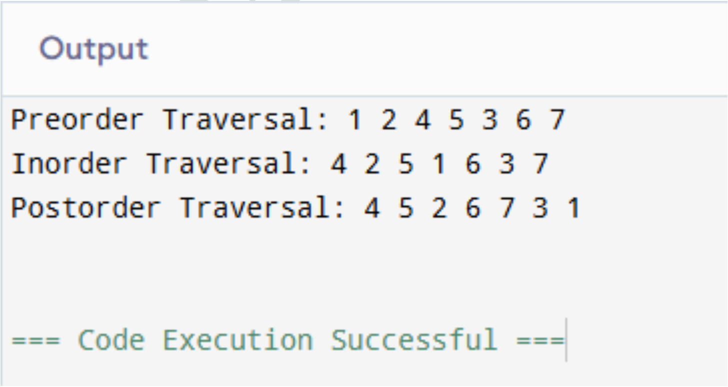
9.Binary Search

Code:

```
#include <stdio.h>

#include <stdlib.h>


// Definition of a node in the binary tree

struct Node {

   int value;

   struct Node* left;

   struct Node* right;

};


// Function to create a new node

struct Node* createNode(int value) {

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

   newNode->value = value;

   newNode->left = newNode->right = NULL;

   return newNode;

}
```

```
// Preorder Traversal: Root -> Left -> Right
void preorder(struct Node* root) {
    if (root != NULL) {
        printf("%d ", root->value);   // Visit the root
        preorder(root->left);         // Traverse the left subtree
        preorder(root->right);        // Traverse the right subtree
    }
}

// Inorder Traversal: Left -> Root -> Right
void inorder(struct Node* root) {
    if (root != NULL) {
        inorder(root->left);          // Traverse the left subtree
        printf("%d ", root->value);   // Visit the root
        inorder(root->right);         // Traverse the right subtree
    }
}

// Postorder Traversal: Left -> Right -> Root
void postorder(struct Node* root) {
    if (root != NULL) {
        postorder(root->left);        // Traverse the left subtree
        postorder(root->right);       // Traverse the right subtree
        printf("%d ", root->value);   // Visit the root
    }
}

// Main function
int main() {
    // Create the root node and other nodes
    struct Node* root = createNode(1);
    root->left = createNode(2);
    root->right = createNode(3);
    root->left->left = createNode(4);
    root->left->right = createNode(5);
    root->right->left = createNode(6);
    root->right->right = createNode(7);

    // Print traversals
    printf("Preorder Traversal: ");
    preorder(root);
    printf("\n");

    printf("Inorder Traversal: ");
    inorder(root);
    printf("\n");

    printf("Postorder Traversal: ");
    postorder(root);
    printf("\n");

    return 0;
}
```

OUTPUT:



```
Preorder Traversal: 1 2 4 5 3 6 7
Inorder Traversal: 4 2 5 1 6 3 7
Postorder Traversal: 4 5 2 6 7 3 1


=== Code Execution Successful ===
```

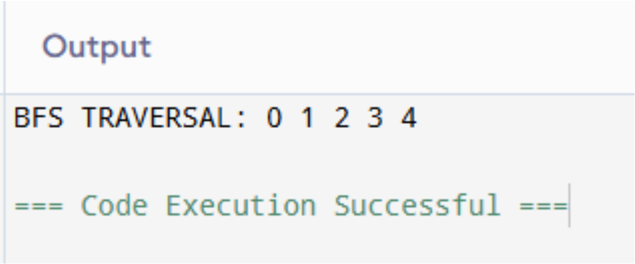
10.a)BFS

Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <stdbool.h>


#define MAX_NODES 100


typedef struct Queue{

    int items[MAX_NODES];

    int front ,rear;

}Queue;


void initQueue(Queue *q){

    q->front =-1;

    q->rear=-1;

}


bool isEmpty(Queue *q){

    return q->front==-1;

}


void enqueue(Queue *q,int value){

    if(q->rear==MAX_NODES-1){

        printf("Queue overflown\n");

        return ;

    }

    if(q->front==-1){


        q->front=0;

    }

    q->items[++q->rear]=value;

}
```

```
int dequeue(Queue *q){
    if(isEmpty(q)){
        printf("Queue Underflow\n");
        return -1;
    }
    int value=q->items[q->front];
    if(q->front == q->rear){
        q->front=q->rear=-1;
    }
    else{
        q->front++;
    }
    return value;
}

typedef struct Graph {
    int adjMatrix[MAX_NODES][MAX_NODES];
    int numNodes;
}Graph;

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

void addEdge(Graph *g,int src,int dest){
    g->adjMatrix[src][dest]=1;
    g->adjMatrix[dest][src]=1;
}

void bfs(Graph *g,int startNode){
    bool visited[MAX_NODES]={false};
    Queue q;
    initQueue(&q);
    visited[startNode]=true;
    enqueue(&q,startNode);
    printf("BFS TRAVERSAL: ");
    while(!isEmpty(&q)){
        int currentNode=dequeue(&q);
        printf("%d ",currentNode);
        for(int i=0;i<g->numNodes;i++){
            if(g->adjMatrix[currentNode][i]==1 && !visited[i]){
                visited[i]=true;
                enqueue(&q,i);
            }
        }
    }

}

int main(){
    Graph  g;
    initGraph(&g,5);
    addEdge(&g,0,1);
    addEdge(&g,0,2);
    addEdge(&g,1,3);
    addEdge(&g,1,4);
    addEdge(&g,2,4);
    bfs(&g,0);
}
```

OUTPUT:



```
BFS TRAVERSAL: 0 1 2 3 4

=== Code Execution Successful ===
```

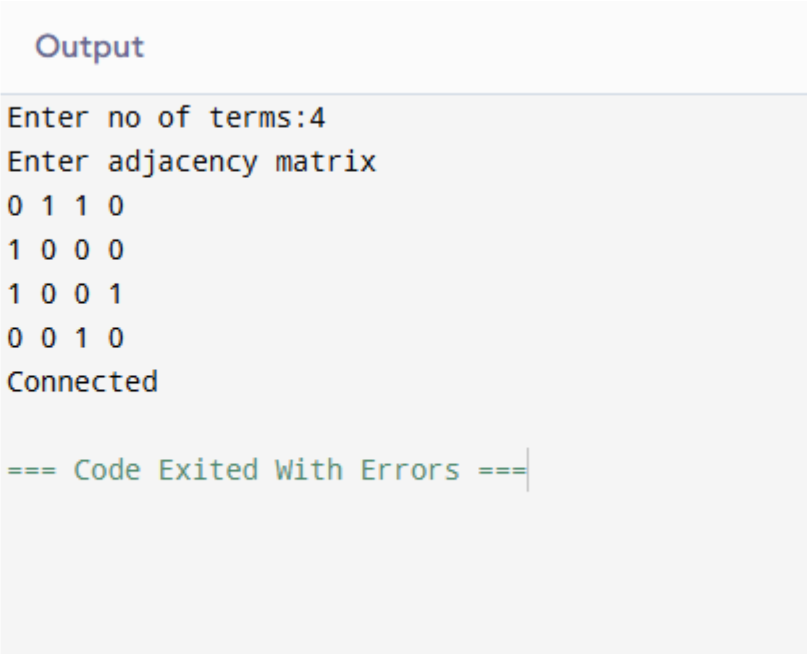
b)DFS

Code:

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

void main(){

   printf("Enter no of terms:");
   scanf("%d",&n);
   printf("Enter adjacency matrix\n");
   for(int i=1;i<=n;i++){
      for(int j=1;j<=n;j++){
         scanf("%d",&a[i][j]);
      }
   }
   for(int i=1;i<=n;i++){
      vis[i]=0;
   }
   dfs(1);
   for(int i=1;i<=n;i++){
      if(vis[i]==0){
         printf("Not connected");
         return;
      }
   }
```

```
    printf("Connected");
}
void dfs(int x){
    vis[x]=1;
    for(int i=1;i<=n;i++){
        if(a[i][x]==1 && vis[i]==0){
            dfs(i);
        }
    }
}
```

OUTPUT:



```
Enter no of terms:4
Enter adjacency matrix
0 1 1 0
1 0 0 0
1 0 0 1
0 0 1 0
Connected

=== Code Exited With Errors ===
```