VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by ROSHNI P**(1BM22CS223)**, 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 year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST) work** prescribed for the said degree.

Prof. Sneha S Bagalkot Dr. Jyothi S Nayak Assistant Professor Professor and Head Department of CSE Department of CSE BMSCE, Bengaluru BMSCE, Bengaluru

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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.

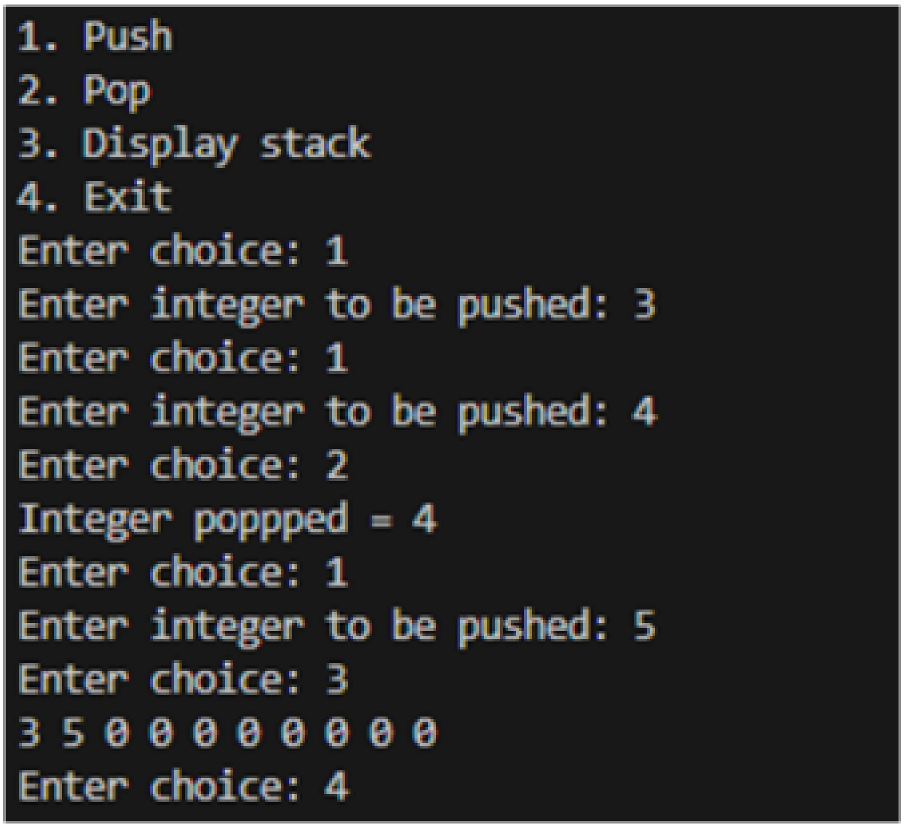
```
#include <stdio.h>
#include<stdlib.h> #include <string.h>

#definesize10 int pos = -1;
```

```
int stack[size];

voidpush(inta); int pop();
void display();

int main(){
printf("1.Push\n2.Pop\n3.Displaystack\n4.Exit\nEnter choice: ");
intchoice; int a;
scanf("%d",&choice); while(choice != 4){
switch(choice){ case 1:
printf("Enterintegertobepushed:"); scanf("%d", &a);
push(a); break;
case 2:
a = pop();
printf("Integerpoppped=%d\n",a); break;
case 3:
display(); break;
default:
printf("Invalid input"); break;

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

}

void push(int a){ if (pos == 9){
printf("Stack Overflow condition"); return;
}
stack[++pos] = a;
}

int pop(){
if (pos == -1){
printf("Stack Underflow condition"); return (int) NULL;
}
return stack[pos--];
}

void display(){
```

```
for(inti=0;i<size;i++){ printf("%d ", stack[i]);
}
```

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

Output:



```
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter integer to be pushed: 3
Enter choice: 1
Enter integer to be pushed: 4
Enter choice: 2
Integer poppped = 4
Enter choice: 1
Enter integer to be pushed: 5
Enter choice: 3
3 5 0 0 0 0 0 0 0 0
Enter choice: 4
```

LAB PROGRAM 2:

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)

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

#define size 20

void push(chara);
char pop();

void display();
```

```
char*postfix(char*exp);
```

```
char* prefix(char* exp);
bool character(char c);
boollower_precedence(charop1,charop2);
 bool isEmpty();
int pos = -1;
char stack[size]; int n;

int main(){


        printf("Entersizeofexpressionintermsofcharacters:"); scanf("%d", &n);

        fflush(stdin);

        char*expr=(char*)malloc(size*sizeof(char)); printf("Enter infix expression: ");

        scanf("%[^\n]s", expr);

        char* postfixexp = postfix(expr);
        printf("Postfixexpression:%s\n",postfixexp); char* prefixexp =
        prefix(expr);

        printf("Prefix expression: %s", prefixexp);



        return 0;

}


bool isEmpty(){

        return pos == -1;
}


void push(char a){

        if (pos == size-1){
                printf("StackOverflowcondition");
                return;

        }

        stack[++pos] = a;
}
```

```
char pop(){

        if (pos == -1){
                printf("StackUnderflowcondition");
                 return (char) NULL;

        }



        charreturn_value=stack[pos]; stack[pos] =
        (char) NULL;

        pos--;

        return return_value;
}


void display(){

        printf("Stack: ");

                for(inti=0;i<size;i++){ printf("%c ",
                        stack[i]);

        }

        printf("\n");
}


bool character(char c){

        return (c >= 'a'&& c <= 'z') || (c >= 'A'&& c <= 'Z') || (c
>= '0'&& c <= '9');
}


bool lower_precedence(char op1, char op2){
        if (op1 == op2 && op2 == '^') return false;
        charop_order[]={'^','/','*','+','-'}; int o1, o2;

        for(int i = 0; i <5; i++){

                if(op_order[i]==op1)o1=i; if
                (op_order[i] == op2) o2 = i;
        }


        return o1 <= o2;


  }


  char* postfix(char* exp){

        char*return_exp=(char*)malloc((size+3)*sizeof(char)); int current =

        0; for(int i = 0; i < n; i++){


              if (character(exp[i])){

                    return_exp[current++] = exp[i];
              }
              else if(exp[i] == '+' || exp[i] == '-' || exp[i] == '*'||
  exp[i] == '/' || exp[i] == '^'){
                    if (isEmpty()) push(exp[i]);


                    else if(lower_precedence(stack[pos], exp[i])){

                                while(lower_precedence(stack[pos], exp[i]) &&

  !isEmpty()){ pop();



  if(stack[pos]!='(')return_exp[current++]= else{




                                 pos--; break;

                              }

                         }
                          push(exp[i]);
```

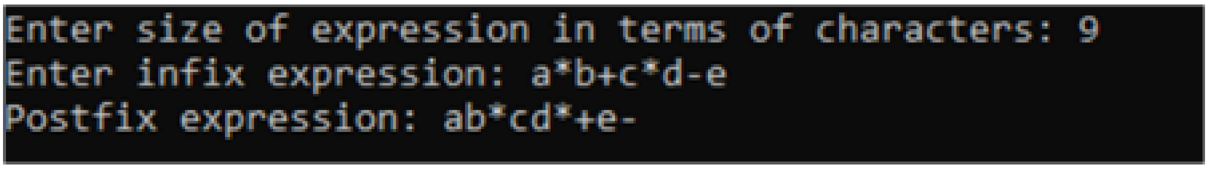
```
            }
```

```
            else push(exp[i]);
        }
        else if(exp[i] == '('){
            push('(');
        }
        else if(exp[i] == ')'){
                while(stack[pos]!='('&&!isEmpty()){ return_exp[current++] = pop();

            }

        }




    }


    while(!isEmpty()){
        if(stack[pos]!='(')return_exp[current++]=pop(); else pos--;

    }


    return return_exp;


}


char* prefix(char* exp){
    char*buffer=malloc(size*sizeof(char)); for(int i =
    n-1; i >= 0; i--){

        buffer[n-i-1] = exp[i];

        if (buffer[n-i-1] == '(') buffer[n-i-1] = ')';
        else if (buffer[n-i-1] == ')') buffer[n-i-1] = '(';
    }


    printf("Reversed String: %s\n", buffer);
    char*return_exp=malloc(size*sizeof(char)); int current =
    0;
```

```
    for(int i = 0; i < n; i++){


        if (character(buffer[i])){
            return_exp[current++] = buffer[i];
        }
        else if(buffer[i] == '+' || buffer[i] == '-' || buffer[i]
== '*' || buffer[i] == '/' || buffer[i] == '^'){
            if (isEmpty()) push(buffer[i]);


            else if(lower_precedence(stack[pos], buffer[i])){

                while(lower_precedence(stack[pos], buffer[i]) &&

!isEmpty()){ pop();


if(stack[pos]!='(')return_exp[current++]= else{


    pos--; break;


                    }

                }
                push(buffer[i]);
            }
            else push(buffer[i]);
        }
        else if(buffer[i] == '('){
            push('(');
        }
        else if(buffer[i] == ')'){
                while(stack[pos]!='('&&!isEmpty()){ return_exp[current++] = pop();

            }

        }
        }
```

```
        while(!isEmpty()){

                if(stack[pos]!='(')return_exp[current++]=pop(); else pos--;

        }



        char*final=(char*)malloc(size*sizeof(char)); for(int i = 0; i <
        strlen(return_exp); i++)

                final[i] = return_exp[strlen(return_exp)-i-1];


        return final;

  }
```

OUTPUT:



```
Enter size of expression in terms of characters: 9
Enter infix expression: a*b+c*d-e
Postfix expression: ab*cd*+e-
```

LAB 3 PROGRAMS:

3a) 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

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

#define size 5

void push(int a);
int pop();
void display();
```

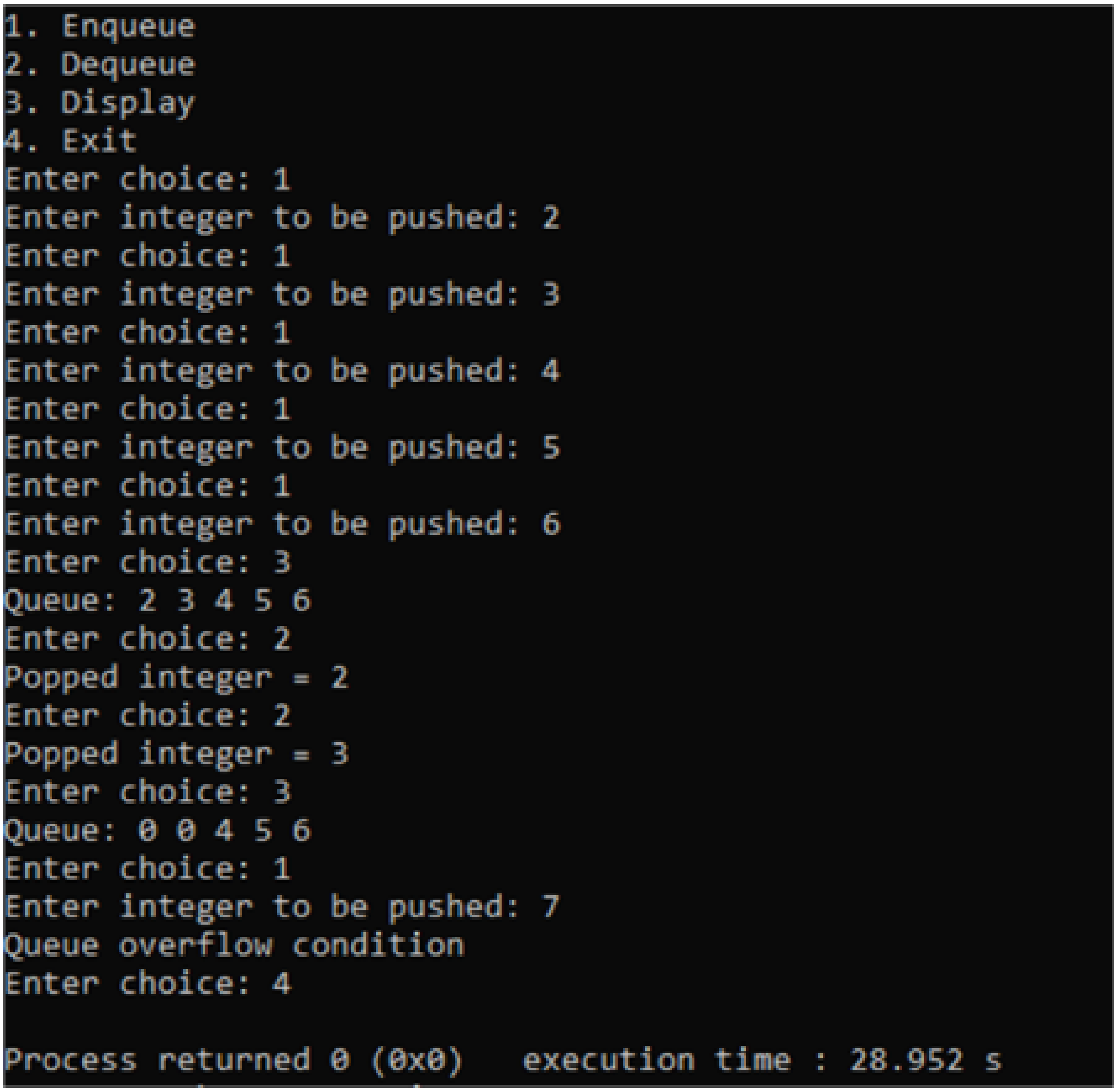
```
int fpos = -1, rpos = -1;
int queue[size];

int main(){
    int choice;
```

```
    printf("1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\nEnter choice: ");
    scanf("%d", &choice);
    int a;
    while(choice != 4){
        switch(choice){
            case 1:
                printf("Enter integer to be pushed: ");
                scanf("%d", &a);
                push(a);
                break;
            case 2:
                a = pop();
                printf("Popped integer = %d\n", a);
                break;
            case 3:
                display();
                break;
            default:
                printf("Idk");
                break;
        }
        printf("Enter choice: ");
        scanf("%d", &choice);
    }

}

void push(int a){
    if (fpos == -1 && rpos == -1){
        queue[++rpos] = a;
        fpos++;
        return;
    }
    else if (rpos == size-1){
        printf("Queue overflow condition\n");
        return;
    }
    else{
        queue[++rpos] = a;
        return;
    }
}
```

```
int pop(){
    if (fpos == -1){
        printf("Queue Underflow condition\n");
    }
    int n = queue[fpos];
    queue[fpos] = (int) NULL;
    fpos++;
```

```
    return n;
}

void display(){
    printf("Queue: ");
    for(int i = 0; i < size; i++)
        printf("%d ", queue[i]);
    printf("\n");
}
```

OUTPUT:



```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter choice: 1
Enter integer to be pushed: 2
Enter choice: 1
Enter integer to be pushed: 3
Enter choice: 1
Enter integer to be pushed: 4
Enter choice: 1
Enter integer to be pushed: 5
Enter choice: 1
Enter integer to be pushed: 6
Enter choice: 3
Queue: 2 3 4 5 6
Enter choice: 2
Popped integer = 2
Enter choice: 2
Popped integer = 3
Enter choice: 3
Queue: 0 0 4 5 6
Enter choice: 1
Enter integer to be pushed: 7
Queue overflow condition
Enter choice: 4

Process returned 0 (0x0)   execution time : 28.952 s
```

3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete &amp; Display The program should print appropriate messages for queue empty and queue overflow conditions

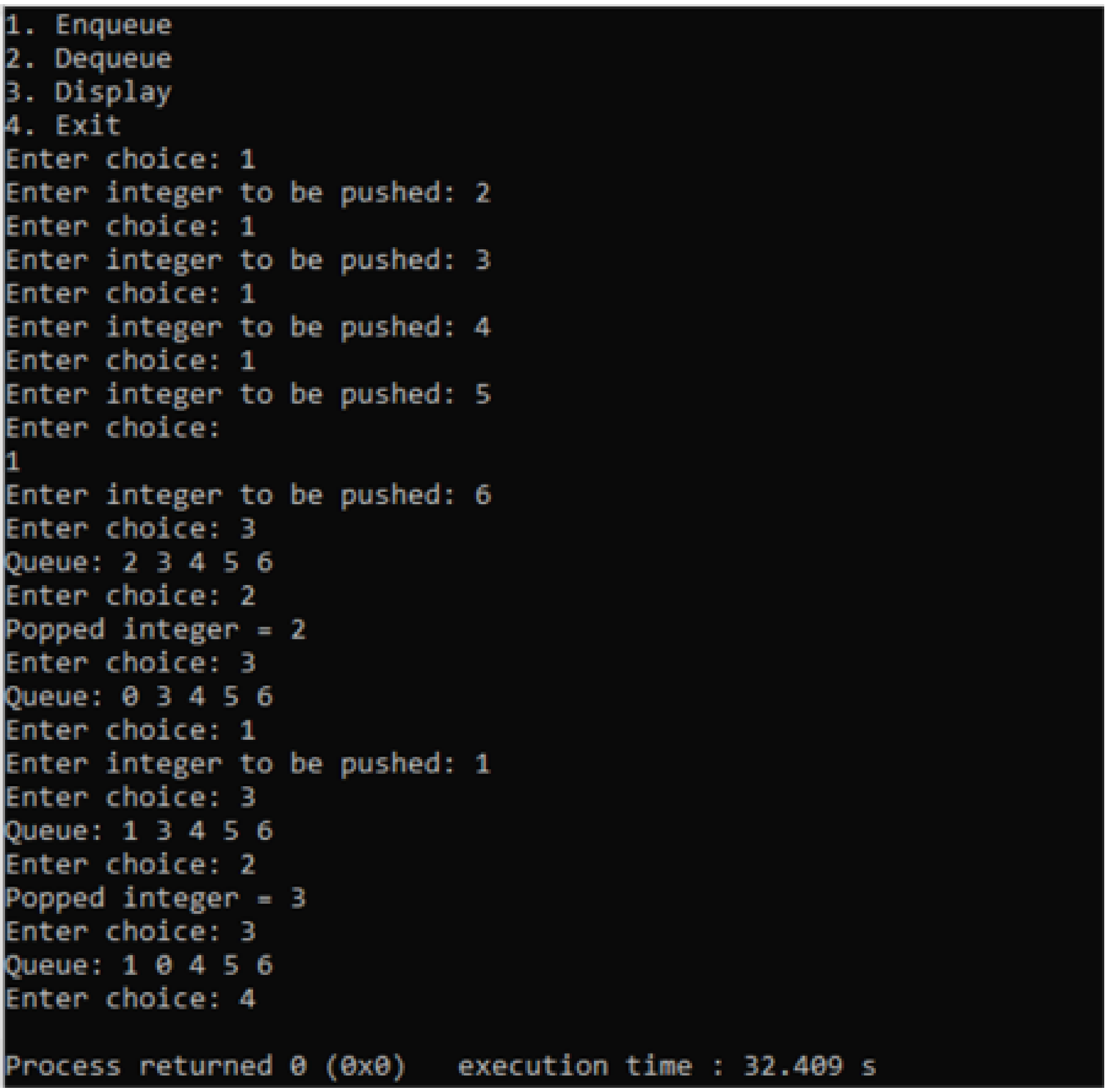
```
#include <stdio.h>
```

```
#include <stdlib.h>
#include <stdbool.h>
#include <string.h>

#define size 5

void push(int a);
int pop();
void display();

int fpos = -1, rpos = -1;
int queue[size];

int main(){
    int choice;
    printf("1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\nEnter choice: ");
    scanf("%d", &choice);
    int a;
    while(choice != 4){
        switch(choice){
            case 1:
                printf("Enter integer to be pushed: ");
                scanf("%d", &a);
                push(a);
                // printf("fpos = %d; rpos = %d\n", fpos%size, rpos%size);
                break;
            case 2:
                a = pop();
                printf("Popped integer = %d\n", a);
                // printf("fpos = %d; rpos = %d\n", fpos%size, rpos%size);
                break;
            case 3:
                display();
                break;
            default:
                printf("Idk");
                break;
        }
        printf("Enter choice: ");
        scanf("%d", &choice);
    }

}

void push(int a){
    if (fpos == -1 && rpos == -1){
        queue[++rpos] = a;
        fpos++;
        return;
    }
```

```
    else if ((rpos+1)%size == (fpos%size)){
        printf("Queue overflow condition\n");
        return;
    }
    else{
        rpos++;
        queue[(rpos%size)] = a;
        return;
    }
```

```
}

int pop(){
   if (fpos == -1){
      printf("Queue Underflow condition\n");
   }
   int n = queue[fpos%size];
   queue[fpos%size] = (int) NULL;
   fpos++;
   return n;
}

void display(){
   printf("Queue: ");
   for(int i = 0; i < size; i++)
      printf("%d ", queue[i]);
   printf("\n");
}
```

OUTPUT:



```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter choice: 1
Enter integer to be pushed: 2
Enter choice: 1
Enter integer to be pushed: 3
Enter choice: 1
Enter integer to be pushed: 4
Enter choice: 1
Enter integer to be pushed: 5
Enter choice:
1
Enter integer to be pushed: 6
Enter choice: 3
Queue: 2 3 4 5 6
Enter choice: 2
Popped integer = 2
Enter choice: 3
Queue: 0 3 4 5 6
Enter choice: 1
Enter integer to be pushed: 1
Enter choice: 3
Queue: 1 3 4 5 6
Enter choice: 2
Popped integer = 3
Enter choice: 3
Queue: 1 0 4 5 6
Enter choice: 4

Process returned 0 (0x0)   execution time : 32.409 s
```

LAB 4 PROGRAMS:
WAP to Implement Singly Linked List with following operations

a) Create a linked list.
b) Insertion of a node at first position, at any position and at end of list.
Display the contents of the linked list.

```
#include <stdio.h>

#include <stdlib.h>



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


Node* head = NULL;


void push();
void append();
void insert();
void display();


void main() {
        int choice;
   while (1) {
      printf("1. Insert at beginning\n");
      printf("2. Insert at end\n");
      printf("3. Insert at position\n");
      printf("4. Display\n");
      printf("5. Exit\n");
      printf("Enter choice: ");
      scanf("%d", &choice);
         switch (choice) {
        case 1:
           push();
           break;
        case 2:
           append();
```

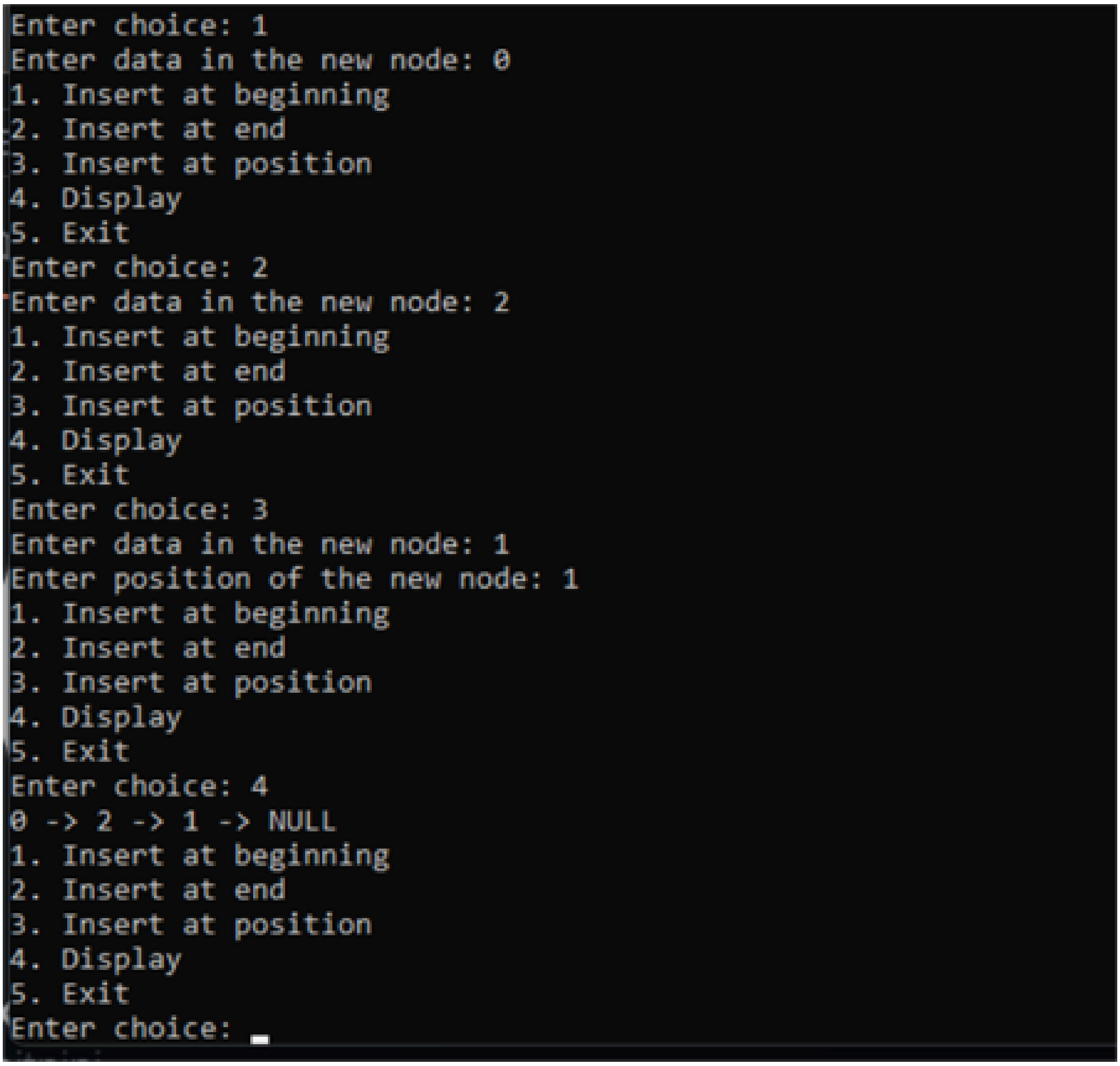
```
                break;

            case 3:

                insert();

                break;

            case 4:

                display();

                break;

            default:

                printf("Exiting the program");

        }

            }

}


void push() {

    Node* temp = (Node*)malloc(sizeof(Node));

            int new_data;

    printf("Enter data in the new node: ");

    scanf("%d", &new_data);

    temp->data = new_data;

    temp->next = head;

            head = temp;

}


void append() {

    Node* temp = (Node*)malloc(sizeof(Node));

            int new_data;
```

```
  printf("Enter data in the new node: ");
```

```
  scanf("%d", &new_data);
  temp->data = new_data;
  temp->next = NULL;
      if (head == NULL) {
    head = temp;
    return;
      }
  Node* temp1 = head;
  while (temp1->next != NULL) {
    temp1 = temp1->next;
      }
  temp1->next = temp;
}

void insert() {
  Node* temp = (Node*)malloc(sizeof(Node));
      int new_data, pos;
  printf("Enter data in the new node: ");
  scanf("%d", &new_data);
  printf("Enter position of the new node: ");
  scanf("%d", &pos);
  temp->data = new_data;
  temp->next = NULL;
      if (pos == 0) {
    temp->next = head;

    head = temp;

    return;
```

```
            }

    Node* temp1 = head;

    while (pos--) {

        temp1 = temp1->next;

            }

    Node* temp2 = temp1->next;

    temp->next = temp2;

    temp1->next = temp;

}


void display() {

    Node* temp1 = head;

    while (temp1 != NULL) {

        printf("%d -> ", temp1->data);

        temp1 = temp1->next;

            }

    printf("NULL\n");

}
```

OUTPUT:



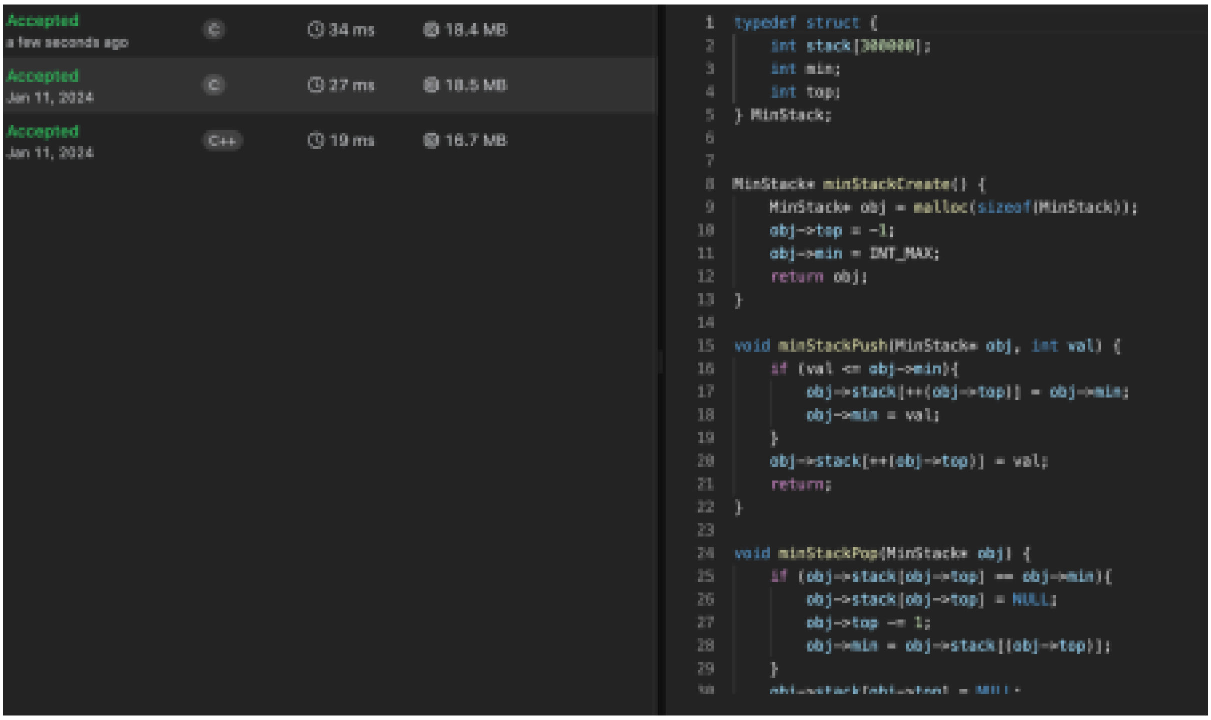
```
Enter choice: 1
Enter data in the new node: 0
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 2
Enter data in the new node: 2
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 3
Enter data in the new node: 1
Enter position of the new node: 1
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 4
0 -> 2 -> 1 -> NULL
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice:
```

Program - Leetcode platform

```
typedef struct {
    int stack[300000];
    int min;
    int top;
} MinStack;


MinStack* minStackCreate() {
    MinStack* obj = malloc(sizeof(MinStack));
    obj->top = -1;
    obj->min = INT_MAX;
    return obj;
}

void minStackPush(MinStack* obj, int val) {
    if (val <= obj->min){
        obj->stack[++(obj->top)] = obj->min;
```

```
        obj->min = val;
    }
    obj->stack[++(obj->top)] = val;
    return;
}

void minStackPop(MinStack* obj) {
    if (obj->stack[obj->top] == obj->min){
        obj->stack[obj->top] = NULL;
        obj->top -= 1;
        obj->min = obj->stack[(obj->top)];
    }
    obj->stack[obj->top] = NULL;
    obj->top -= 1;
}

int minStackTop(MinStack* obj) {
    return obj->stack[obj->top];
}

int minStackGetMin(MinStack* obj) {
    return obj->min;
}

void minStackFree(MinStack* obj) {
    free(obj);
}
```

OUTPUT:



Accepted a few seconds ago	C	34 ms	18.4 MB
Accepted Jan 11, 2024	C	27 ms	18.5 MB
Accepted Jan 11, 2024	C++	19 ms	18.7 MB

```
typedef struct {
    int stack[300000];
    int min;
    int top;
} MinStack;


MinStack* minStackCreate() {
    MinStack* obj = malloc(sizeof(MinStack));
    obj->top = -1;
    obj->min = INT_MAX;
    return obj;
}

void minStackPush(MinStack* obj, int val) {
    if (val <= obj->min){
        obj->stack[++(obj->top)] = obj->min;
        obj->min = val;
    }
    obj->stack[++(obj->top)] = val;
    return;
}

void minStackPop(MinStack* obj) {
    if (obj->stack[obj->top] == obj->min){
        obj->stack[obj->top] = NULL;
        obj->top -= 1;
        obj->min = obj->stack[(obj->top)];
    }
    obj->stack[obj->top] = NULL;
```

LAB 5 PROGRAMS:

WAP to Implement Singly Linked List with following operations

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.

```
#include <stdio.h>

#include <stdlib.h>



struct node

 {

    int data;

    struct node *next;

 };



void create_ll(struct node **start);

void display(struct node *start);
void pop(struct node **start);

void end_delete(struct node **start);

void delete_at_pos(struct node **start);

void free_list(struct node *start);


int main(void)

{

   struct node *start = NULL;

   int option;


   do
```

```
          {

printf("\n\n *****MAIN MENU *****");

printf("\n 1: Create a list");

printf("\n 2: Display the list");

printf("\n 3: Delete a node from the beginning");

printf("\n 4: Delete a node from the end");

printf("\n 5: Delete a from a specific position");

printf("\n 6: EXIT");

printf("\n Enter your option : ");

scanf("%d", &option);


      switch (option)

      {

      case 1:

create_ll(&start);
```

```
printf("\n LINKED LIST CREATED");

            break;

        case 2:

            display(start);

            break;

        case 3:

            pop(&start);

            break;

        case 4:

end_delete(&start);

            break;

        case 5:
```

```
delete_at_pos(&start);

            break;

        case 6:

free_list(start);

printf("\nExiting....\n");

            break;

        }

            } while (option != 6);


    return 0;

}


void create_ll(struct node **start)

 {
   struct node *new_node, *ptr;

   int num;

printf("Enter -1 to end\n");

printf("Enter the data : \n");

scanf("%d", &num);


   while (num != -1)

         {

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


      if (new_node == NULL)

       {

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

```
exit(EXIT_FAILURE);

       }


new_node->data = num;

new_node->next = NULL;


      if (*start == NULL)

       {

         *start = new_node;

       }

      else

       {

ptr = *start;
```

```
            while (ptr->next != NULL)
ptr = ptr->next;

ptr->next = new_node;
        }

printf("\nEnter the data : ");
scanf("%d", &num);
            }
}

void display(struct node *start)
 {
    struct node *ptr = start;
```

```
    while (ptr != NULL)
            {
printf("\t %d", ptr->data);
ptr = ptr->next;
            }
}

void pop(struct node **start)
 {
    if (*start == NULL)
            {
printf("List is empty\n");
```

```
      return;
         }

   struct node *ptr = *start;
   *start = (*start)->next;
   free(ptr);
}

void end_delete(struct node **start)
 {
   if (*start == NULL)
         {
printf("List is empty\n");
      return;
```

```
         }

   struct node *ptr = *start;
   struct node *ptr1 = NULL;

   while (ptr->next != NULL)
         {
      ptr1 = ptr;
ptr = ptr->next;
         }

   if (ptr1 != NULL)
```

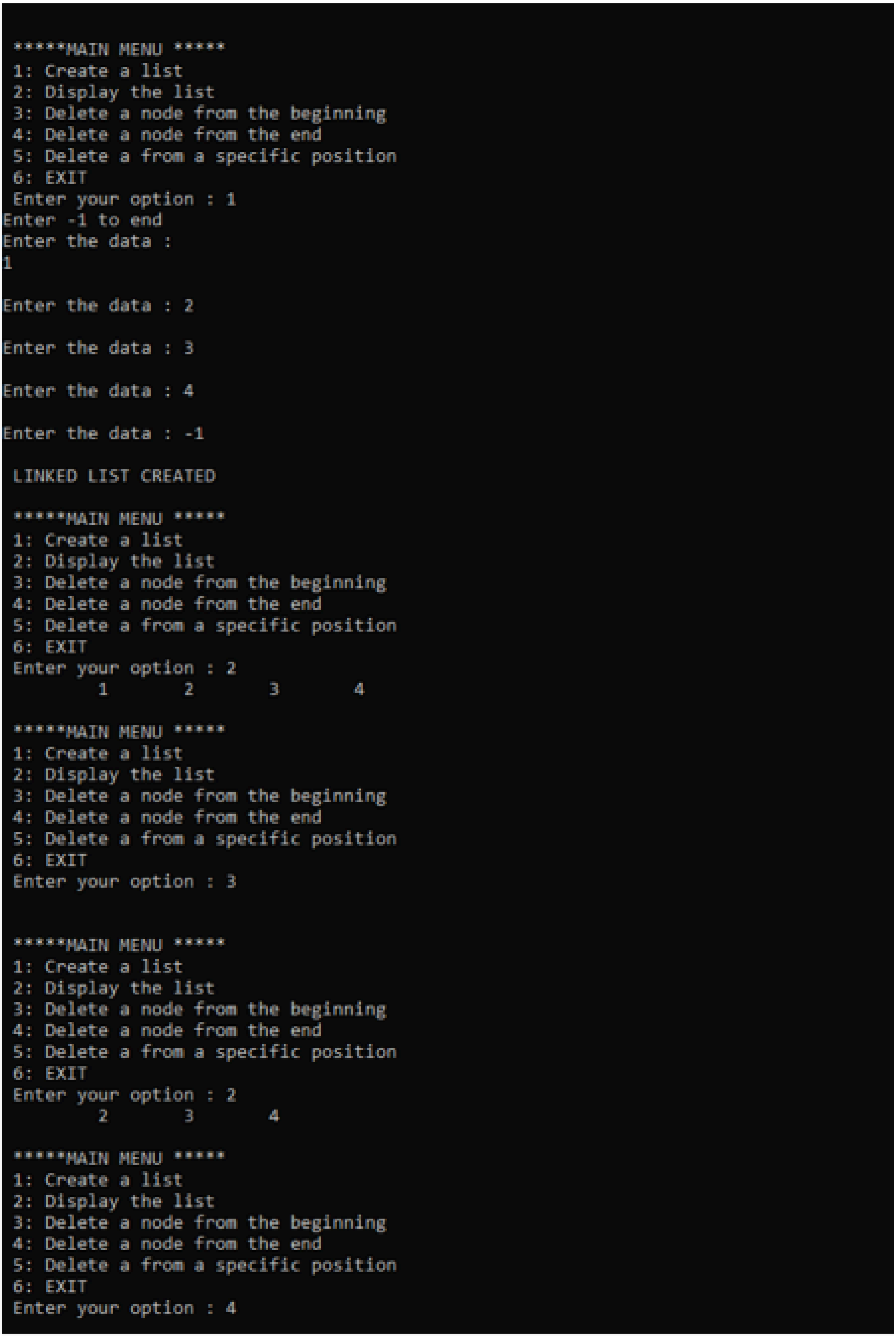
```
            {
        ptr1->next = NULL;
        free(ptr);
            }
    else
            {
        // Only one node in the list
        free(ptr);
        *start = NULL;
            }
}

void delete_at_pos(struct node **start)
 {
    if (*start == NULL)
```

```
            {
printf("List is empty\n");
        return;
            }

    int loc;
printf("\nEnter the location of the node which has to be deleted : ");
scanf("%d", &loc);

    struct node *ptr = *start;
    struct node *ptr1 = NULL;
    for (int i = 0; i<loc; i++)
            {
        ptr1 = ptr;
ptr = ptr->next;


        if (ptr == NULL)
         {
printf("There are less than %d elements in the list\n", loc);
          return;
         }
            }


    if (ptr1 != NULL)
            {
        ptr1->next = ptr->next;
```

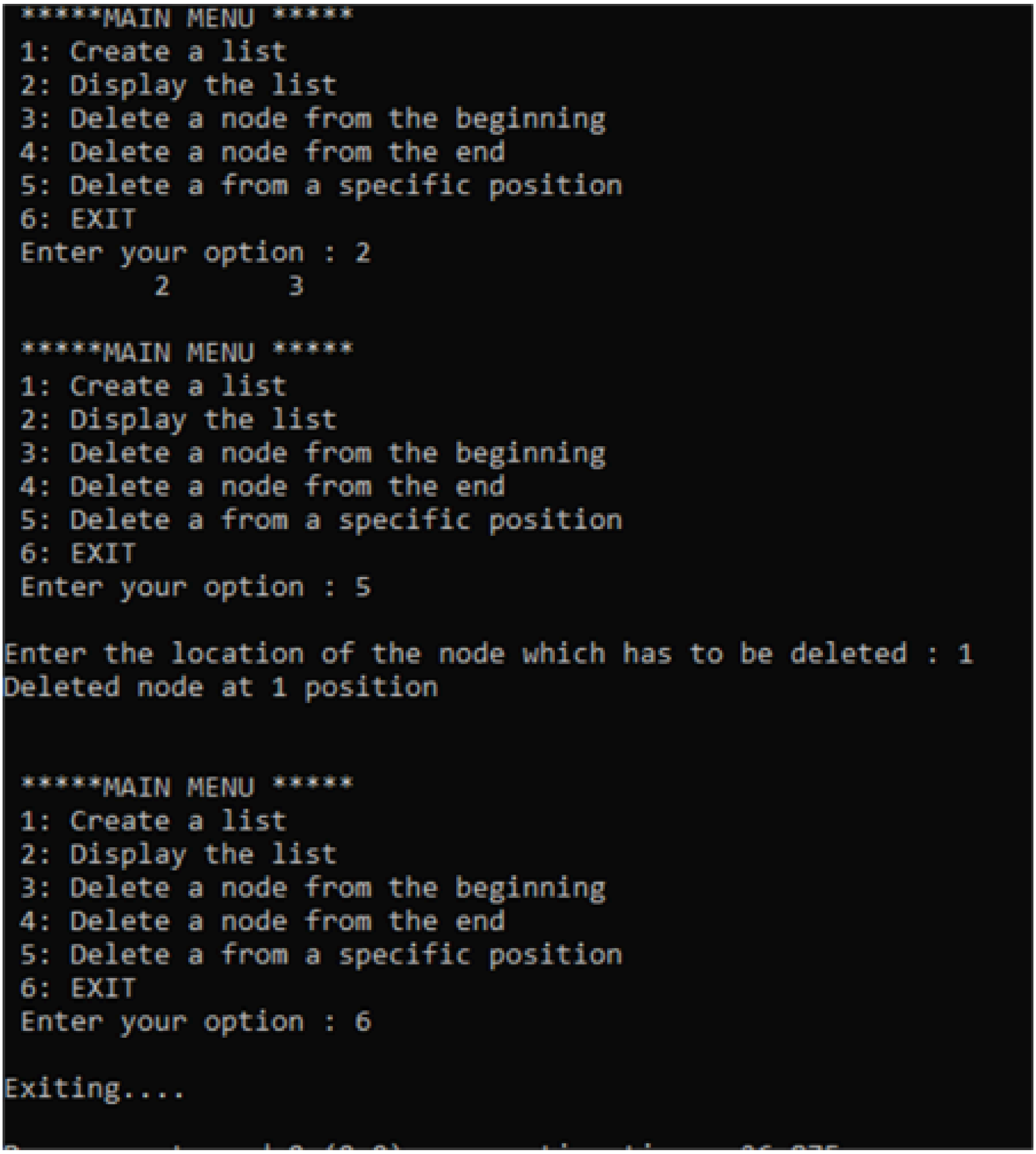
```
       free(ptr);
printf("Deleted node at %d position\n", loc);
           }
    else
           {
       // Deleting the first node
       *start = ptr->next;
       free(ptr);
printf("Deleted node at %d position\n", loc);
           }
```

```
}


void free_list(struct node *start)
 {
    struct node *ptr = start;
    struct node *next_node;


    while (ptr != NULL)
            {
next_node = ptr->next;
        free(ptr);
ptr = next_node;
            }
}
```

OUTPUT:



```

 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 1
Enter -1 to end
Enter the data :
1

Enter the data : 2

Enter the data : 3

Enter the data : 4

Enter the data : -1

 LINKED LIST CREATED

 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 2
         1       2       3       4

 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 3


 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 2
         2       3       4

 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 4
```

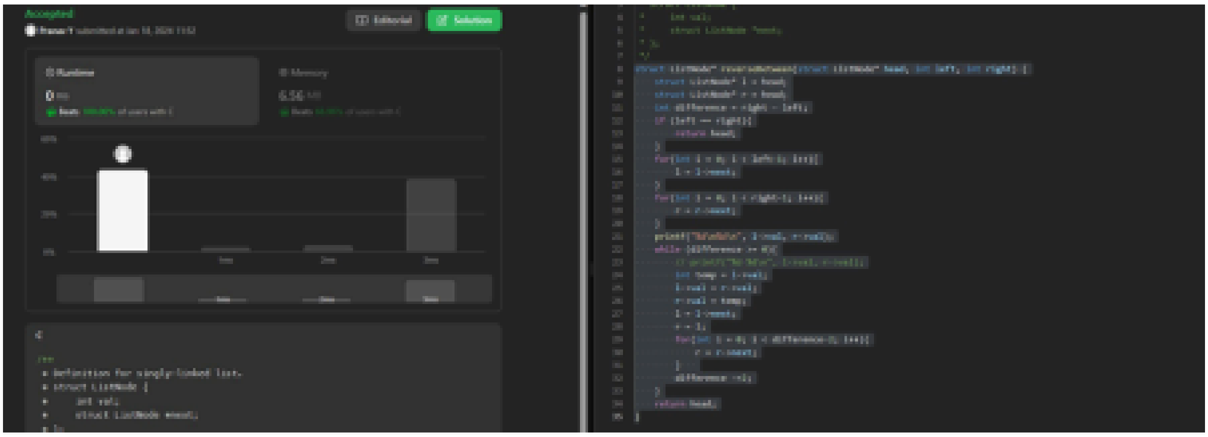


```
 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 2
         2       3

 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 5

Enter the location of the node which has to be deleted : 1
Deleted node at 1 position


 *****MAIN MENU *****
 1: Create a list
 2: Display the list
 3: Delete a node from the beginning
 4: Delete a node from the end
 5: Delete a from a specific position
 6: EXIT
 Enter your option : 6

Exiting....
```

LEETCODE PROGRAM:

```
struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {
   struct ListNode* l = head;
   struct ListNode* r = head;
   int difference = right - left;
   if (left == right){
      return head;
   }
   for(int i = 0; i < left-1; i++){
      l = l->next;
   }
   for(int i = 0; i < right-1; i++){
        r = r->next;
    }
    printf("%d\n%d\n", l->val, r->val);
    while (difference >= 0){
        // printf("%d %d\n", l->val, r->val);
        int temp = l->val;
        l->val = r->val;
        r->val = temp;
        l = l->next;
        r = l;
        for(int i = 0; i < difference-2; i++){
            r = r->next;
        }
        difference -=2;
    }
    return head;
}
```

OUTPUT:



LAB 6 PROGRAMS:

6a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

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

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

node *head = NULL;
node *head1 = NULL;
int count = 0;

void insert(int data, int position);
void delete(int position);
```

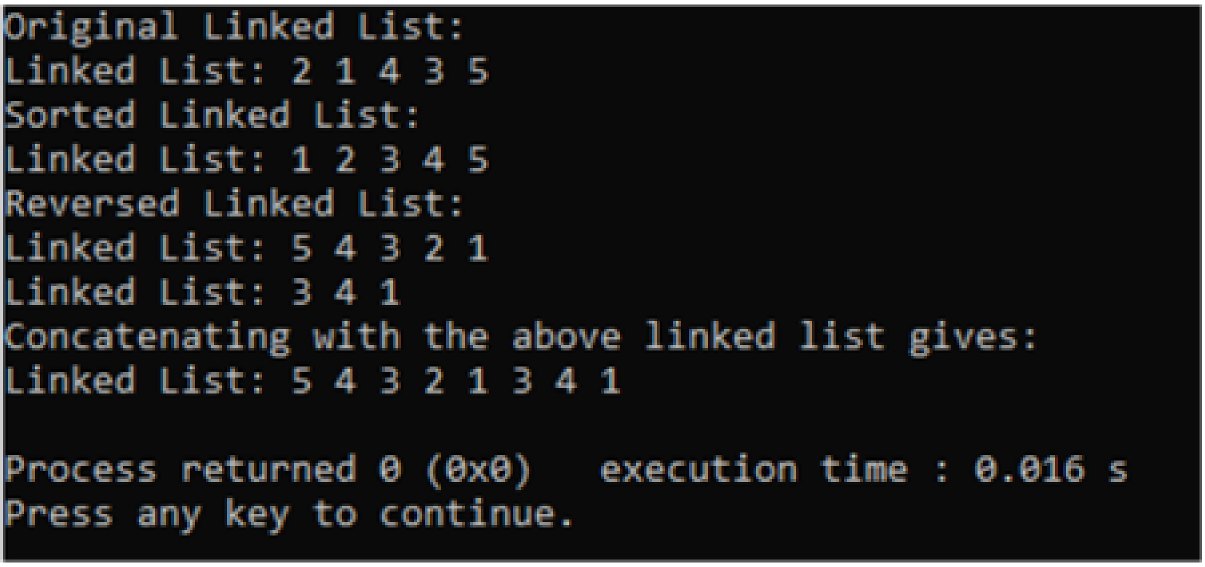
```
void display();
void sort();
void reverse();
void concat(node** head1, node** head2);

int main(){
    insert(2, 0);
    insert(1, 1);
    insert(4, 2);
    insert(3, 3);
    insert(5, 4);
    printf("Original Linked List: \n");
    display();
    sort();
    printf("Sorted Linked List: \n");
    display();
    reverse();
    printf("Reversed Linked List: \n");
    display();
    head1 = head;
    head = NULL;
    insert(3, 0);
    insert(4, 1);
    insert(1, 2);
    display();
    concat(&head1, &head);
    head = head1;
    printf("Concatenating with the above linked list gives: \n");
    display();

    return 0;
}

void insert(int data, int position){
    if (position == 0){
        node* new_node = (node*)malloc(sizeof(node));
        new_node->data = data;
        new_node->next = head;
        head = new_node;
        count++;
        return;

    } else if (position == count){
        node* new_node = malloc(sizeof(node));
        new_node->data = data;
        new_node->next = NULL;
        node* temp = head;
        while(temp->next != NULL)
            temp = temp->next;
        temp->next = new_node;
```

```
        count++;
        return;

    } else if (position > count || position < 0){
        printf("Unable to insert at given position\n");
        return;
    } else {
        node* temp = head;
        for(int i = 0; i < position-1; i++)
            temp = temp->next;
        node* new_node = malloc(sizeof(node));
        new_node->data = data;
        new_node->next = temp->next;
        temp->next = new_node;
        count++;
        return;
    }
}

void delete(int position){
    if (position == 0){
        node* temp = head;
        head = head->next;
        free(temp);
        count--;
        return;
    } else if (position == count-1){
        node* temp = head;
        for(int i = 1; i < count-1; i++)
            temp = temp->next;
        node* temp1 = temp->next;
        temp->next = NULL;
        free(temp1);
        count--;
        return;
    } else if (position > count || position < 0){
        printf("Unable to delete at given position\n");
        return;
    } else {
        node* temp = head;
        for(int i = 0; i < position-1; i++)
            temp = temp->next;
        node* temp1 = temp->next;
        temp->next = temp1->next;
        free(temp1);
        count--;
        return;
    }
}
```

```
void sort(){
    int i, j, min_index;
    node *i_node=head, *j_node=head, *min_node=NULL;
    for(int i = 0; i < count-1; i++, i_node=i_node->next){ //
    printf("Got here\n");
        min_index = i;
        min_node = i_node;
        j_node = i_node->next;
        for(int j = i+1; j < count; j++, j_node=j_node->next){
            // printf("Got here too\n");
            if (j_node->data < i_node->data){
                min_index = j;
                min_node = j_node;
            }
        }
        // printf("%d\n", min_index);
        if (min_index != i){
            // printf("Found a min element\n");
            int temp = i_node->data;
            i_node->data = min_node->data;
            min_node->data = temp;
            // display();
        }
    }
}

void reverse(){
    node *prev = NULL, *next=NULL;
    while(head != NULL){
        next = head->next;
        head->next = prev;
        prev = head;
        head = next;
    }
    head = prev;
}

void concat(node **head1, node **head2){
    node *temp1 = *head1;
    while (temp1->next != NULL){
        temp1 = temp1->next;
    }
    // printf("Got here atleast?\n");
    temp1->next = *head2;
    // printf("Got here?\n");
}

void display(){
    node* temp = head;
    printf("Linked List: ");
```

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

OUTPUT:



```
Original Linked List:
Linked List: 2 1 4 3 5
Sorted Linked List:
Linked List: 1 2 3 4 5
Reversed Linked List:
Linked List: 5 4 3 2 1
Linked List: 3 4 1
Concatenating with the above linked list gives:
Linked List: 5 4 3 2 1 3 4 1

Process returned 0 (0x0)   execution time : 0.016 s
Press any key to continue.
```

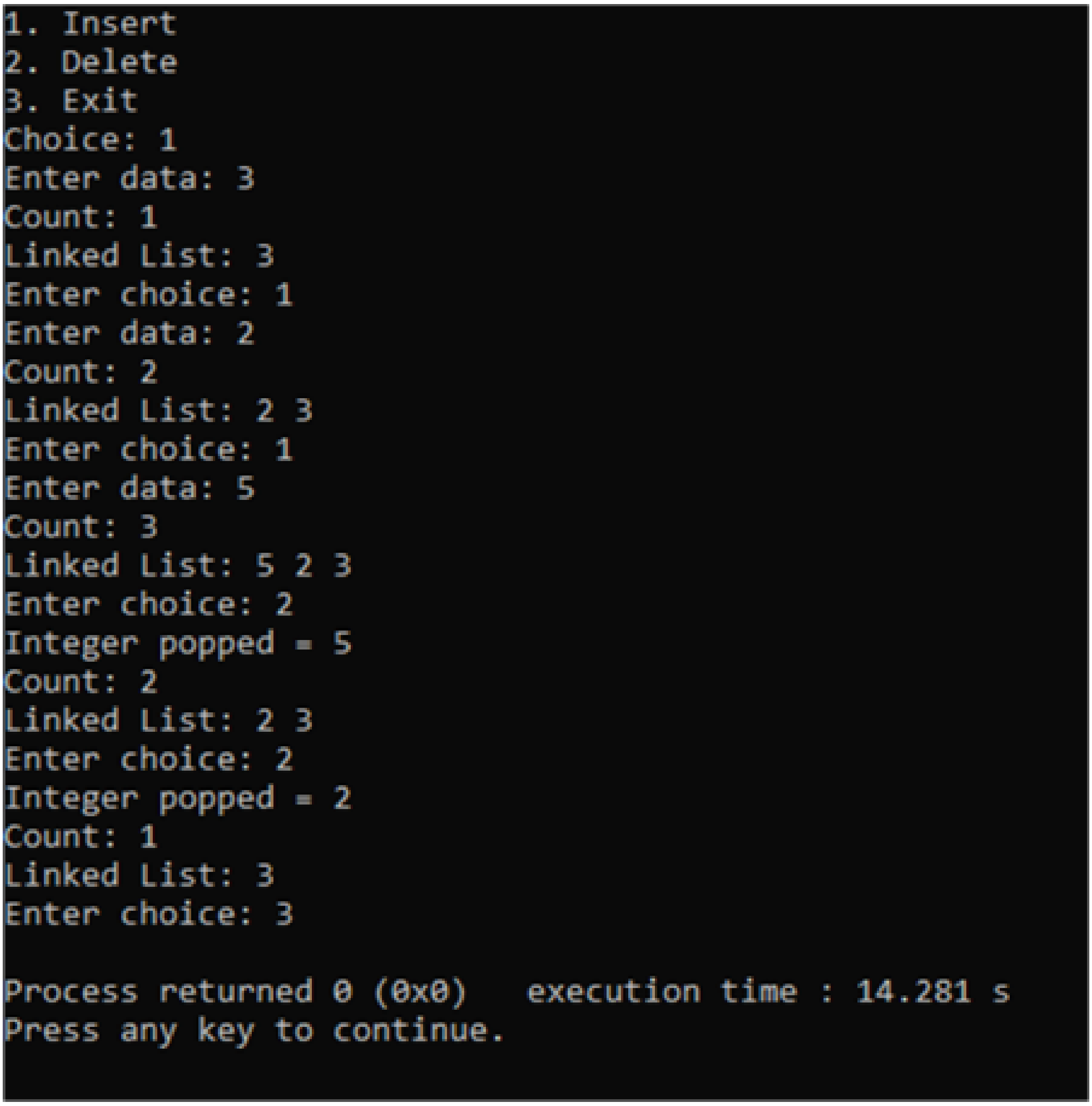
6b) WAP to Implement Single Link List to simulate Stack &amp; Queue Operations.

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

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

node* head = NULL;
int count = 0;

void insert(int data);
int delete();
void display();
```

```
int main(){
    int data, choice, pos;
    printf("1. Insert\n2. Delete\n3. Exit\nChoice: ");
    scanf("%d", &choice);
    while(choice != 3){
        if (choice == 1){
            printf("Enter data: ");
            scanf("%d", &data);
```

```
            insert(data);
            printf("Count: %d\n", count);
        } else if (choice == 2){
            printf("Integer popped = %d\n", delete());
            printf("Count: %d\n", count);
        }
        display();
        printf("Enter choice: ");
        scanf("%d", &choice);
    }


    return 0;
}

void insert(int data){
    node* new_node = (node*)malloc(sizeof(node));
    new_node->data = data;
    new_node->next = head;
    head = new_node;
    count++;
    return;

}

int delete(){
    node* temp = head;
    head = head->next;
    int t = temp->data;
    free(temp);
    count--;
    return t;

}

void display(){
    node* temp = head;
    printf("Stack: ");
    while (temp->next != NULL){
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("%d ", temp->data);
    printf("\n");
}
```

OUTPUT:



```
1. Insert
2. Delete
3. Exit
Choice: 1
Enter data: 3
Count: 1
Linked List: 3
Enter choice: 1
Enter data: 2
Count: 2
Linked List: 2 3
Enter choice: 1
Enter data: 5
Count: 3
Linked List: 5 2 3
Enter choice: 2
Integer popped = 5
Count: 2
Linked List: 2 3
Enter choice: 2
Integer popped = 2
Count: 1
Linked List: 3
Enter choice: 3

Process returned 0 (0x0)   execution time : 14.281 s
Press any key to continue.
```

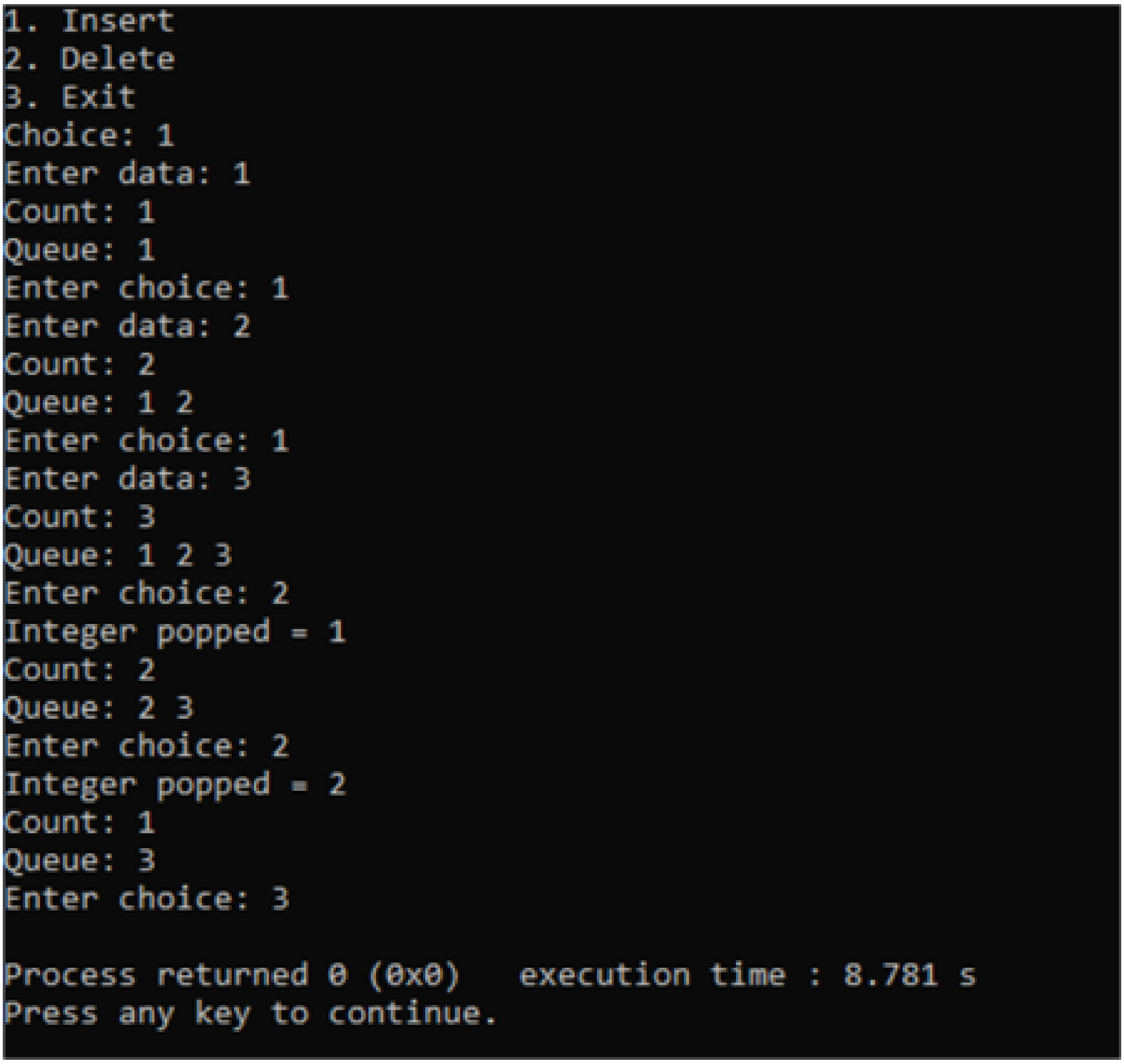
II)QUEUE:

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

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

node* head = NULL;
int count = 0;

void insert(int data);
int delete();
void display();
```

```
int main(){
    int data, choice, pos;
    printf("1. Insert\n2. Delete\n3. Exit\nChoice: ");
    scanf("%d", &choice);
    while(choice != 3){
        if (choice == 1){
            printf("Enter data: ");
            scanf("%d", &data);
            insert(data);
            printf("Count: %d\n", count);
        } else if (choice == 2){
            printf("Integer popped = %d\n", delete());
            printf("Count: %d\n", count);
        }
        display();
        printf("Enter choice: ");
        scanf("%d", &choice);
    }


    return 0;
}

void insert(int data){
    node* new_node = malloc(sizeof(node));
    new_node->data = data;
    new_node->next = NULL;
    if (head == NULL){
        head = new_node;
        count++;
        return;
    }
    node* temp = head;
    while(temp->next != NULL)
        temp = temp->next;
    temp->next = new_node;
    count++;
    return;

}

int delete(){
    node* temp = head;
    head = head->next;
    int t = temp->data;
    free(temp);
    count--;
    return t;

}
```

```
void display(){
    node* temp = head;
    printf("Queue: ");
    while (temp->next != NULL){
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("%d ", temp->data);
    printf("\n");
}
```

OUTPUT:



```
1. Insert
2. Delete
3. Exit
Choice: 1
Enter data: 1
Count: 1
Queue: 1
Enter choice: 1
Enter data: 2
Count: 2
Queue: 1 2
Enter choice: 1
Enter data: 3
Count: 3
Queue: 1 2 3
Enter choice: 2
Integer popped = 1
Count: 2
Queue: 2 3
Enter choice: 2
Integer popped = 2
Count: 1
Queue: 3
Enter choice: 3

Process returned 0 (0x0)   execution time : 8.781 s
Press any key to continue.
```

LAB 7 PROGRAMS:
WAP to Implement doubly link list with primitive operations

a) Create a doubly linked list.
b) Insert a new node to the left of the node.
c) Delete the node based on a specific value

d) Display the contents of the list

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

typedef struct Node{
   int data;
   struct Node *next;
   struct Node *prev;
} node;
```

```
node* head = NULL;
int count = 0;

void insert(int data, int position);
void delete(int element);
void display();

int main(){
  int data, choice, pos;
  printf("1. Insert\n2. Delete\n3. Exit\nChoice: ");
  scanf("%d", &choice);
  while(choice != 3){
     if (choice == 1){
        printf("Enter data and position: ");
        scanf("%d%d", &data, &pos);
        insert(data, pos);
        printf("Count: %d\n", count);
     } else if (choice == 2){
        printf("Enter element: ");
        scanf("%d", &pos);
        delete(pos);
        printf("Count: %d\n", count);
     }
     display();
     printf("Enter choice: ");
     scanf("%d", &choice);
  }


  return 0;
}

void insert(int data, int position){
  if (position == 0){
     node* new_node = malloc(sizeof(node));
     new_node->data = data;
     new_node->next = head;
```

```
     new_node->prev = NULL;
     if (head != NULL) head->prev =
     new_node; head = new_node;
     count++;
     return;
  } else if (position == count){
     node* new_node = malloc(sizeof(node));
     new_node->data = data;
     new_node->next = NULL;
     node* temp = head;
```

```
        while(temp->next != NULL)
            temp = temp->next;
        temp->next = new_node;
        new_node->prev = temp;
        count++;
        return;

    } else if (position > count || position < 0){
        printf("Unable to insert at given position\n");
        return;
    } else {
        node* temp = head;
        for(int i = 0; i < position-1; i++)
            temp = temp->next;
        node* new_node = malloc(sizeof(node));
        new_node->data = data;
        new_node->next = temp->next;
        new_node->prev = temp;
        temp->next->prev = new_node;
        temp->next = new_node;
        count++;
        return;
    }
}

void delete(int element){
    int position = 0; node *temp = head;
    if (head == NULL){
        printf("List is empty, cannot delete"); return;
    }
    for(;position < count; temp=temp->next,
        position++) if (temp->data == element) break;
    if (temp == NULL){
        printf("Element does not exist in list"); return;
    }
    if (position == 0){
        node* temp = head;
        temp = temp->next;
        temp->prev = NULL;
        free(head);
```

```
        head = temp;
        count--;
        return;
    } else if (position == count-1){
        node* temp = head;
        for(int i = 1; i < count-1; i++)
            temp = temp->next;
        node* temp1 = temp->next;
        temp->next = NULL;
        free(temp1);
        count--;
        return;
    } else if (position > count || position <
        0){ printf("Unable to delete at
        position\n"); return;
    } else {
        node* temp = head;
        for(int i = 0; i < position; i++)
            temp = temp->next;
        temp->next->prev = temp->prev;
        temp->prev->next = temp->next;
        free(temp);
        count--;
        return;
    }
}

void display(){
    node* temp = head;
    printf("Linked List: ");
    while (temp->next != NULL){
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("%d ", temp->data);
    printf("\n");
}
```

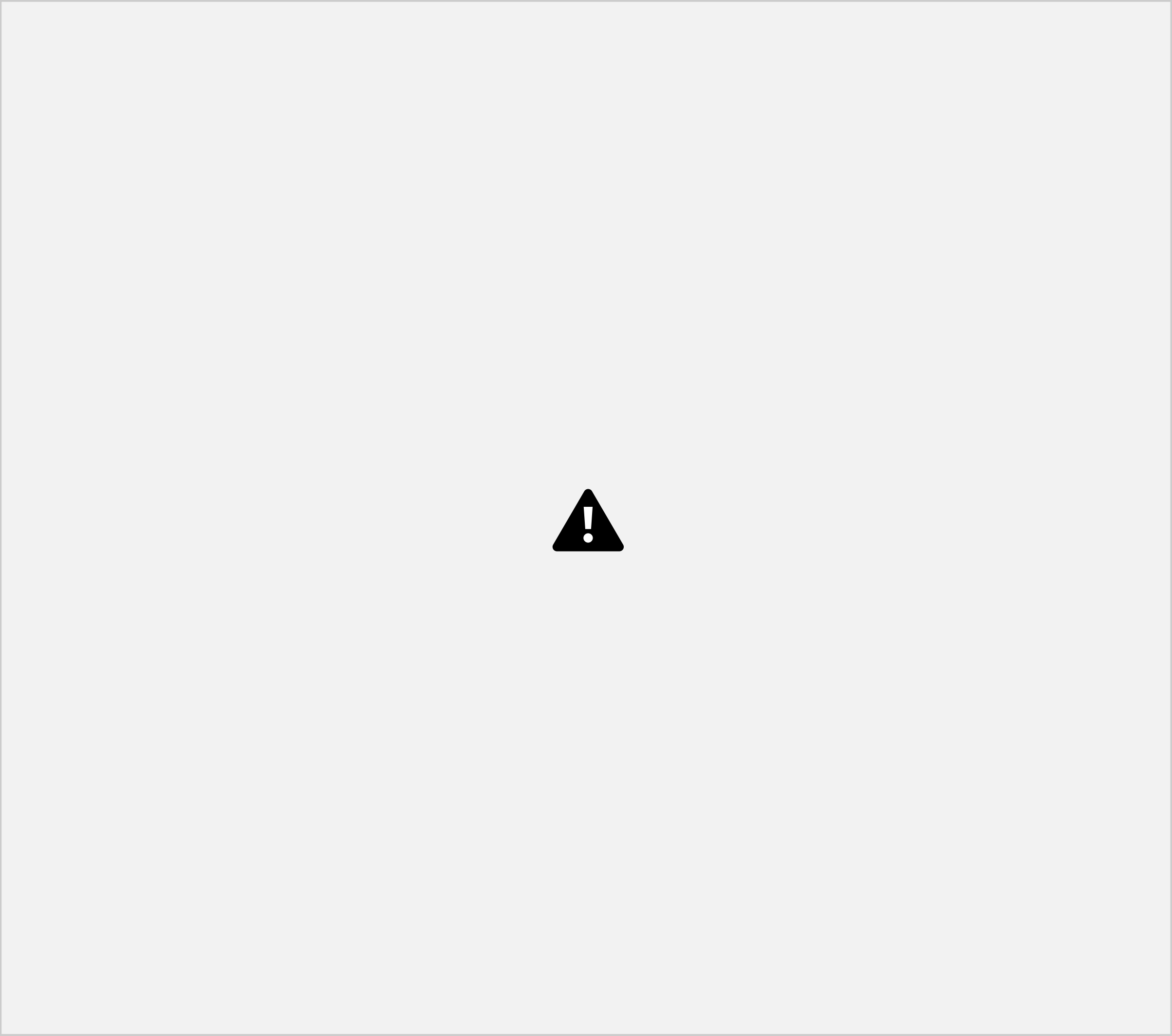
OUTPUT:

Program - Leetcode platform

```
struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize) {
    struct ListNode* temp = head; int n = 0;
    for(; temp != NULL; temp=temp->next, n++);
    struct ListNode** lists = (struct ListNode**)malloc(k*sizeof(struct
    ListNode*)); for(int i = 0; i < k; i++) lists[i] = NULL;
    int earlier_lists = n%k, size=n/k;
    int current = 0; bool list_over = false;
    temp = head;
    *returnSize = k;
```

```
  for(int i = earlier_lists; i > 0; i--){
        // printf("Entering here\n");
        struct ListNode* temp1 = temp;
        lists[current++] = temp;
        for(int j = 0; j < size; j++) temp1 = temp1->next;
        temp = temp1->next;
        temp1->next = NULL;
  }
  // printf("%d %d %d", lists[0]->val, lists[1]->val, lists[2]->val);
  if (temp == NULL) return lists;
  for(int i = 0; i < k-earlier_lists; i++){
        struct ListNode* temp1 = temp;
        if (temp1 == NULL) break;
        for(int j = 0; j < size-1; j++) temp1 = temp1->next;
        lists[current++] = temp;
        temp = temp1->next;
        temp1->next = NULL;
        // for(int l = 0; l < k; l++){
        // for(struct ListNode* temp2 = lists[l]; temp2 != NULL; temp2 = temp2->next){ //
        printf("%d ", temp2->val);
        // }
        // printf("\n");
        // }
  }
  return lists;
}
```

OUTPUT:



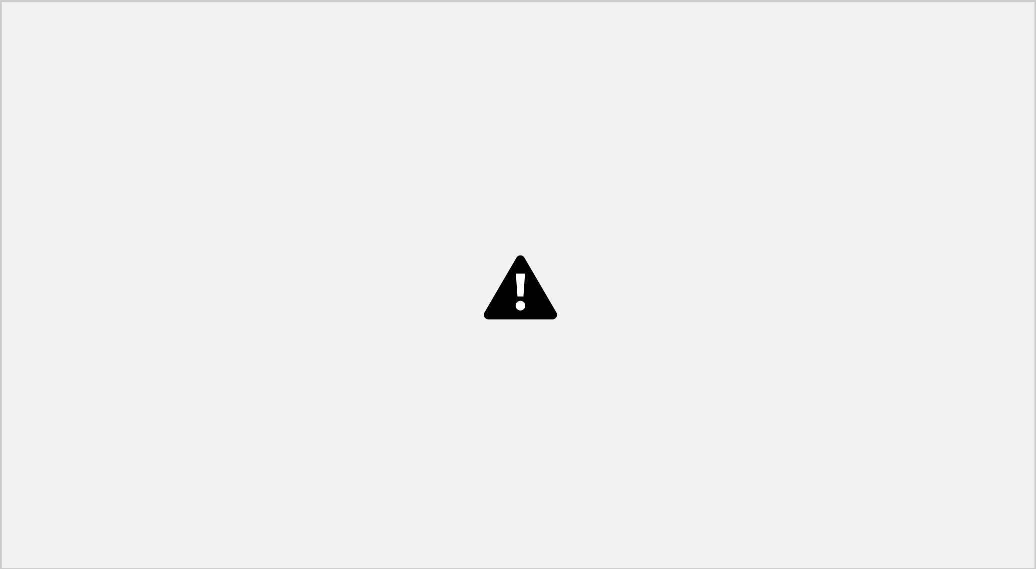
LAB 8 PROGRAMS:
Write a program

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

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

typedef struct Node{
    int data;
    struct Node *left;
    struct Node *right;
} node;

node *root = NULL;

void insert(node **root, int data);
void preorder(node **root);
void postorder(node **root);
void inorder(node **root);

int main(){
    int choice, data;
    insert(&root, 8);
    insert(&root, 3);
    insert(&root, 1);
    insert(&root, 6);
    insert(&root, 4);
    insert(&root, 7);
    insert(&root, 10);
    insert(&root, 14);
    insert(&root, 13);
    printf("1. Preorder\n2. Inorder\n3. Postorder\n4. Exit\nChoice: ");
    scanf("%d", &choice);
    while (choice != 4){
        if (choice == 1){
            preorder(&root);
            printf("\n");
        } else if (choice == 2){
            inorder(&root);
            printf("\n");
        } else if (choice == 3){
            postorder(&root);
            printf("\n");
        }
        printf("Enter choice: ");
        scanf("%d", &choice);
    }
}

void insert(node **root, int data){
    if (*root == NULL) {
        node *new_node = malloc(sizeof(node));
        new_node->data = data;
        new_node->right = NULL;
        new_node->left = NULL;
        *root = new_node;
        return;
    }
    if (data < (*root)->data){
        insert(&((*root)->left), data);
    } else if (data > (*root)->data){
        insert(&((*root)->right), data);
    }
    return;
}
```

```
void preorder(node **root){
   if (*root != NULL){
      printf("%d ", (*root)->data);
      preorder(&((*root)->left));
      preorder(&((*root)->right));
   }
}

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

void inorder(node **root){
   if (*root != NULL) {
       inorder(&(*root)->left);
      printf("%d ", (*root)->data);
       inorder(&(*root)->right);
   }
}
```

OUTPUT:



LEETCODE PROGRAM:

```
struct ListNode* rotateRight(struct ListNode* head, int k) {
   struct ListNode *temp = head;
   if (head == NULL) return NULL;
   if (head->next == NULL) return head;
   if (k == 0) return head;
   int size = 1;
   for(; temp->next != NULL; temp=temp->next, size++);
   k %= size;
```

```
   if (k == 0) return head;
   temp->next = head;
   struct ListNode *temp1 = head;
   for(int i = 0; i < (size-k-1); temp1 = temp1->next, i++);
   head = temp1->next;
   temp1->next = NULL;
   return head;
}
```

OUTPUT:

LAB 9 PROGRAMS:

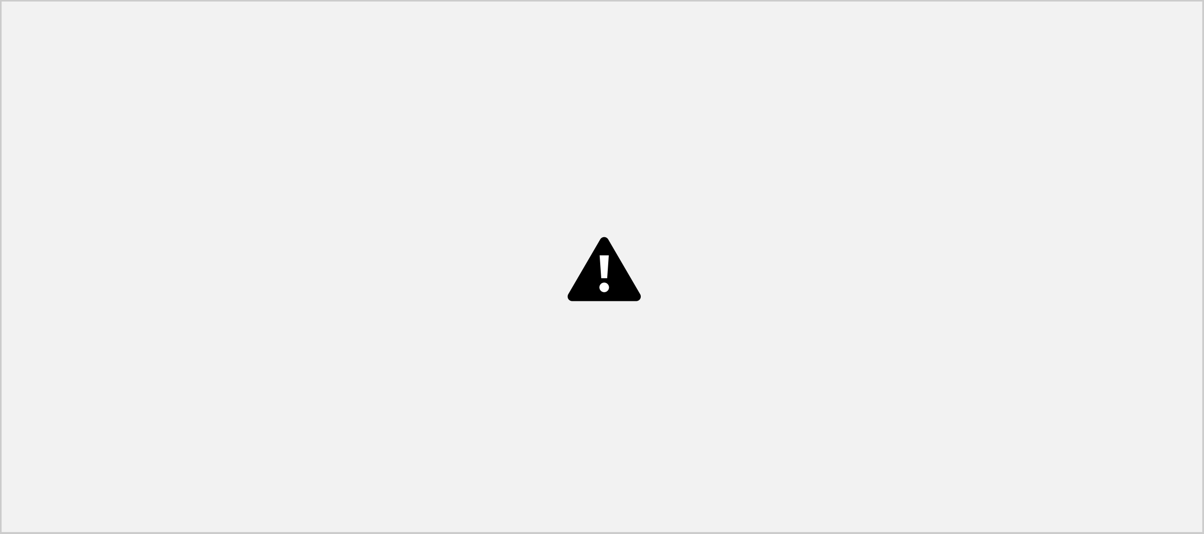
9a) Write a program to traverse a graph using BFS method.

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

#define size 7

void push(int a);
int pop();
void display();
void bfs(int graph[][7]);

int fpos = -1, rpos = -1;
int queue[size];

int main(){
  int adj_matrix[7][7] = {
       {0, 1, 0, 1, 0, 0, 0},
       {1, 0, 1, 1, 0, 1, 1},
       {0, 1, 0, 1, 1, 1, 0},
       {1, 1, 1, 0, 0, 0, 0},
       {0, 0, 1, 0, 0, 0, 1},
```

```
        {0, 1, 1, 0, 0, 0, 0},
        {0, 1, 0, 0, 1, 0, 0},
    };
    for(int i = 0; i < 7; i++) queue[i] = NULL;
    // display();
    bfs(adj_matrix);
    return 0;

}

void bfs(int graph[][7]){
    int visited[7];
    for(int i = 0; i < 7; i++) visited[i] = 0;
    push(0); visited[0]= 1;
    while (fpos != size){
        for(int i = 0; i < 7; i++){
            if(graph[queue[fpos]][i] == 1 && visited[i] != 1){
                push(i);
                visited[i] = 1;
                // break;
            }
        }
        printf("%d ", pop());
        // printf("%d\n", new_node);
    }
}

void push(int a){
    if (fpos == -1 && rpos == -1){
        queue[++rpos] = a;
        fpos++;
        return;
    }
    else if (rpos == size-1){
        printf("Queue overflow condition\n");
        return;
    }
    else{
        queue[++rpos] = a;
        return;
    }
}

int pop(){
    if (fpos == -1){
       printf("Queue Underflow condition\n");
    }
    int n = queue[fpos];
    queue[fpos] = (int) NULL;
    fpos++;
```

```
   return n;
}

void display(){
   printf("Queue: ");
    for(int i = 0; i < size; i++)
       printf("%d ", queue[i]);
   printf("\n");
}
```

OUTPUT:



9b) Write a program to check whether given graph is connected or not using DFS method.

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

#define size 7
int pos = -1;
int stack[size];

void push(int a);
int pop();
void display();
void dfs(int graph[][7]);

int main(){
    int adj_matrix[7][7] = {
        {0, 1, 0, 1, 0, 0, 0},
        {1, 0, 1, 1, 1, 0, 1, 1},
        {0, 1, 0, 1, 1, 1, 0},
        {1, 1, 1, 0, 0, 0, 0},
        {0, 0, 1, 0, 0, 0, 1},
        {0, 1, 1, 0, 0, 0, 0},
```

```
        {0, 1, 0, 0, 1, 0, 0},
    };
    for(int i = 0; i < 7; i++) stack[i] = NULL;
    // display();
    dfs(adj_matrix);
    return 0;


}

void dfs(int graph[][7]){
    int visited[7];
    for (int i = 0; i < 7; i++) visited[i] = 0;
    push(0); visited[0] = 1; printf("0 ");
    // printf("%d ", pos);
    // return;
    // display();
    while(pos != -1){
        bool new_node = false;
        for(int i = 0; i < 7; i++){
            // printf("%d ", graph[stack[pos]][i]);
            if(graph[stack[pos]][i] == 1 && visited[i] != 1){
                new_node = true;
                // printf("Current top: %d\n", i);
                push(i);
                // display();
                visited[i] = 1; printf("%d ", i);
                break;
            }
        }
        // printf("%d\n", new_node);
        if (!new_node) pop();
    }

}

void push(int a){
    if (pos == size-1){
        printf("Stack Overflow condition");
        return;
    }
```

```
   stack[++pos] = a;
}

int pop(){
   if (pos == -1){
      printf("Stack Underflow condition");
      return (int) NULL;
   }
   return stack[pos--];
```

```
}

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

OUTPUT:

LAB 10 PROGRAMS:

Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F.

Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.

Let the keys in K and addresses in L are integers.

Design and develop a Program in C that uses Hash function H: K -&gt; L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L.

Resolve the collision (if any) using linear probing.

```
#include <stdio.h>

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

```
#include <string.h>

#define size 10

int table[size];

void push(int data);
int pop(int data);
void search(int data);
void display();
```

```
int main(){
    for(int i = 0; i < size; i++) table[i] = -1;
    int choice;
    printf("1. Insert\n2. Delete \n3. Display\n4. Exit\nChoice: ");
    scanf("%d", &choice);
    int a;
    while(choice != 4){
        switch(choice){
            case 1:
                printf("Enter integer to be pushed: ");
                scanf("%d", &a);
                push(a);
                break;
            case 2:
                printf("Enter integer to be popped: ");
                scanf("%d", &a);
                int res = pop(a);
                if (res == 0) printf("Integer popped\n");
                else printf("Integer not found\n");
                break;
            case 3:
                display();
                break;
            default:
                printf("Idk");
                break;
        }
        printf("Enter choice: ");
        scanf("%d", &choice);
    }
}

void push(int data){
    int hash = data%size;
    while (table[hash] != -1 && hash <= (hash+size-1)) hash = (hash+1)%size;
    if (table[hash] == -1) table[hash] = data;
    else printf("Table is full");
}
```

```
int pop(int data){
    int hash = data%size;
     for(int i = 0; (table[hash] != data) || (i < size); i++, hash =
     (hash+1)%size); if (table[hash] == data) {
        table[hash] = -1; return 0;
     }
    return -1;
}

void display(){
```

```
printf("Table: ");
for(int i = 0; i < size; i++)
printf("%d ", table[i]);
printf("\n");
}
```

OUTPUT: