VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

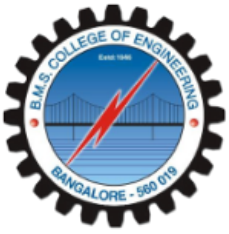
LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

Tanush Prajwal S (1BM22CS304)

in partial fulfillment 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
Dec 2023- March 2024

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

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **Tanush Prajwal S (1BM22CS304)**, 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 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. Lakshmi Neelima
Assistant Professor
Department of CSE
BMSCE, Bengaluru

Dr. Jyothi S Nayak
Professor and Head
Department of CSE
BMSCE, Bengaluru

Index Sheet

Course outcomes:

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

LAB PROGRAM 1

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.

CODE

```
#include <stdio.h>
#include <stdlib.h>
#define size 5
void push(int);
void pop();
void display();
int stack[size],top=-1;
void main(){
    int op,n;
    printf("enter the operation\n 1.push \n 2.pop\n 3.display\n enter -1 to stop\n");
    while(1){
            scanf("%d",&op);
    if (op==-1){
            printf("stopping the operations\n");
    break;
    }
    else{
        switch(op){
        case 1:printf("enter the values\n");

        scanf("%d",&n);
        push(n);
        break;
        case 2:pop();
        break;
        case 3:display();
        break;
        default: printf("wrong choice\n");
        }
    }

    }
}
void push(int n){
     if(top==size-1){
        printf("stack overflow condition\n");
```

```
    }
    else{
      top++;
      stack[top]=n;
      printf("push operation is succesfull\n");
      }
    }
void pop(){
    if(top==-1){
      printf("stack underflow condition\n");

    }
    else{
      printf("%d pop() operation successfull\n",stack[top]);
      top--;
    }
}

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


}
}
```

OUTPUT

```
enter the operation
 1.push
 2.pop
 3.display
 enter -1 to stop
1
enter the values
40
push operation is succesfull
1
enter the values
50
push operation is succesfull
3
50      40
-1
stopping the operations


...Program finished with exit code 0
Press ENTER to exit console.
```

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)

CODE

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

char stack[100];
int top = -1,size;

void push(char item)
{
   if(top >= size-1)
   {
      printf("\nStack Overflow.");
   }
   else
   {
      top = top+1;
      stack[top] = item;
   }
}
char pop()
{
   char item ;
   if(top <0)
   {
      printf("\nStack Underflow\n");
   }
   else
   {
      item = stack[top];
      top = top-1;
      return(item);
   }
}
int is_operator(char symbol)
```

```
{
   if(symbol == '^' || symbol == '*' || symbol == '/' || symbol == '+' || symbol =='-')
   {
      return 1;
   }
   else
   {
   return 0;
   }
}
int precedence(char symbol)
{
   if(symbol == '^')
   {
      return(3);
   }
   else if(symbol == '*' || symbol == '/')
   {
      return(2);
   }
   else if(symbol == '+' || symbol == '-')
   {
      return(1);
   }
   else
   {
      return(0);
   }
}

void InfixToPostfix(char infix_exp[], char postfix_exp[])
{
   int i, j;
   char item;
   char x;

   push('(');
   strcat(infix_exp,")");

   i=0;
   j=0;
   item=infix_exp[i];
```

```
while(item != '\0')
{
    if(item == '(')
    {
        push(item);
    }
    else if( isdigit(item) || isalpha(item))
    {
        postfix_exp[j] = item;
        j++;
    }
    else if(is_operator(item) == 1)
    {
        x=pop();
        while(is_operator(x) == 1 && precedence(x)>= precedence(item))
        {
            postfix_exp[j] = x;
            j++;
            x = pop();
        }
        push(x);

        push(item);
    }
    else if(item == ')')
    {
        x = pop();
        while(x != '(')
        {
            postfix_exp[j] = x;
            j++;
            x = pop();
        }
    }
    else
    {
        printf("\nInvalid infix Expression.\n");
        exit(1);
    }
    i++;
    item = infix_exp[i];
}
postfix_exp[j] = '\0';
```

```
}
main()
{
    char infix[100], postfix[100];
    printf("\nEnter size of stack");
    scanf("%d",&size);
        printf("Assume the infix expression contains single letter variables and single digit constants only.\n");
    printf("\nEnter Infix expression : ");
    scanf(" %s",infix);
    InfixToPostfix(infix,postfix);
    printf("Postfix Expression: ");
    printf("%s",postfix);
}
```

OUTPUT

```
Enter size of stack4
Assume the infix expression contains single letter variables and single digit constants only.

Enter Infix expression : 4a+6b+m*k
Postfix Expression: 4a6b+mk*+

...Program finished with exit code 0
Press ENTER to exit console.
```

LAB PROGRAM 3

write a program to simulate the working of the queue of integers using an array. Provide the following operations: Insert, delete, display. The program should print appropriate message for overflow and underflow condition

CODE

```
#include<stdio.h>
#include<conio.h>
#define MAX 3
int queue[MAX];
int front=-1,rear=-1;
void insert(void);
int delete_element(void);
int peek(void);
void display(void);
int main()
{
   int option,val;
   do
   {
      printf("\n\n****MAIN MENU****");
      printf("\n 1.Insert an element");
      printf("\n 2.Delete an element");
      printf("\n 3.Peek");
      printf("\n 4.Display the queue");
      printf("\n 5.Exit");
      printf("\n Enter your option:");
      scanf("%d",&option);
      switch(option)
      {
      case 1:
         insert();
         break;
      case 2:
         val=delete_element();
         if(val!=-1)
            printf("\n The number deleted is :%d",val);
            break;
```

```
        case 3:
            val=peek();
            if(val!=-1)
                printf("\n The first value in queue is:%d",val);
            break;
        case 4:
            display();
            break;
        }
    }while(option!=5);
    getch();
    return 0;
}
void insert()
{
    int num;
    printf("\n Enter the number to be inserted in the queue:");
    scanf("%d",&num);
    if(rear==MAX-1)
        printf("\n OVERFLOW");
    else if(front==-1 &&rear==-1)
        front=rear=0;
    else
        rear++;
    queue[rear]=num;
}
int delete_element()
{
    int val;
    if(front==-1||front>rear)
    {
        printf("\n UNDERFLOW");
        return -1;
    }
    else
    {
        val=queue[front];
        front++;
        if(front>rear)
            front=rear=-1;
        return val;
    }
}
```

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

OUTPUT

```
****MAIN MENU****
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. Exit
Enter your option: 1

Enter the number to be inserted in the queue: 1


****MAIN MENU****
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. Exit
Enter your option: 2

The number deleted is: 1

****MAIN MENU****
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. Exit
Enter your option: 3

Queue is empty

****MAIN MENU****
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. Exit
Enter your option: 4


Queue is empty

****MAIN MENU****
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. Exit
Enter your option: 5


...Program finished with exit code 0
Press ENTER to exit console.
```

LAB PROGRAM 4

write a program to simulate the working of a circular queue using an array. Provide the following operations: insert, delete & display. The program should print appropriate message for queue empty and queue overflow conditions.

CODE

```
#include <stdio.h>

#define QUE_SIZE 3

int item, front = 0, rear = -1, q[QUE_SIZE], count = 0;

void insertrear() {
    if (count == QUE_SIZE) {
        printf("Queue overflow\n");
        return;
    }
    rear = (rear + 1) % QUE_SIZE;
    q[rear] = item;
    count++;
}

int deletefront() {
    if (count == 0)
        return -1;
    item = q[front];
    front = (front + 1) % QUE_SIZE;
    count = count - 1;
    return item;
}

void displayQ() {
    int i, f;
    if (count == 0) {
        printf("Queue is empty\n");
        return;
    }
    f = front;
    printf("Contents of queue: ");
    for (i = 1; i <= count; i++) {
```

```
        printf("%d ", q[f]);
        f = (f + 1) % QUE_SIZE;
    }
    printf("\n");
}

int main() {
    int choice;
    for (;;) {
        printf("\n1: Insert rear\n2: Delete front\n3: Display\n4: Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                printf("Enter the item to be inserted: ");
                scanf("%d", &item);
                insertrear();
                break;
            case 2:
                item = deletefront();
                if (item == -1)
                    printf("Queue is empty\n");
                else
                    printf("Item deleted: %d\n", item);
                break;
            case 3:
                displayQ();
                break;
            case 4:
                return 0;
            default:
                printf("Invalid choice\n");
        }
    }
    return 0;
}
```

OUTPUT

```
1: Insert rear
2: Delete front
3: Display
4: Exit
Enter your choice: 1
Enter the item to be inserted:
25

1: Insert rear
2: Delete front
3: Display
4: Exit
Enter your choice: 1
Enter the item to be inserted: 35

1: Insert rear
2: Delete front
3: Display
4: Exit
Enter your choice: 2
Item deleted: 25

1: Insert rear
2: Delete front
3: Display
4: Exit
Enter your choice: 3
Contents of queue: 35

1: Insert rear
2: Delete front
3: Display
4: Exit
Enter your choice: 4


...Program finished with exit code 0
Press ENTER to exit console.
```

LAB PROGRAM 5

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.

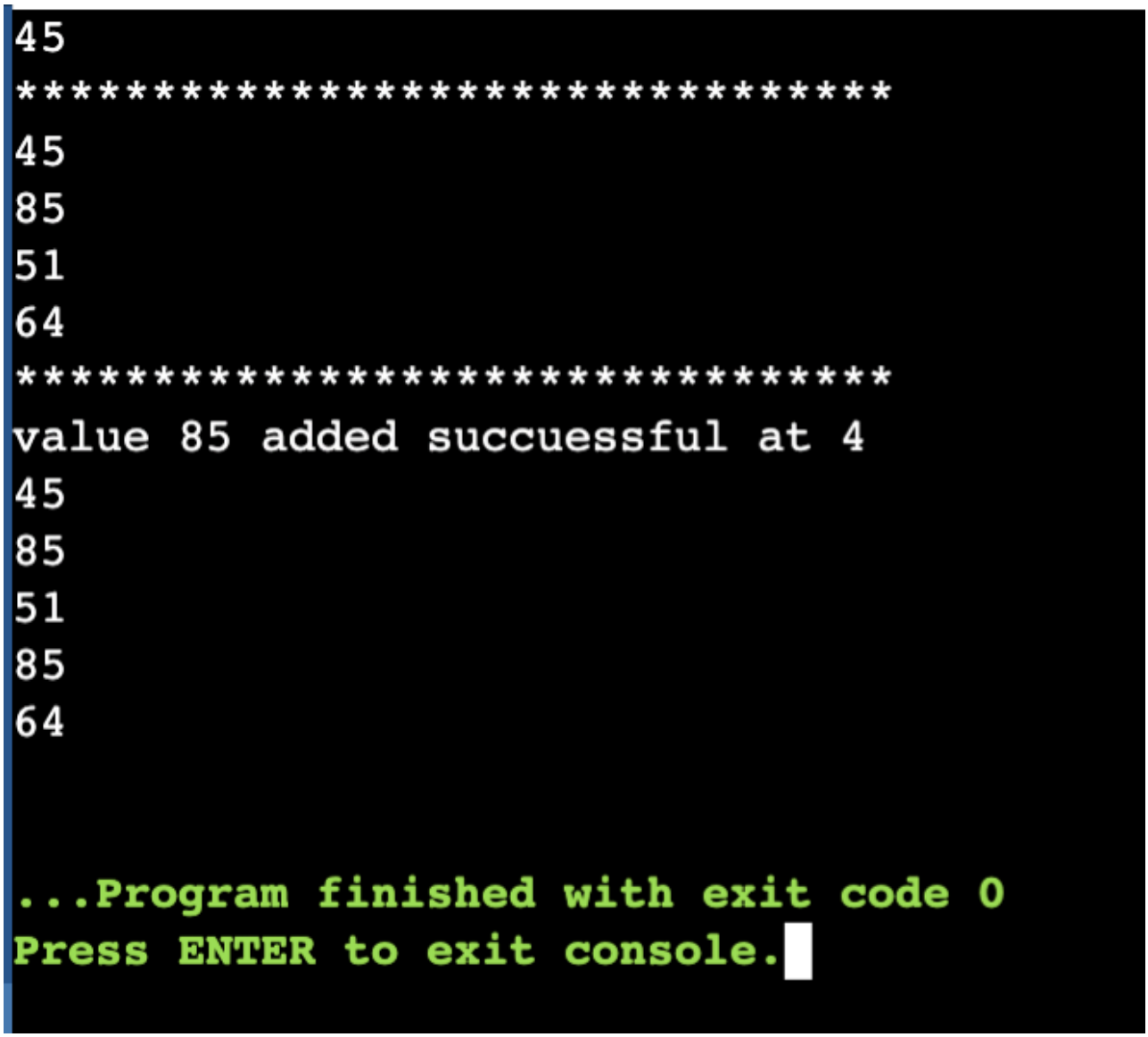
Display the contents of the linked list.

CODE

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
int data;
struct node *next;
};
void printData(struct node *head)
{
if(head==NULL)
{
printf("The list is empty");
}else{
struct node *ptr=head;
while(ptr!=NULL)
{
printf("%d\n",ptr->data);
ptr=ptr->next;
}}
}
void insertBeg(struct node **head,int value)
{
struct node *temp=(struct node*)malloc(sizeof(struct node));
temp->data=value;
temp->next=*head;
*head=temp;
}
void insertEnd(struct node*head, int value)
{
struct node *ptr=head;
```

```
struct node *temp=(struct node*)malloc(sizeof(struct node));
temp->data=value;
temp->next=NULL;
while(ptr->next!=NULL){
ptr=ptr->next;
}
ptr->next=temp;
}
void insertAtPos(struct node *head,int value,int pos)
{
struct node *ptr,*ptr2;
struct node *temp=(struct node*)malloc(sizeof(struct node));
temp->data=value;
temp->next=NULL;
int position=pos;
ptr=head;
while(pos!=1)
{
ptr2=ptr;
ptr=ptr->next;
pos--;
}
temp->next=ptr2->next;
ptr2->next=temp;
printf("value %d added succuessful at %d\n",value,position);
}
int main()
{
struct node *head=NULL;
insertBeg(&head,34);
printData(head);
printf("-----------------------------\n");
insertEnd(head,75);
insertEnd(head,56);
insertEnd(head,87);
printData(head);
printf("-----------------------------\n");
insertAtPos(head,89,3);
printData(head);
}
```

OUTPUT


45
****
45
85
51
64
****
value 85 added succuessful at 4
45
85
51
85
64
...Program finished with exit code 0
Press ENTER to exit console.

LAB PROGRAM 6

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.

CODE

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

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

struct node *head = NULL, *newnode, *temp;

void create() {
    int i, n;
    printf("Enter the number of elements: ");
    scanf("%d", &n);

    for (i = 0; i < n; i++) {
        newnode = (struct node *)malloc(sizeof(struct node));
        printf("Enter the element %d: ", i + 1);
        scanf("%d", &newnode->data);
        newnode->next = NULL;

        if (head == NULL) {
            temp = head = newnode;
        } else {
            temp->next = newnode;
            temp = newnode;
        }
    }
}

void display() {
    temp = head;
    printf("The elements are:\n");
    while (temp != NULL) {
        printf("%d\n", temp->data);
        temp = temp->next;
    }
}

void delete_beg() {
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }
```

```
    temp = head;
    head = temp->next;
    free(temp);
}

void delete_end() {
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }
    temp = head;
    struct node *prevnode = NULL;
    while (temp->next != NULL) {
        prevnode = temp;
        temp = temp->next;
    }
    if (prevnode == NULL) {
        head = NULL;
    } else {
        prevnode->next = NULL;
    }
    free(temp);
}

void delete_pos() {
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }
    int pos, i = 1;
    printf("Enter the position: ");
    scanf("%d", &pos);
    temp = head;
    struct node *prevnode = NULL;
    while (i < pos && temp != NULL) {
        prevnode = temp;
        temp = temp->next;
        i++;
    }
    if (temp == NULL) {
        printf("Position out of range\n");
        return;
    }
    if (prevnode == NULL) {
        head = temp->next;
    } else {
        prevnode->next = temp->next;
    }
    free(temp);
}

int main() {
    int choice;
```

```
    while (1) {
        printf("\nEnter operation:\n1. Create\n2. Display\n3. Delete at beginning\n4. Delete at end\n5.
Delete at position\n6. -1 to end\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        if (choice == -1) {
            printf("Operation completed!\n");
            break;
        } else {
            switch (choice) {
                case 1:
                    create();
                    break;
                case 2:
                    display();
                    break;
                case 3:
                    delete_beg();
                    break;
                case 4:
                    delete_end();
                    break;
                case 5:
                    delete_pos();
                    break;
                default:
                    printf("Invalid output\n");
            }
        }
    }

    return 0;
}
```

OUTPUT

```
Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 1
Enter the number of elements: 3
Enter the element 1: 12
Enter the element 2: 13
Enter the element 3: 14

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 3

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 5
Enter the position: 2

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 2
The elements are:
13

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 4

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 2
The elements are:
```

```
Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 2
The elements are:
13

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 4

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: 2
The elements are:

Enter operation:
1. Create
2. Display
3. Delete at beginning
4. Delete at end
5. Delete at position
6. -1 to end
Enter your choice: -1
Operation completed!


...Program finished with exit code 0
Press ENTER to exit console.
```

LAB PROGRAM 7

All-sort,reverse,concatenation.

CODE

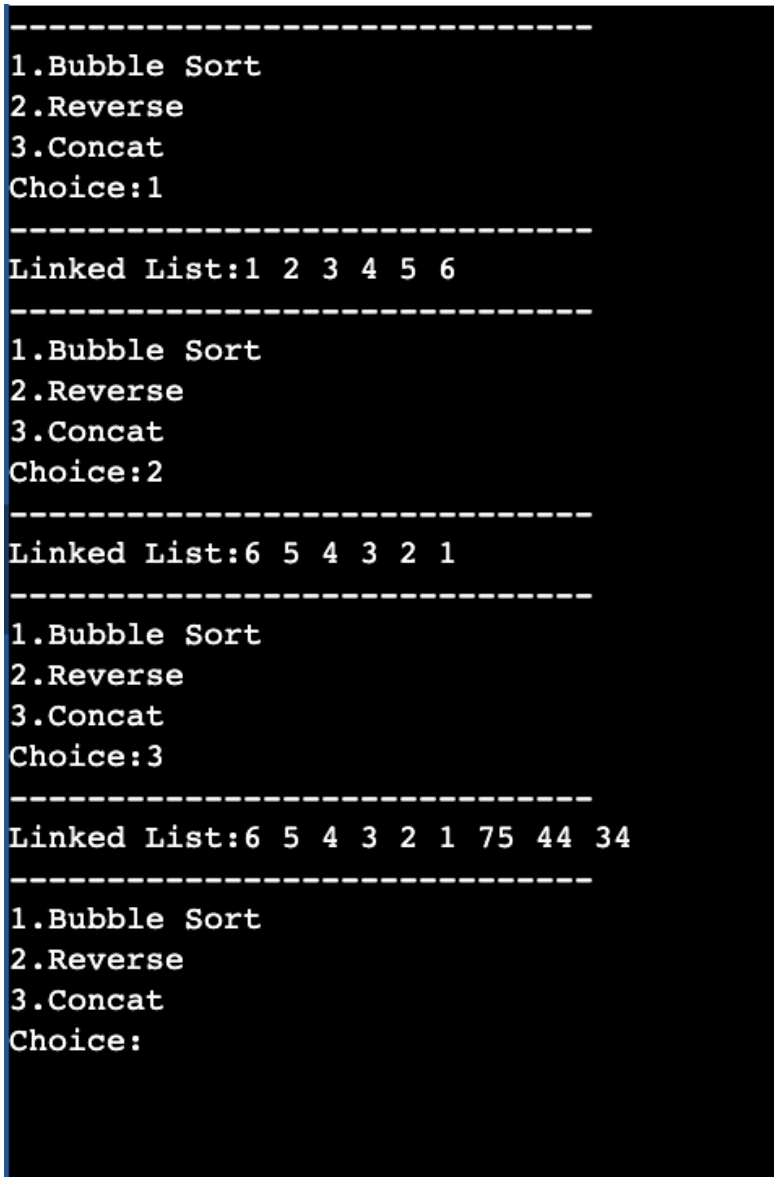
```
#include <stdio.h>
#include <stdlib.h>

struct node
{
    int data;
    struct node *next;

};

void append(struct node **head, int new_data)
{
    struct node *new_node = (struct node *)malloc(sizeof(struct node));

    new_node->data = new_data;
    new_node->next = NULL;
    struct node *last = *head;

    if (*head == NULL)
        *head = new_node;
    else
    {
        while (last->next != NULL)
            last = last->next;

        last->next = new_node;
    }
}


void display(struct node *head)
{
    if (head == NULL)
    {
        printf("Linked List empty.\n");
        return;
    }
    printf("Linked List:");
```

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


void bubble_sort(struct node *head)
{
    struct node *prev;
    struct node *cur;
    int nex;
    int flag = 1;
    int flag2 = 1;

    while (flag)
    {
        prev = head;
        while (prev != NULL && prev->next != NULL)
        {
            cur = prev->next;

            if (cur->data < prev->data)
            {
                nex = cur->data;
                cur->data = prev->data;
                prev->data = nex;
            }

            prev = prev->next;
        }

        int max = 0;
        prev = head;

        while (prev != NULL)
        {
            if (max > prev->data)
            {
                flag2 = 0;
                break;
```

```
            }
            max = prev->data;
            prev = prev->next;
        }

        if (flag2)
            flag = 0;
        else
            flag2 = 1;
    }
}

void reverse(struct node **head)
{
    struct node *prev = NULL;
    struct node *current = *head;
    struct node *next = NULL;

    while (current != NULL)
    {
        next = current->next;
        current->next = prev;


        prev = current;
        current = next;
    }

    *head = prev;
}

void concat(struct node *head1,struct node *head2){
    struct node *prev=head2;

    while(prev!=NULL){
                append(&head1,prev->data);
        prev=prev->next;
    }
}

int main()
{
    struct node *head=NULL;
```

```
    int choice;
    append(&head,5);
    append(&head,2);
    append(&head,3);
    append(&head,4);
    append(&head,1);
    append(&head,6);
    struct node *head2=NULL;

  while (1)
    {
        printf("-----------------------------\n");
        printf("1.Bubble Sort\n2.Reverse\n3.Concat\nChoice:");
        scanf("%d",&choice);
        printf("-----------------------------\n");
        switch (choice)
        {
            case 1:bubble_sort(head);
                   display(head);

                   break;
            case 2: reverse(&head);
                    display(head);
                    break;

            case 3:
                    append(&head2,76);
                    append(&head2,43);
                    append(&head2,34);

                    concat(head,head2);
                    display(head);
                    break;

        }
    }
    return 0;
}
```

OUTPUT


1.Bubble Sort
2.Reverse
3.Concat
Choice:1
Linked List:1 2 3 4 5 6
1.Bubble Sort
2.Reverse
3.Concat
Choice:2
Linked List:6 5 4 3 2 1
1.Bubble Sort
2.Reverse
3.Concat
Choice:3
Linked List:6 5 4 3 2 1 75 44 34
1.Bubble Sort
2.Reverse
3.Concat
Choice:

LAB PROGRAM 8

Stack implementation using single linked list

CODE

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

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

void append(struct node** head, int new_data) {
    struct node* new_node = (struct node*)malloc(sizeof(struct node));
    if (new_node == NULL) {
        printf("Memory allocation failed.\n");
        return;
    }

    new_node->data = new_data;
    new_node->next = NULL;

    if (*head == NULL)
        *head = new_node;
    else {
        struct node* last = *head;
        while (last->next != NULL)
            last = last->next;

        last->next = new_node;
    }
}

void display(struct node* head) {
    if (head == NULL) {
        printf("Linked List empty.\n");
        return;
    }

    printf("Stack: ");
    while (head != NULL) {
        printf("%d ", head->data);
```

```
        head = head->next;
    }
    printf("\n");
}

void del_end(struct node** head) {
    if (*head == NULL) {
        printf("List Empty\n");
        return;
    }
    struct node* last = *head;
    struct node* prev = NULL;
    while (last->next != NULL) {
        prev = last;
        last = last->next;
    }
    if (prev != NULL)
        prev->next = NULL;
    free(last);
}

int main() {
    struct node* head = NULL;
    int choice, value;

    do {
        printf("1. Push\n2. Pop\n3. Display\n4. Exit\nChoice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                printf("Enter value: ");
                scanf("%d", &value);
                append(&head, value);
                display(head);
                break;
            case 2:
                del_end(&head);
                display(head);
                break;
            case 3:
                display(head);
                break;
            case 4:
```

```
            printf("Exiting program.\n");
            break;
        default:
            printf("Invalid choice\n");
    }
} while (choice != 4);

    return 0;
}
```

OUTPUT

```
/tmp/XB0zfdXbH5.o
1. Push
2. Pop
3. Display
4. Exit
Choice: 1
Enter value: 25
Stack: 25
1. Push
2. Pop
3. Display
4. Exit
Choice: 1
Enter value: 35
Stack: 25 35
1. Push
2. Pop
3. Display
4. Exit
Choice: 2
Stack: 25
1. Push
2. Pop
3. Display
4. Exit
Choice: 3
Stack: 25
1. Push
2. Pop
3. Display
4. Exit
Choice: 4
Exiting program.
```

LAB PROGRAM 8

Queue implementation using single linked list

CODE

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


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


struct Queue {
struct Node* front;
struct Node* rear;
};


struct Node* createNode(int data) {
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
if (newNode == NULL) {
printf("Memory allocation failed.\n");
exit(EXIT_FAILURE);
}
newNode->data = data;
newNode->next = NULL;
return newNode;
}


struct Queue* initializeQueue() {
struct Queue* queue = (struct Queue*)malloc(sizeof(struct Queue));
if (queue == NULL) {
printf("Memory allocation failed.\n");
exit(EXIT_FAILURE);
}
queue->front = queue->rear = NULL;
return queue;
}


void enqueue(struct Queue* queue, int data) {
struct Node* newNode = createNode(data);

if (queue->rear == NULL) {
queue->front = queue->rear = newNode;
return;
}

queue->rear->next = newNode;
queue->rear = newNode;
}
```

```
void dequeue(struct Queue* queue) {
if (queue->front == NULL) {
printf("Queue underflow. Cannot dequeue.\n");
return;
}

struct Node* temp = queue->front;
queue->front = queue->front->next;


if (queue->front == NULL) {
queue->rear = NULL;
}

free(temp);
}


void displayQueue(struct Queue* queue) {
if (queue->front == NULL) {
printf("Queue is empty.\n");
return;
}

struct Node* current = queue->front;
printf("Queue: ");
while (current != NULL) {
printf("%d ", current->data);
current = current->next;
}
printf("\n");
}


void freeQueue(struct Queue* queue) {
while (queue->front != NULL) {
struct Node* temp = queue->front;
queue->front = queue->front->next;
free(temp);
}
free(queue);
}

int main() {
struct Queue* queue = initializeQueue();
int choice, data;

do {
printf("\nMenu:\n");
printf("1. Enqueue\n");
printf("2. Dequeue\n");
printf("3. Display\n");
printf("4. Exit\n");

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

```
switch (choice) {
case 1:
printf("Enter data to enqueue: ");
scanf("%d", &data);
enqueue(queue, data);
break;

case 2:
dequeue(queue);
break;

case 3:
displayQueue(queue);
break;

case 4:
printf("Exiting the program.\n");
break;

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

} while (choice != 4);

freeQueue(queue);

return 0;
}
```

OUTPUT

```
/tmp/XB0zfdXbH5.o

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 100

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 200

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue: 200

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
```

LAB PROGRAM 9
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

CODE

```
#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

```
/tmp/XB0zfdXbH5.o
1. Insert
2. Delete
3. Exit
Choice: 1
Enter data and position: 25
0
Count: 1
Linked List: 25
Enter choice: 1
Enter data and position: 35
1
Count: 2
Linked List: 25 35
Enter choice: 2
Enter element: 25
Count: 1
Linked List: 35
Enter choice: 3
```

LAB PROGRAM 10

Tree Program(inorder, postorder, preorder)

CODE

```
#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

```
/tmp/XB0zfdXbH5.o
1. Preorder
2. Inorder
3. Postorder
4. Exit
Choice: 1
8 3 1 6 4 7 10 14 13
Enter choice: 2
1 3 4 6 7 8 10 13 14
Enter choice:
3
1 4 7 6 3 13 14 10 8
Enter choice: 4
```

LAB PROGRAM 11
BFS & DFS

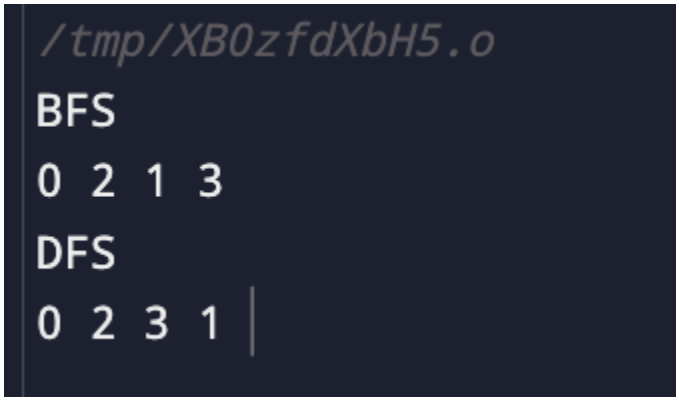
CODE

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_SIZE 100
struct Node {
int data;
struct Node* next;
};
struct Graph {
int numVertices;
struct Node** adjLists;
int* visited;
};
struct Node* createNode(int data) {
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
newNode->data = data;
newNode->next = NULL;
return newNode;
}
struct Graph* createGraph(int numVertices) {
struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
graph->numVertices = numVertices;
graph->adjLists = (struct Node*)malloc(numVertices * sizeof(struct Node));
graph->visited = (int*)malloc(numVertices * sizeof(int));
for (int i = 0; i < numVertices; i++) {
graph->adjLists[i] = NULL;
graph->visited[i] = 0;
}
return graph;
}
void addEdge(struct Graph* graph, int src, int dest) {
struct Node* newNode = createNode(dest);
```

```
newNode->next = graph->adjLists[src];
graph->adjLists[src] = newNode;
newNode = createNode(src);
newNode->next = graph->adjLists[dest];
graph->adjLists[dest] = newNode;
}
void BFS(struct Graph* graph, int startVertex) {
int queue[MAX_SIZE];
int front = -1, rear = -1;
graph->visited[startVertex] = 1;
queue[++rear] = startVertex;
while (front != rear) {
int currentVertex = queue[++front];
printf("%d ", currentVertex);
struct Node* temp = graph->adjLists[currentVertex];
while (temp) {
int adjVertex = temp->data;
if(graph->visited[adjVertex] == 0) {
graph->visited[adjVertex] = 1;
queue[++rear] = adjVertex;
}
temp = temp->next;
}
}
}
void DFS(struct Graph* graph, int vertex) {
graph->visited[vertex] = 1;
printf("%d ", vertex);
struct Node* temp = graph->adjLists[vertex];
while (temp) {
int adjVertex = temp->data;
if (graph->visited[adjVertex] == 0) {
DFS(graph, adjVertex);
}
temp = temp->next;
}
}
int main(){
struct Graph* graph = createGraph(4);
addEdge(graph, 0, 1);
addEdge(graph, 0, 2);
addEdge(graph, 1, 2);
```

```
addEdge(graph, 2, 3);
printf("BFS\n");
BFS(graph, 0);
for (int i = 0; i < graph->numVertices; i++){
graph->visited[i] = 0;
}
printf("\nDFS\n");
DFS(graph, 0);
return 0;
}
```

OUTPUT



LAB PROGRAM 12

Balanced Parentheses(LeetCode)

CODE

```
#include <stdio.h>
#include <string.h>
int scoreOfParentheses(char *s)
{
    int stack[50];
    int top = -1;
    int score = 0;
    for (int i = 0; s[i] != '\0'; i++)
    {
        if (s[i] == '(')
        {
            stack[++top] = score;
            score = 0;
        }
        else
        {
            score = stack[top--] + (score == 0 ? 1 : 2 * score);
        }
    }
    return score;
}
```

OUTPUT

LAB PROGRAM 13

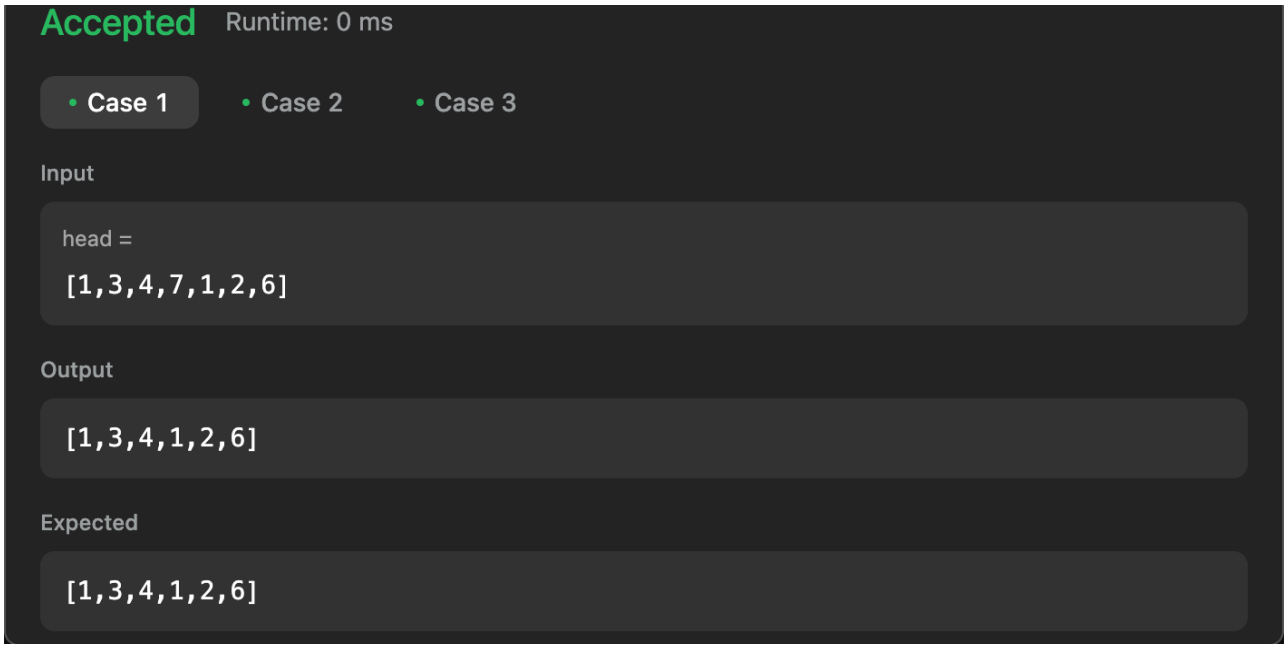
Delete the Middle Node of a Linked List(LeetCode)

CODE

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


struct Node* deleteMiddle(struct Node* head) {
    if (head == NULL)
        return NULL;
    if (head->next == NULL) {
        free(head);
        return NULL;
    }


    struct Node* slow_ptr = head;
    struct Node* fast_ptr = head;
    struct Node* prev;
```

```
    while (fast_ptr != NULL && fast_ptr->next != NULL) {
        fast_ptr = fast_ptr->next->next;
        prev = slow_ptr;
        slow_ptr = slow_ptr->next;
    }


    prev->next = slow_ptr->next;
    free(slow_ptr);

    return head;
}


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

OUTPUT



LAB PROGRAM 14

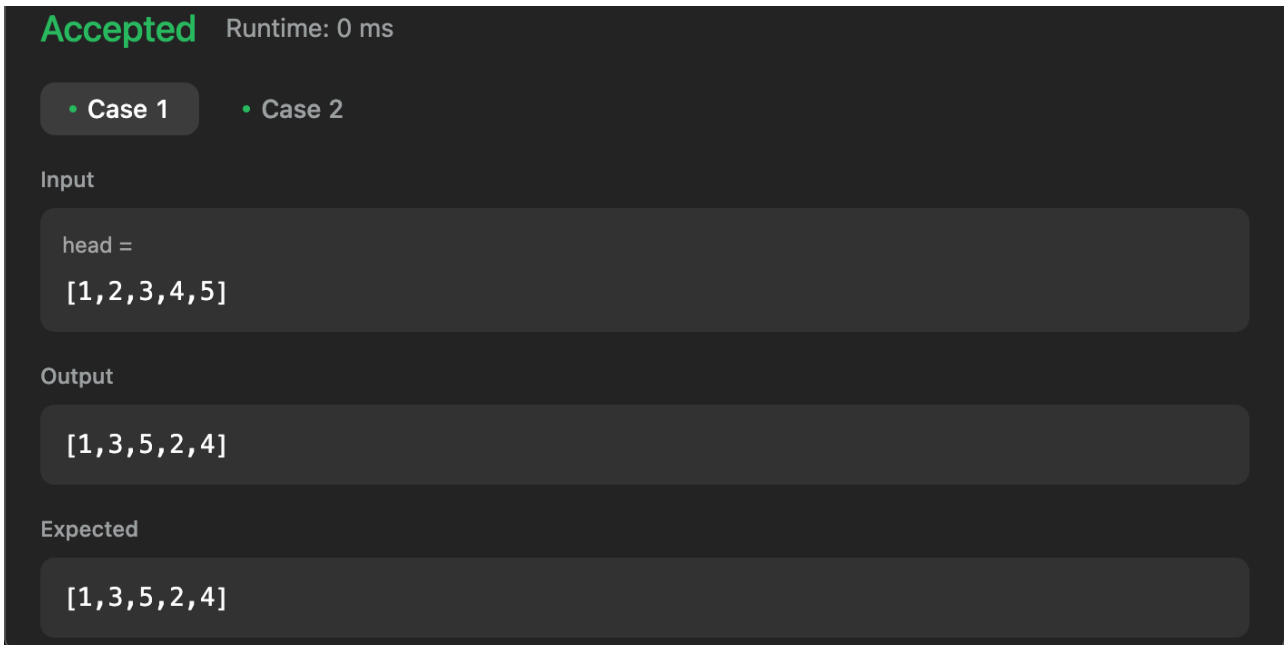
Odd Even Linked List

CODE

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

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

struct ListNode* oddEvenList(struct ListNode* head) {
if (head == NULL || head->next == NULL || head->next->next == NULL)
return head;

struct ListNode *odd = head;
struct ListNode *even = head->next;
struct ListNode *evenHead = even;

while (even != NULL && even->next != NULL) {
odd->next = even->next;
odd = odd->next;
even->next = odd->next;
even = even->next;
}

odd->next = evenHead;
return head;
```

```
}
struct ListNode* newNode(int val)
{
struct ListNode* node = (struct ListNode*)malloc(sizeof(struct ListNode));
node->val = val;
node->next = NULL;
return node;
}
```

OUTPUT



LAB PROGRAM 15

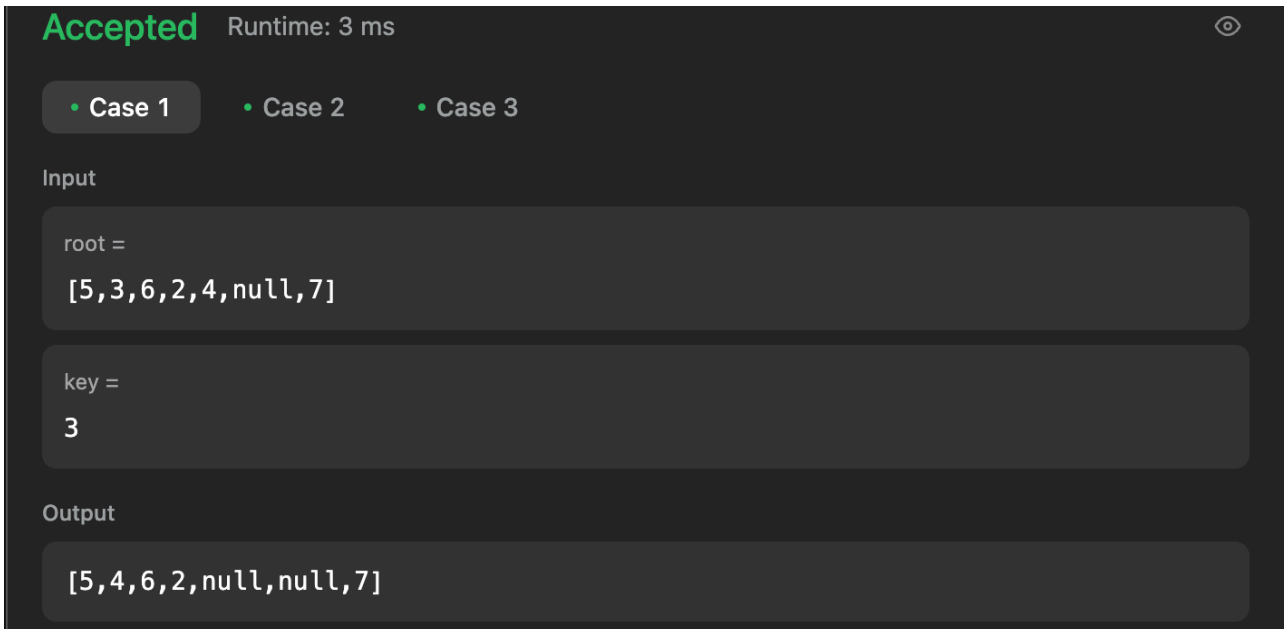
Delete a node in BST .

CODE

```
struct TreeNode* minValueNode(struct TreeNode* node)
{
struct TreeNode* current = node;
while (current && current->left != NULL)
current = current->left;
return current;
}
struct TreeNode* deleteNode(struct TreeNode* root, int key) {
if (root == NULL) return root;
if (key < root->val)
root->left = deleteNode(root->left, key);
else if (key > root->val)
root->right = deleteNode(root->right, key);
else {
if (root->left == NULL) {
struct TreeNode* temp = root->right;
free(root);
return temp;
} else if (root->right == NULL) {
struct TreeNode* temp = root->left;
free(root);
return temp;
}
struct TreeNode* temp = minValueNode(root->right);
```

```
root->val = temp->val;
root->right = deleteNode(root->right, temp->val);
}
return root;
}
```

OUTPUT



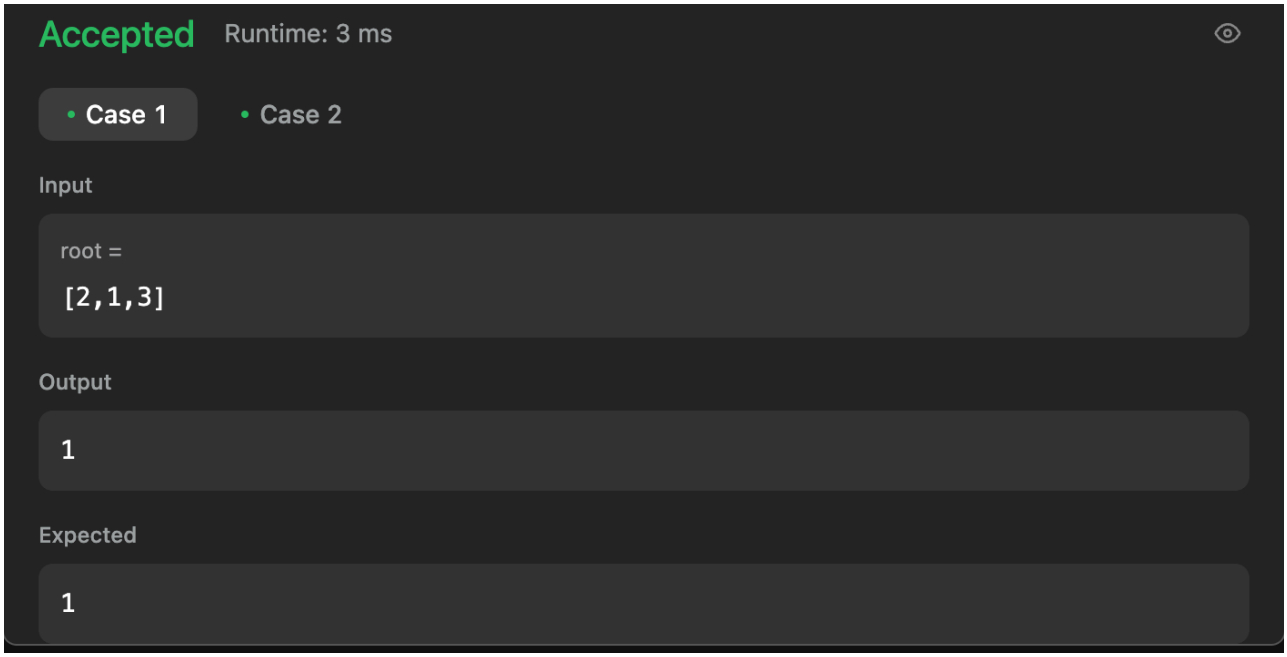
LAB PROGRAM 16

Bottom Left Tree Value.

CODE

```
void findBottomLeft(struct TreeNode* node, int depth, int* maxDepth, int* leftmostValue) {
if (node == NULL)
return;

if (depth > *maxDepth) {
*maxDepth = depth;
*leftmostValue = node->val;
}

findBottomLeft(node->left, depth + 1, maxDepth, leftmostValue);
findBottomLeft(node->right, depth + 1, maxDepth, leftmostValue);
}

int findBottomLeftValue(struct TreeNode* root) {
int maxDepth = 0;
int leftmostValue = root->val;

findBottomLeft(root, 1, &maxDepth, &leftmostValue);

return leftmostValue;
}
```

OUTPUT


Accepted
Runtime: 3 ms
• Case 1
• Case 2
Input
root =
[2,1,3]
Output
1
Expected
1