VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

VEMULA DHANUSH REDDY (1BM22CS324)

in partial fulfillment for the award of the degree of
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **" DATA STRUCTURES "** carried out by **VEMULA DHANUSH REDDY (1BM22CS324)**, 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.

Surabhi S
Assistant Professor
Department of CSE
BMSCE, Bengaluru

Dr. Jyothi S Nayak
Professor and Head
Department of CSE
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.

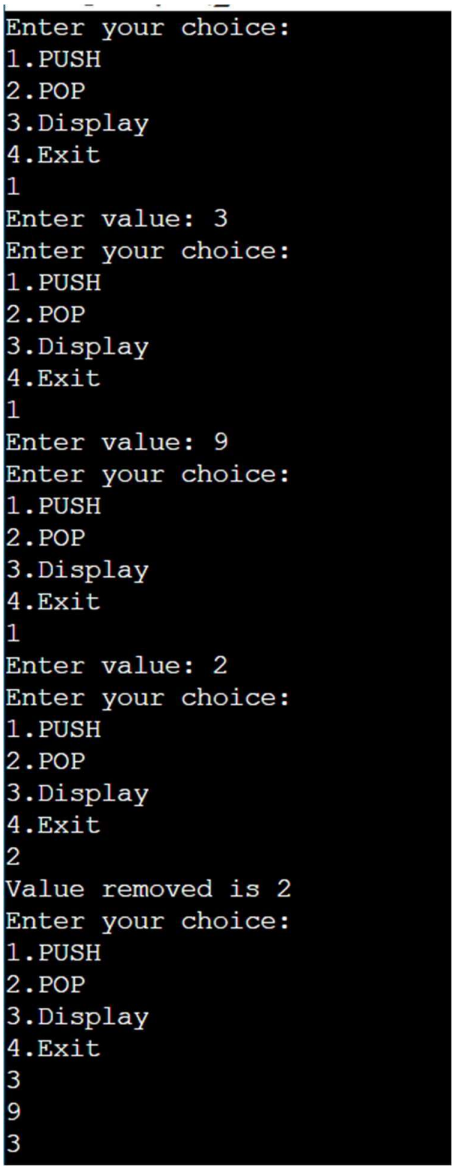
Lab Program 1a: Write a program to implement basic stack operations such as PUSH, POP, and Display.

Code:

```
#include<stdio.h>
#include<ctype.h>
#include <stdlib.h>
#define s 5
int stack[s];
int t=-1;

void PUSH(int a)
{
   if(t==s-1)
      printf("Stack is full");
   else
   {
      t++;
      stack[t]=a;
   }
}
void POP()
{
   if(t==-1)
      printf("Stack is empty");
   else
   {
      printf("Value removed is %d\n",stack[t]);
      t--;
   }
}
void display()
{
   int i;
   for(i=t; i>=0;i--)
      printf("%d\n",stack[i]);
}
int main()
{
   int ch;
   do
   {
      printf("Enter your choice:\n1.PUSH\n2.POP\n3.Display\n4.Exit\n");
      scanf("%d",&ch);
      switch(ch)
      {
         case 1: {
                  printf("Enter value: ");
                  int n;
```

```
                scanf("%d",&n);
                PUSH(n);
            }break;
        case 2: POP(); break;
        case 3: display(); break;
        case 4: exit(0);
      }
   }while(1);
   return 0;
}
```

Output:



Lab Program 1b:

Write a program 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 <ctype.h>
#define SIZE 50
char stack[SIZE];
int top=-1;

void push(char elem)
{
        stack [++top]=elem;
}

char pop()
{
        return(stack [top--]);
}
int pr(char symbol)
{
        if (symbol == '^')
        {
                return(3);
        }
        else if(symbol=='*' || symbol=='/')
        {
                return(2);
        }
        else if(symbol == '+' || symbol == '-')
        {
                return(1);
        }
        else
        {
                return(0);
        }
}
void main()
{
        char infix[50], postfix[50],ch,elem;
        int i=0,k=0;
        printf("Enter Infix Expression : ");
        scanf("%s", infix);
        push('#');
        while ((ch=infix[i++]) != '\0')
        {
```

```
            if( ch == '(')
                    push(ch);
            else if(isalnum(ch))
                    postfix[k++]=ch;
            else
            {
                    if( ch == ')')
                    {
                        while (stack[top] != '(')
                        postfix[k++]=pop();
                        elem=pop();
                    }
                    else
                    {
                       while( pr(stack [top]) >= pr(ch) )
                       postfix [k++]=pop();
                       push(ch);
                    }
            }
        }
        while (stack[top] != '#')
                 postfix[k++]=pop();
        postfix[k]='\0';
        printf("\nPostfix Expression = %s\n", postfix);
}
```

Output:

```
Enter Infix Expression : A+B*C-D+H*I

Postfix Expression = ABC*+D-HI*+
```

Lab Program 2a: Write a program 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

Code:

```
#include<stdio.h>
#include<ctype.h>
#include <stdlib.h>
#define s 5
int queue[s], f=-1, r=-1;

int isfull()
{
   if(f==(s-1))
      return 1;
   else
      return 0;
}
int isempty()
{
   if(f==-1||r==-1)
      return 1;
   else
      return 0;
}
void insert()
{
   int i;
   printf("Enter value: ");
   scanf("%d",&i);
   if(isfull())
      printf("Queue is full");
   else if(f==-1)
   {
      f=0;
      r=0;
   }
   else
      r=r+1;
   queue[r]=i;
}
void qdelete()
{
   if(isempty())
      printf("Queue is empty");
   else if(f==r)
   {
      f=-1;
      r=-1;
   }
```

```
    else
    {
        printf("Value removed is %d\n",queue[f]);
        f=f+1;
    }
}
void display()
{
    int i;
    if(isempty())
        printf("Queue is empty");
    else
    {
        printf("Queue is: ");
        for(i=f; i<=r;i++)
            printf("%d\t",queue[i]);
        printf("\n");
    }
}
int main()
{
    int ch;
    while(1)
    {
        printf("Enter your choice:\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1: insert(); break;
            case 2: qdelete(); break;
            case 3: display(); break;
            case 4: {
                        printf("Name: Amrutha Ravi \tUSN:1BM22CS036");
                        exit(0);
                    }
        }
    }
    return 0;
}
```

Output:

```
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
1
Enter value: 1
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
1
Enter value: 3
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
1
Enter value: 5
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
3
Queue is: 1     3       5
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
2
Value removed is 1
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
3
Queue is: 3     5
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
4

Process returned 0 (0x0)   execution time : 11.359 s
Press any key to continue.
```

Lab Program 2b: WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions.

Code:

```
#include<stdio.h>
#include<ctype.h>
#include <stdlib.h>
#define s 5
int queue[s], f=-1, r=-1;

int isfull()
{
   if(f==(r+1)||f==0 && r==(s-1))
      return 1;
   else
      return 0;
}
int isempty()
{
   if(f==-1||f>r)
      return 1;
   else
      return 0;
}
void insert()
{
   int i;
   printf("Enter value: ");
   scanf("%d",&i);
   if(isfull())
      printf("Queue is full");
   else if(isempty())
   {
      f=0;
      r=0;
   }
   else
      r=(r+1)%s;
   queue[r]=i;
}
void qdelete()
{
   if(isempty())
      printf("Queue is empty");
   else if(f==r)
   {
      f=-1;
      r=-1;
```

```
    }
    else
    {
        printf("Value removed is %d\n",queue[f]);
        f=(f+1)%s;
    }
}
void display()
{
    int i;
    if(isempty())
        printf("Queue is empty");
    else
    {
        printf("Queue is: ");
        for(i=f; i!=r;i=(i+1)%s)
            printf("%d\t",queue[i]);
        printf("%d",queue[i]);
        printf("\n");
    }
}
int main()
{
    int ch;
    while(1)
    {
        printf("Enter your choice:\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1: insert(); break;
            case 2: qdelete(); break;
            case 3: display(); break;
            case 4: {
                        exit(0);
                    }
        }
    }
    return 0;
}
```

Output:

```
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
1
Enter value: 3
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
3
Queue is: 5     7       3
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
2
Value removed is 5
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
1
Enter value: 7
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
3
Queue is: 7     3       7
Enter your choice:
1.Insert
2.Delete
3.Display
4.Exit
4
```

Lab Program 3a: Write a program to implement Singly Linked List with the following operations

d. **Create a linked list.**
e. **Insertion of a node at the first position, at any position, and at the end of the list.**
f. **Display the contents of the linked list.**

Code:

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

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

struct node *createnode(int val) {
   struct node *newnode = (struct node*)malloc(sizeof(struct node));
   newnode->data = val;
   newnode->next = NULL;
   return newnode;
}

void insert_beg(struct node **head, int val) {
   struct node *newnode = createnode(val);
   newnode->next = *head;
   *head = newnode;
}

void insert_end(struct node *head, int val) {
   struct node *newnode = createnode(val);
   struct node *temp = head;
   while (temp->next != NULL) {
      temp = temp->next;
   }
   temp->next = newnode;
}

void insert_at_pos(struct node *head, int val, int pos) {
   struct node *newnode = createnode(val);
   struct node *temp = head;
   for (int i = 1; i < pos - 1 && temp != NULL; i++) {
      temp = temp->next;
   }
   if (temp != NULL) {
      newnode->next = temp->next;
      temp->next = newnode;
   } else {
      printf("Invalid Position\n");
   }
```

```
}

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

int main() {
   struct node *head = NULL;
   insert_beg(&head, 1);
   display(head);
   insert_end(head, 3);
   display(head);
   insert_at_pos(head, 2, 2);
   display(head);
   return 0;
}
```

Output:

```
1 NULL
1 3 NULL
1 2 3 NULL

Process returned 0 (0x0)   execution time : 0.031 s
Press any key to continue.
```

Lab Program 3b: Write a program to implement a Singly Linked List with the following operations: deletion of the 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 *createnode(int val) {
   struct node *newnode = (struct node*)malloc(sizeof(struct node));
   newnode->data = val;
   newnode->next = NULL;
   return newnode;
}

void insert_beg(struct node **head, int val) {
   struct node *newnode = createnode(val);
   newnode->next = *head;
   *head = newnode;
}

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

void delete_beg(struct node **head)
{
   if(*head==NULL)
   {
      printf("Empty list");
   }
   else
   {
      struct node *temp=*head;
      *head=(*head)->next;
      free(temp);
   }
}
```

```
void delete_end(struct node **head)
{
   if(*head==NULL)
   {
      printf("Empty list");
   }
   else if ((*head)->next==NULL)
   {
      free(*head);
      return NULL;
   }
   else
   {
      struct node*temp=*head;
      struct node*p=NULL;
      while(temp->next!=NULL)
      {
         p=temp;
         temp=temp->next;
      }
      free(temp);
      p->next=NULL;
   }
}

void delete_val(struct node **head,int val)
{
   struct node *temp=*head;
   struct node* p= NULL;
   while(temp!=NULL&&temp->data!=val)
   {
      p=temp;
      temp=temp->next;
   }
   if(temp!=NULL)
   {
      if(p==NULL)
      {
         *head=(*head)->next;
      }
      else
      {
         p->next=temp->next;
      }
      free(temp);
   }
   else{
      printf("Element %d not found",val);
   }
}
```

```
int main() {
   struct node *head = NULL;
   insert_beg(&head, 5);
   insert_beg(&head,  4);
   insert_beg(&head,  3);
   insert_beg(&head,  2);
   insert_beg(&head,  1);

   display(head);

   delete_beg(&head);
   delete_end(&head);
   delete_val(&head,3);
   display(head);
   return 0;
```

Output:

```
1 2 3 4 5 NULL
2 4 NULL

Process returned 0 (0x0)   execution time : 0.030 s
Press any key to continue.
```

Lab Program 4a: Write a program to implement a Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

Code:

```
#include<stdio.h>
#include<stdlib.h>
struct node {
   int data;
   struct node *next;
};
void display(struct node *head)
{
   struct node *ptr = head;
   while (ptr != NULL)
   {
      printf("%d\t", ptr->data);
      ptr = ptr->next;
   }
   printf("\n");
}
void sort(struct node **head)
{
   if (*head == NULL)
      return;
   struct node *current, *next;
   int temp;
   current = *head;
   while (current->next != NULL)
   {
      next = current->next;
      while (next != NULL)
      {
         if (current->data > next->data)
         {
            temp = current->data;
            current->data = next->data;
            next->data = temp;
         }
         next = next->next;
      }
      current = current->next;
   }
}
void reverse(struct node **head)
{
   struct node *cur=*head, *prev=NULL, *next=NULL;
   while(cur!=NULL)
   {
      next=cur->next;
```

```
        cur->next=prev;
        prev=cur;
        cur=next;
    }
    *head=prev;
}
struct node *concatenate(struct node **head1, struct node **head2)
{
    if (*head1 == NULL)
    {
        *head1 = *head2;
        return *head1;
    }
    if (*head2 == NULL)
        return *head1;
    struct node *temp = *head1;
    while (temp->next != NULL)
        temp = temp->next;
    temp->next = *head2;
    return *head1;
}
void PUSH(struct node **head)
{
    struct node *node = (struct node*)malloc(sizeof(struct node));
    if (node == NULL)
    {
        printf("Overflow\n");
        exit(1);
    }
    int n;
    printf("Enter value: ");
    scanf("%d", &n);
    node->data = n;
    node->next = *head;
    *head = node;
}
int main()
{
    struct node *head1 = NULL, *head2 = NULL;
    int ch;
    printf("Creating list 1\nEnter no. of elements: ");
    int n, i;
    scanf("%d",  &n);
    for (i = 0; i < n; i++)
        PUSH(&head1);
    printf("List 1: ");
    display(head1);
    sort(&head1);
    printf("Sorted list: ");
    display(head1);
```

```
    reverse(&head1);
    printf("Reversed list: ");
    display(head1);
    printf("Creating list 2\nEnter no. of elements: ");
    int n1, i1;
    scanf("%d", &n1);
    for (i1 = 0; i1 < n1; i1++)
        PUSH(&head2);
    printf("List 2: ");
    display(head2);
    sort(&head2);
    printf("Sorted list: ");
    display(head2);
    reverse(&head2);
    printf("Reversed list: ");
    display(head2);
    printf("Concatenating the 2 lists \n");
    struct node *h = concatenate(&head1, &head2);
    display(h);
    return 0;
}
```

Output:

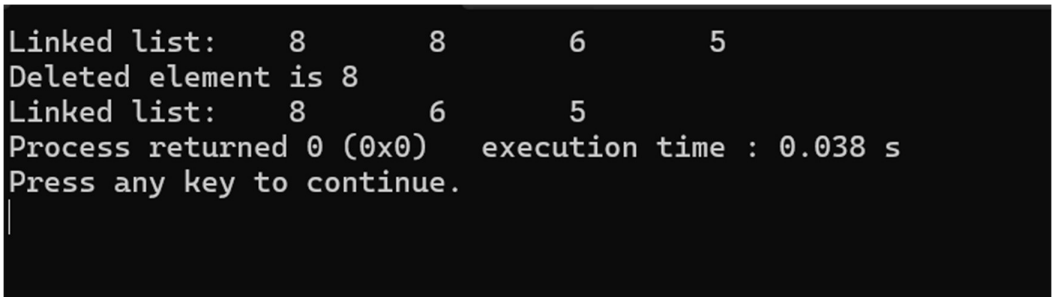
```
Creating list 1
Enter no. of elements: 3
Enter value: 2
Enter value: 4
Enter value: 6
List 1: 6       4       2
Sorted list: 2  4       6
Reversed list: 6        4       2
Creating list 2
Enter no. of elements: 3
Enter value: 3
Enter value: 5
Enter value: 7
List 2: 7       5       3
Sorted list: 3  5       7
Reversed list: 7        5       3
Concatenating the 2 lists
6       4       2       7       5       3
```

Program 4b: Write a program to implement a Single Link List to simulate Stack Operations.

Code:

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

struct node {
   int data;
   struct node *next;
};
struct node *top=NULL;

void push(int x)
{
   struct node * newnode=(struct node *)malloc(sizeof(struct node));
   newnode->data=x;
   newnode->next=top;
   top=newnode;
}

void display()
{
   struct node *temp=top;
   printf("Linked list: ");
   while(temp!=NULL)
   {
      printf("\t%d",temp->data);
      temp=temp->next;
   }
}

void pop()
{
   struct node *temp=top;
   printf("\nDeleted element is %d\n",temp->data);
   top=top->next;
   free(temp);
}
int main()
{
   push(5);
   push(6);
   push(8);
   push(8);
   display();
   pop();
   display();
}
```

Output:


Linked list: 8 8 6 5
Deleted element is 8
Linked list: 8 6 5
Process returned 0 (0x0) execution time : 0.038 s
Press any key to continue.

Program 4c: Write a program to implement a Single Link List to simulate Queue Operations.

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

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

struct node * front=0;
struct node * rear=0;

void enqueue(int x)
{
   struct node * newnode = (struct node*)malloc(sizeof(struct node));
   newnode->data=x;
   newnode->next=NULL;
   if(front==0&&rear==0)
   {
      front=rear=newnode;
   }
   else
   {
      rear->next=newnode;
      rear=newnode;
   }
}

void displayq()
{
   struct node * temp=front;
   while(temp!=0)
   {
      printf("\t%d",temp->data);
      temp=temp->next;
   }
}
void dequeue()
{
   struct node * temp;
   if(front==0&&rear==0)
   {
      printf("Empty");
   }
   else
   {
      temp=front;
```

```
        front=front->next;
        printf("\nDeleted element is %d\n",temp->data);
        free(temp);
    }
}
int main()
{
    enqueue(5);
    enqueue(6);
    enqueue(7);
    displayq();
    dequeue();
    displayq();
}
```

Output:

```
Queue :         5       6       7
Deleted element is : 5
Queue :         6       7
Process returned 0 (0x0)   execution time : 0.031 s
Press any key to continue.
```

Lab Program 5: Write a program to Implement doubly link list with primitive operations

e. **Create a doubly linked list.**
f. **Insert a new node to the left of the node.**
g. **Delete the node based on a specific value**
h. **Display the contents of the list**

Code:

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

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

struct Node* createNode(int value) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = value;
   newNode->prev = NULL;
   newNode->next = NULL;
   return newNode;
}

void insertLeft(struct Node** head, int value, int targetValue) {
   struct Node* newNode = createNode(value);

   if (*head == NULL) {
      *head = newNode;
      return;
   }

   struct Node* current = *head;

   while (current != NULL && current->data != targetValue)
   {
      current = current->next;
   }

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

```
        newNode->next = current;
        current->prev = newNode;
    } else {
        printf("Node with value %d not found.\n", targetValue);
    }
}

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

    struct Node* current = *head;


    while (current != NULL && current->data != value) {
        current = current->next;
    }

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

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

        free(current);
        printf("Node with value %d deleted.\n", value);
    } else {
        printf("Node with value %d not found.\n", value);
    }
}

void display(struct Node* head) {
    struct Node* current = head;

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

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

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


    insertLeft(&head, 3, 0);
    insertLeft(&head, 2, 3);
    insertLeft(&head, 1, 2);

    printf("Initial list: ");
    display(head);

    insertLeft(&head, 4, 3);
    printf("List after insertion: ");
    display(head);


    deleteNode(&head, 2);
    printf("List after deletion: ");
    display(head);

    return 0;
}
```

Output:

```
Initial list: 1 <-> 2 <-> 3 <-> NULL
List after insertion: 1 <-> 2 <-> 4 <-> 3 <-> NULL
Node with value 2 deleted.
List after deletion: 1 <-> 4 <-> 3 <-> NULL

Process returned 0 (0x0)   execution time : 0.013 s
Press any key to continue.
```

Leetcode problem #856: Score Of Parenthesis

Code :

```
int scoreOfParentheses(char* s) {
    int n = strlen(s), ans = 0;
    int d = 0, i = 0;
    while (i < n) {
        if (s[i] == '(') d++;
        else {
            d--;
            if (i > 0 && s[i - 1] == '(') {
                ans += 1 << d;
            }
        }
        i++;
    }
    return ans;
}
```

Output:

Lab Program 6: 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.**

Code:

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

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


struct Node *createNode(int value) {
   struct Node *newNode = (struct Node *)malloc(sizeof(struct Node));
   newNode->data = value;
   newNode->left = newNode->right = NULL;
   return newNode;
}


struct Node *insert(struct Node *root, int value) {
   if (root == NULL) {
      return createNode(value);
   }

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

   return root;
}


void inorderTraversal(struct Node *root) {
   if (root != NULL) {
      inorderTraversal(root->left);
      printf("%d ", root->data);
      inorderTraversal(root->right);
   }
}


void preorderTraversal(struct Node *root) {
```

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


void postorderTraversal(struct Node *root) {
    if (root != NULL) {
        postorderTraversal(root->left);
        postorderTraversal(root->right);
        printf("%d ", root->data);
    }
}


void display(struct Node *root) {
    printf("In-order Traversal: ");
    inorderTraversal(root);
    printf("\n");

    printf("Pre-order Traversal: ");
    preorderTraversal(root);
    printf("\n");

    printf("Post-order Traversal: ");
    postorderTraversal(root);
    printf("\n");
}

int main() {
    struct Node *root = NULL;


    root = insert(root, 50);
    insert(root, 30);
    insert(root, 20);
    insert(root, 40);
    insert(root, 70);
    insert(root, 60);
    insert(root, 80);

    display(root);

    return 0;
}
```

Output:

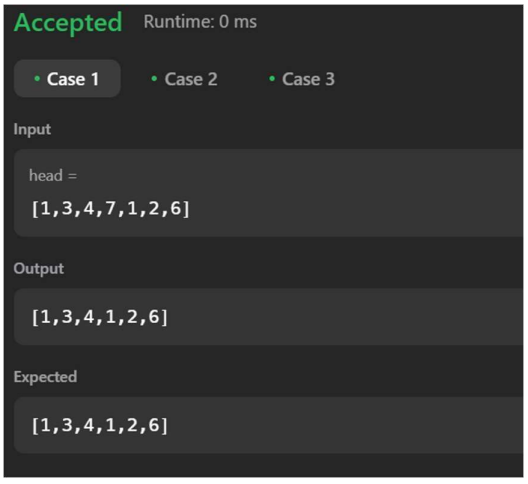
```
In-order Traversal: 20 30 40 50 60 70 80
Pre-order Traversal: 50 30 20 40 70 60 80
Post-order Traversal: 20 40 30 60 80 70 50

Process returned 0 (0x0)   execution time : 0.032 s
Press any key to continue.
```

Leetcode Program 2095 : Delete the middle node of a linked list

Code:

```
 Definition for singly-linked list.
 struct ListNode {
   int val;
   struct ListNode *next;
 };
 struct ListNode* deleteMiddle(struct ListNode* head) {
   if (head == NULL) return NULL;
   struct ListNode* prev = (struct ListNode*)malloc(sizeof(struct ListNode));
   prev->val = 0;
   prev->next = head;
   struct ListNode* slow = prev;
   struct ListNode* fast = head;
   while (fast != NULL && fast->next != NULL) {
      slow = slow->next;
      fast = fast->next->next;
   }
   struct ListNode* temp = slow->next;
   slow->next = slow->next->next;
   free(temp);
   struct ListNode* newHead = prev->next;
   free(prev);
   return newHead;
}
```

Output:

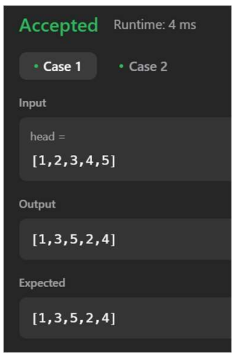


Leetcode Program 328: Odd Even Linked List

Code:

```
 Definition for singly-linked list.
 struct ListNode {
     int val;
     struct ListNode *next;
 };
struct ListNode* oddEvenList(struct ListNode* head) {
   if(head==NULL || head->next==NULL)
      return head;
    struct ListNode* oddH = NULL, *oddT = NULL, *evenH = NULL, *evenT = NULL;
    struct ListNode* curr = head;
      int i = 1;
      while(curr != NULL){
         if(i%2 != 0){
            if(oddH == NULL){
               oddH = curr;
               oddT = curr;
            }
            else{
               oddT -> next = curr;
               oddT = curr;
            }
         }
         else{
            if(evenH == NULL){
               evenH = curr;
               evenT = curr;
            }
            else{
               evenT -> next = curr;
               evenT = curr;
            }
         }
         i++;
         curr = curr -> next;
      }
         evenT -> next = NULL;
         oddT -> next = NULL;
      oddT->next = evenH;
      return oddH;
}
```

Output:



Lab Program 7a: Write a program to traverse a graph using the BFS method.

Code:

```
#include<stdio.h>
#include<conio.h>
void bfs(int a[20][20], int n, int src, int t[20][2], int s[])
{
	int f,r,q[20],u,v,k=0,i;
	for(i=1;i<=n;i++)
		s[i]=0;
	f=r=k=0;
	q[r]=src;
	s[src]=1;
	while(f<=r)
	{
		u=q[f++];
		for(v=1;v<=n;v++)
		{
			if(a[u][v]==1 && s[v]==0)
			{
				s[v]=1;
				q[++r]=v;
				t[k][0]=u;
				t[k][1]=v;
				k++;
			}
		}
	}
}
void main()
{
	int n,a[20][20],src,t[20][2],flag,s[20],i,j;
	printf("Enter the number of nodes\n");
	scanf("%d", &n);
	printf("Enter the adjacency matrix\n");
	for(i=0;i<n;i++)
	{
		for(j=0;j<n;j++)
			scanf("%d", &a[i][j]);
	}
	printf("Enter the source\n");
	scanf("%d", &src);
	bfs(a,n,src,t,s);
	flag=0;
	for(i=0;i<n;i++)
	{
		if(s[i]==0)
		{
			printf("Vertex %d is not reachable\n", i);
```

```
                flag=1;
            }
            else
                printf("Vertex %d is reachable\n", i);
        }
        if(flag==1)
            printf("Some nodes are not visited\n");
        else
        {
            printf("The BFS traversal is\n");
            for(i=0;i<n;i++)
                printf("%d%d\n", t[i][0], t[i][1]);
        }
        getch();
}
```

Output:

```
Enter the number of nodes
4
Enter the adjacency matrix
1 0 1 1
1 0 0 1
1 1 0 1
1 1 1 0
Enter the source
0
Vertex 0 is reachable
Vertex 1 is reachable
Vertex 2 is reachable
Vertex 3 is reachable
The BFS traversal is
02
03
21
00
```

Lab Program 7b: Write a program to check whether a graph is connected or not using the DFS method.

Code:

```
#include<stdio.h>
#include<conio.h>
int a[1][10];
void dfs(int n, int cost[10][10], int u, int s[])
{
        int v;
        s[u]=1;
        for(v=0;v<n;v++)
        {
                if((cost[u][v]==1) && (s[v]==0))
                        dfs(n,cost,v,s);
        }
}
void main()
{
        int n,i,j,cost[10][10],s[10],con,flag;
        printf("Enter the number of nodes\n");
        scanf("%d", &n);
        printf("Enter the adjacency matrix\n");
        for(i=0;i<n;i++)
        {
                for(j=0;j<n;j++)
                        scanf("%d", &cost[i][j]);
        }
        con=0;
        for(j=0;j<n;j++)
        {
                for(i=0;i<n;i++)
                s[i]=0;
                dfs(n,cost,j,s);
                flag=0;
                for(i=0;i<n;i++)
                {
                        if(s[i]==0)
                                flag=1;
                }
                if(flag==0)
                        con=1;
        }
        if(con==1)
                printf("Graph is connected\n");
        else
                printf("Graph is not connected\n");
        getch();
}
```

Output:

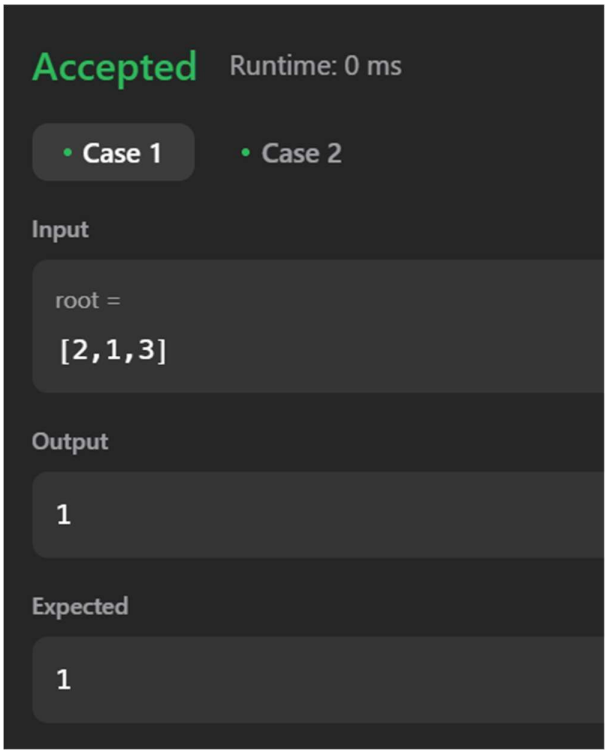
```
Enter the number of nodes
4
Enter the adjacency matrix
1 0 1 1
1 1 0 1
1 1 1 0
1 0 1 1
Graph is connected
```

Leetcode program 513 : Find bottom left Tree value

Code:

```
struct TreeNode {
    int val;
    struct TreeNode *left;
    struct TreeNode *right;
 };
int findBottomLeftValue(struct TreeNode* root) {
      int value=root->val;
       int  mdepth=0;
     void transverse(struct TreeNode* p,int depth){
          if(!p)
             return;
          if(depth>mdepth){
             mdepth=depth;
             value=p->val;
          }
          transverse(p->left,depth+1);
          transverse(p->right,depth+1);
     }
     transverse(root,0);
return value;
}
```

Output:


Accepted
Runtime: 0 ms
• Case 1
• Case 2
Input
root =
[2,1,3]
Output
1
Expected
1

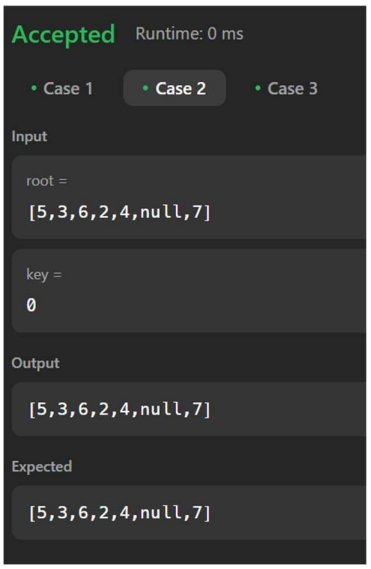

Accepted
Runtime: 0 ms
• Case 1
• Case 2
Input
root =
[1,2,3,4,null,5,6,null,null,7]
Output
7
Expected
7

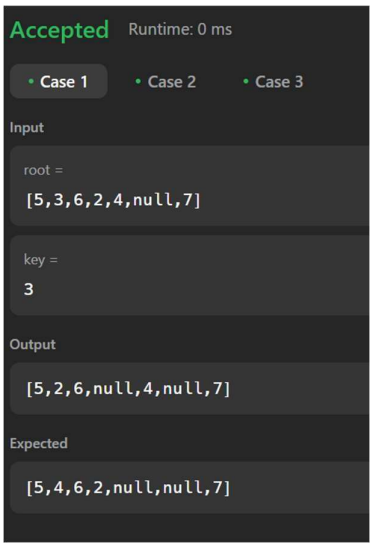
Leetcode problem 450: Delete Node in a BST

Code:

```
 Definition for a binary tree node.
 struct TreeNode {
     int val;
     struct TreeNode *left;
     struct TreeNode *right;
 };
struct TreeNode* deleteNode(struct TreeNode* root, int key) {
    if (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 && !root->right)
                return NULL;
            if (!root->left || !root->right)
                return root->left ? root->left : root->right;
            struct TreeNode* temp = root->left;
            while (temp->right != NULL)
                temp = temp->right;
            root->val = temp->val;
            root->left = deleteNode(root->left, temp->val);
        }
    }
    return root;
}
```

Output :


Accepted
Runtime: 0 ms
• Case 1
• Case 2
• Case 3
Input
root =
[5,3,6,2,4,null,7]
key =
0
Output
[5,3,6,2,4,null,7]
Expected
[5,3,6,2,4,null,7]


Accepted
Runtime: 0 ms
• Case 1
• Case 2
• Case 3
Input
root =
[5,3,6,2,4,null,7]
key =
3
Output
[5,2,6,null,4,null,7]
Expected
[5,4,6,2,null,null,7]


Accepted
Runtime: 0 ms
• Case 1
• Case 2
• Case 3
Input
root =
[]
key =
0
Output
[]
Expected
[]