VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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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

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B.M.S. COLLEGE OF ENGINEERING
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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **VATSAL AMRUTHLING MURAL(1BM22CS323)**, 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.

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Index Sheet

Course outcomes:

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

	data structures.

Lab program 1:

Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display
The program should print appropriate messages for stack overflow, stack underflow.

```
#include <stdio.h>

#include <stdlib.h>



#define STACK_SIZE 5



void push(int st[], int *top) {

int item;

if (*top == STACK_SIZE - 1)

printf("Stack overflow\n");

else {

printf("\nEnter an item: ");

scanf("%d", &item);

(*top)++;

st[*top] = item;

}

}



void pop(int st[], int *top) {

if (*top == -1)

printf("Stack   underflow\n");

else {
```

```
printf("\n%d item was deleted", st[(*top)]);
(*top)--;
}
}

void display(int st[], int *top) {
int i;
if (*top == -1) {
printf("Stack is empty\n");
return;
}
for (i = 0; i <= *top; i++)
printf("%d\t", st[i]);
}

int main() {
int st[STACK_SIZE], top = -1, c;
while (1) {
printf("\n1.  Push\n2.  Pop\n3.  Display\n");
printf("\nEnter your choice: ");
scanf("%d", &c);
switch (c) {
case  1:
push(st, &top);
break;
case 2:
pop(st, &top);
```

```
break;
case 3:
display(st, &top);
break;
default:
printf("\nInvalid choice!!!");
exit(0);
}
}
return 0;
}
```

Output:

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

Enter your choice: 1

Enter an item: 23

1. Push
2. Pop
3. Display

Enter your choice: 1

Enter an item: 34

1. Push
2. Pop
3. Display

Enter your choice: 1

Enter an item: 21

1. Push
2. Pop
3. Display

Enter your choice: 1
```

```
Enter an item: 21

1. Push
2. Pop
3. Display

Enter your choice: 2

21 item was deleted
1. Push
2. Pop
3. Display

Enter your choice: 1

Enter an item: 43

1. Push
2. Pop
3. Display

Enter your choice: 4

Invalid choice!!!
Process returned 0 (0x0)   execution time : 32.209 s
Press any key to continue.
```

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  <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;

}


int 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);

return 0;
}
```

Output:

```
Enter Infix Expression: ACD+(B-C)

Postfix Expression: ACDBC-+

Process returned 0 (0x0)   execution time : 35.229 s
Press any key to continue.
```

Lab program 3a:

WAP to simulate the working of a queue of integers using an array. Provide the following operations

a) Insert

b) Delete

c) Display

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

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

#define MAX_SIZE 5

typedef struct {
int queue[MAX_SIZE];
int front, rear;
int size;
```

```
} Queue;

void initQueue(Queue *q) {
q->front = 0;
q->rear = -1;
q->size = 0;
}

bool isEmpty(Queue *q) {
return q->size == 0;
}

bool isFull(Queue *q) {
return q->size == MAX_SIZE;
}

void enqueue(Queue *q, int item) {
if (isFull(q)) {
printf("Queue Overflow! Cannot insert element.\n");
return;
}
q->rear = (q->rear + 1) % MAX_SIZE;
q->queue[q->rear] = item;
q->size++;
printf("Inserted %d into the queue.\n", item);
}

int dequeue(Queue *q) {
if (isEmpty(q)) {
printf("Queue Underflow! Cannot delete element.\n");
return -1;
}
int item = q->queue[q->front];
q->front++;
q->size--;
printf("Deleted %d from the queue.\n", item);
return item;
}

void display(Queue *q) {
if (isEmpty(q)) {
printf("Queue is empty.\n");
return;
}
printf("Queue elements: ");
for (int i = q->front; i <= q->rear; i++) {
printf("%d ", q->queue[i]);
}
printf("\n");
}
```

```
int main() {
Queue q;
initQueue(&q);

int choice, item;
do {
printf("\n1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
case 1:
if (isFull(&q)) {
printf("Queue Overflow. Cannot enqueue.\n");
} else {
printf("Enter element to enqueue: ");
scanf("%d", &item);
enqueue(&q, item);
}
break;
case 2:
dequeue(&q);
break;
case 3:
display(&q);
break;
case 4:
printf("Exiting...\n");
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 4);
return 0;
}
```

Output:

```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 6
Inserted 6 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 7
Inserted 7 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 4
Inserted 4 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 8
Inserted 8 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 9
Inserted 9 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Queue Overflow. Cannot enqueue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue elements: 6 7 4 8 9

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Queue Overflow. Cannot enqueue.
```

```
4. Exit
Enter your choice: 3
Queue elements: 6 7 4 8 9

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Queue Overflow. Cannot enqueue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 6 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 7 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 4 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 8 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 9 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.
```

Lab program 3b:

WAP to simulate the working of a circular queue of integers using an array. Provide the following operations.

a) Insert

b) Delete

c) Display

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

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

#define MAX_SIZE 5

typedef struct {
int queue[MAX_SIZE];
int front, rear;
int size;
} CircularQueue;

void initQueue(CircularQueue *cq) {
cq->front = 0;
cq->rear = -1;
cq->size = 0;
}

bool isEmpty(CircularQueue *cq) {
return cq->size == 0;
}

bool isFull(CircularQueue *cq) {
return cq->size == MAX_SIZE;
}

void enqueue(CircularQueue *cq, int item) {
if (isFull(cq)) {
printf("Queue Overflow! Cannot insert element.\n");
return;
}
cq->rear = (cq->rear + 1) % MAX_SIZE;
cq->queue[cq->rear] = item;
cq->size++;
printf("Inserted %d into the queue.\n", item);
}
```

```
int dequeue(CircularQueue *cq) {
if (isEmpty(cq)) {
printf("Queue Underflow! Cannot delete element.\n");
return -1;
}
int item = cq->queue[cq->front];
cq->front = (cq->front + 1) % MAX_SIZE;
cq->size--;
printf("Deleted %d from the queue.\n", item);
return item;
}

void display(CircularQueue *cq) {
if (isEmpty(cq)) {
printf("Queue is empty.\n");
return;
}
printf("Queue elements: ");
int i, count;
for (count = 0, i = cq->front; count < cq->size; count++, i = (i + 1) % MAX_SIZE) {
printf("%d ", cq->queue[i]);
}
printf("\n");
}

int main() {
CircularQueue cq;
initQueue(&cq);

int choice, item;
do {
printf("\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
case 1:
printf("Enter element to enqueue: ");
scanf("%d", &item);
enqueue(&cq, item);
break;
case 2:
dequeue(&cq);
break;
case 3:
display(&cq);
break;
case 4:
printf("Exiting...\n");
```

```
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 4);
return 0;
}
```
Output:

```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 3
Inserted 3 into the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 4
Inserted 4 into the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 7
Inserted 7 into the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 8
Inserted 8 into the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 5
Inserted 5 into the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 6
Queue Overflow! Cannot insert element.
```

```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 9
Queue Overflow! Cannot insert element.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 3 from the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 4 from the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 7 from the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 8 from the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 5 from the queue.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.
```

```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue is empty.

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 4
Exiting...

Process returned 0 (0x0)   execution time : 35.708 s
Press any key to continue.
```

Lab program 4:

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.

c) Display the contents of the linked list.

```
#include <stdio.h>

#include  <stdlib.h>


typedef struct Node {

int data;

struct Node *next;

} Node;


Node* createNode(int data) {

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

if (newNode == NULL) {

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

exit(1);
```

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

Node* insertAtBeginning(Node *head, int data) {
Node *newNode = createNode(data);
newNode->next = head;
return newNode;
}

Node* insertAtPosition(Node *head, int data, int position) {
if (position < 1) {
printf("Invalid position!\n");
return head;
}

Node *newNode = createNode(data);

if (position == 1 || head == NULL) {
newNode->next = head;
return newNode;
}

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

```
while (count < position - 1 && current != NULL) {
current = current->next;
count++;
}

if (current == NULL) {
printf("Position out of range!\n");
return head;
}

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

Node* insertAtEnd(Node *head, int data) {
Node *newNode = createNode(data);
if (head == NULL) {
return newNode;
}

Node *current = head;
while (current->next != NULL) {
current = current->next;
}
current->next = newNode;
return head;
```

```
}

void displayList(Node *head) {
if (head == NULL) {
printf("List is empty.\n");
return;
}
Node *current = head;
printf("List elements: ");
while (current != NULL) {
printf("%d ", current->data);
current = current->next;
}
printf("\n");
}

void freeList(Node *head) {
Node *current = head;
Node *temp;
while (current != NULL) {
temp = current;
current = current->next;
free(temp);
}
}

int main() {
```

```
Node *head = NULL;
int choice, data, position;
do {
printf("\n1. Insert at beginning\n2. Insert at position\n3. Insert at end\n4. Display\n5. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);
switch (choice) {
case 1:
printf("Enter data to insert at beginning: ");
scanf("%d", &data);
head = insertAtBeginning(head, data);
break;
case 2:
printf("Enter data to insert: ");
scanf("%d", &data);
printf("Enter position to insert at: ");
scanf("%d", &position);
head = insertAtPosition(head, data, position);
break;
case 3:
printf("Enter data to insert at end: ");
scanf("%d", &data);
head = insertAtEnd(head, data);
break;
case 4:
displayList(head);
break;
```

```
case 5:

freeList(head);

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

break;

default:

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

}

} while (choice != 5);

return 0;

}
```

Output:

```
1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 1
Enter data to insert at beginning: 5

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 1
Enter data to insert at beginning: 8

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 1
Enter data to insert at beginning: 7

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 2
Enter data to insert: 6
Enter position to insert at: 2

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 4
List elements: 7 6 8 5

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 3
Enter data to insert at end: 6
```

```
1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 3
Enter data to insert at end: 5

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 2
Enter data to insert: 8
Enter position to insert at: 5

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 4
List elements: 7 6 8 5 8 6 5

1. Insert at beginning
2. Insert at position
3. Insert at end
4. Display
5. Exit
Enter your choice: 5
Exiting...

Process returned 0 (0x0)   execution time : 68.611 s
Press any key to continue.
```

Lab program 5:

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>


typedef struct Node {
```

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

Node* createNode(int data) {
Node *newNode = (Node*)malloc(sizeof(Node));
if (newNode == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
newNode->data = data;
newNode->next = NULL;
return newNode;
}

Node* insertAtBeginning(Node *head, int data) {
Node *newNode = createNode(data);
newNode->next = head;
return newNode;
}

Node* deleteFirstNode(Node *head) {
if (head == NULL) {
printf("List is empty. Nothing to delete.\n");
return NULL;
}
Node *temp = head;
```

```c
head = head->next;

free(temp);

printf("Deleted the first node from the list.\n");

return head;

}

Node* deleteSpecifiedNode(Node *head, int key) {

Node *current = head;

Node *prev = NULL;


if (current != NULL && current->data == key) {

head = head->next;

free(current);

printf("Deleted node with key %d from the list.\n", key);

return head;

}


while (current != NULL && current->data != key) {

prev = current;

current = current->next;

}


if (current == NULL) {

printf("Key %d not found in the list.\n", key);

return head;

}


prev->next = current->next;
```

```
free(current);

printf("Deleted node with key %d from the list.\n", key);

return head;

}


Node*  deleteLastNode(Node  *head)  {

if (head == NULL) {

printf("List is empty. Nothing to delete.\n");

return NULL;

}


if (head->next == NULL) {

free(head);

printf("Deleted the last node from the list.\n");

return NULL;

}


Node *prev = NULL;

Node *current = head;

while (current->next != NULL) {

prev = current;

current = current->next;

}


prev->next = NULL;

free(current);

printf("Deleted the last node from the list.\n");
```

```
return head;
}

void displayList(Node *head) {
if (head == NULL) {
printf("List is empty.\n");
return;
}
Node *current = head;
printf("List elements: ");
while (current != NULL) {
printf("%d ", current->data);
current = current->next;
}
printf("\n");
}

void freeList(Node *head) {
Node *current = head;
Node *temp;
while (current != NULL) {
temp = current;
current = current->next;
free(temp);
}
}
```

```
int main() {

Node *head = NULL;

int choice, data, key;

do {

printf("\n1. Insert at beginning\n2. Delete first node\n3. Delete specified node\n4. Delete last node\n5. Display\n6. Exit\n");

printf("Enter your choice: ");

scanf("%d", &choice);


switch (choice) {

case 1:

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

scanf("%d", &data);

head = insertAtBeginning(head, data);

break;

case 2:

head  =  deleteFirstNode(head);

break;

case 3:

printf("Enter the key of node to delete: ");

scanf("%d", &key);

head = deleteSpecifiedNode(head, key);

break;

case 4:

head  =  deleteLastNode(head);

break;

case 5:

displayList(head);
```

```
break;
case 6:
freeList(head);
printf("Exiting...\n");
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 6);
return 0;
}
```

Output:

```
1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 1
Enter data to insert at beginning: 6

1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 1
Enter data to insert at beginning: 8

1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 3
Enter the key of node to delete: 6
Deleted node with key 6 from the list.

1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 1
Enter data to insert at beginning: 2

1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 1
Enter data to insert at beginning: 4

1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 4
Deleted the last node from the list.

1. Insert at beginning
2. Delete first node
3. Delete specified node
4. Delete last node
5. Display
6. Exit
Enter your choice: 5
List elements: 4 2 8
```

Lab program 6a:

WAP to Implement Single Link List with following operations

a) Sort the linked list.

b) Reverse the linked list.

c) Concatenation of two linked lists

```
#include <stdio.h>

#include <stdlib.h>


typedef struct Node {

int data;

struct Node *next;

} Node;


Node* createNode(int data) {

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

if (newNode == NULL) {

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

exit(1);

}

newNode->data = data;

newNode->next = NULL;

return newNode;

}


Node* insertAtBeginning(Node *head, int data) {

Node *newNode = createNode(data);

newNode->next = head;

return newNode;

}
```

```
void displayList(Node *head) {

if (head == NULL) {

printf("List is empty.\n");

return;

}

Node *current = head;

printf("List elements: ");

while (current != NULL) {

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

current = current->next;

}

printf("\n");

}


Node* sortLinkedList(Node *head) {

if (head == NULL || head->next == NULL)

return head;


Node *prev = head;

Node *current = head->next;

while (current != NULL) {

Node *innerPrev = NULL;

Node *innerCurrent = head;

while (innerCurrent != current) {

if (innerCurrent->data > current->data) {

prev->next = current->next;

current->next = innerCurrent;
```

```
if (innerPrev == NULL)

head = current;

else

innerPrev->next = current;

current = prev->next;

break;

}

innerPrev = innerCurrent;

innerCurrent  =  innerCurrent->next;

}

if (innerCurrent == current) {

prev = current;

current = current->next;

}

}

return head;

}


Node*  reverseLinkedList(Node  *head)  {

Node *prev = NULL;

Node *current = head;

Node *next = NULL;


while (current != NULL) {

next = current->next;

current->next = prev;

prev = current;
```

```
current = next;
}

head = prev;
return head;
}

Node* concatenateLinkedLists(Node *list1, Node *list2) {
if (list1 == NULL)
return list2;
if (list2 == NULL)
return list1;

Node *current = list1;
while (current->next != NULL) {
current = current->next;
}
current->next = list2;
return list1;
}

int main() {
Node *list1 = NULL;
Node *list2 = NULL;

list1 = insertAtBeginning(list1, 40);
list1 = insertAtBeginning(list1, 60);
```

```
list1 = insertAtBeginning(list1, 20);

printf("List 1:\n");
displayList(list1);

list1 = sortLinkedList(list1);
printf("Sorted List 1:\n");
displayList(list1);

list1 = reverseLinkedList(list1);
printf("Reversed List 1:\n");
displayList(list1);

list2 = insertAtBeginning(list2, 30);
list2 = insertAtBeginning(list2, 70);
list2 = insertAtBeginning(list2, 80);

printf("List 2:\n");
displayList(list2);

list2 = sortLinkedList(list2);
printf("Sorted List 2:\n");
displayList(list2);

list2 = reverseLinkedList(list2);
printf("Reversed List 2:\n");
displayList(list2);
```

```
Node *concatenatedList = concatenateLinkedLists(list1, list2);

printf("Concatenated List:\n");

displayList(concatenatedList);


return 0;

}
```

Output:

```
List 1:
List elements: 20 60 40
Sorted List 1:
List elements: 20 40 60
Reversed List 1:
List elements: 60 40 20
List 2:
List elements: 80 70 30
Sorted List 2:
List elements: 30 70 80
Reversed List 2:
List elements: 80 70 30
Concatenated List:
List elements: 60 40 20 80 70 30

Process returned 0 (0x0)   execution time : 0.039 s
Press any key to continue.
```

Lab program 6b:

WAP to implement Stack & Queues using Linked Representation

Stack

```
#include <stdio.h>

#include <stdlib.h>


typedef struct StackNode {

int data;
```

```
struct StackNode* next;
} StackNode;

StackNode* createStackNode(int data) {
StackNode* newNode = (StackNode*)malloc(sizeof(StackNode));
if (newNode == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
newNode->data = data;
newNode->next = NULL;
return newNode;
}

int isEmpty(StackNode* root) {
return (root == NULL);
}

void push(StackNode** root, int data) {
StackNode* newNode = createStackNode(data);
newNode->next = *root;
*root = newNode;
printf("Pushed %d onto the stack.\n", data);
}

int pop(StackNode** root) {
if (isEmpty(*root)) {
```

```
printf("Stack Underflow! Cannot pop element.\n");
return -1;
}
int popped = (*root)->data;
StackNode* temp = *root;
*root = (*root)->next;
free(temp);
return popped;
}

int peek(StackNode* root) {
if (isEmpty(root)) {
printf("Stack is empty.\n");
return -1;
}
return  root->data;
}

void displayStack(StackNode* root) {
if (isEmpty(root)) {
printf("Stack is empty.\n");
return;
}
printf("Stack elements: ");
while (root != NULL) {
printf("%d ", root->data);
root = root->next;
```

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

int main() {
StackNode* stack = NULL;
int choice, data;
do {
printf("\n1. Push\n2. Pop\n3. Peek\n4. Display\n5. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
case 1:
printf("Enter data to push onto the stack: ");
scanf("%d", &data);
push(&stack, data);
break;
case 2:
printf("Popped %d from the stack.\n", pop(&stack));
break;
case 3:
printf("Top element of the stack: %d\n", peek(stack));
break;
case 4:
displayStack(stack);
break;
```

```
case 5:

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

break;

default:

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

}

} while (choice != 5);

return 0;

}
```

Output:

```
1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter data to push onto the stack: 6
Pushed 6 onto the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter data to push onto the stack: 5
Pushed 5 onto the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter data to push onto the stack: 3
Pushed 3 onto the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 2
Popped 3 from the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 3
Top element of the stack: 5

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 4
Stack elements: 5 6 2

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 5
Exiting...

Process returned 0 (0x0)   execution time : 142.839 s
Press any key to continue.
```

Queue:

```
#include <stdio.h>

#include <stdlib.h>
```

```
typedef struct QueueNode {
int data;
struct QueueNode* next;
} QueueNode;

typedef struct {
QueueNode* front;
QueueNode* rear;
} Queue;

QueueNode* createQueueNode(int data) {
QueueNode* newNode = (QueueNode*)malloc(sizeof(QueueNode));
if (newNode == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
newNode->data = data;
newNode->next = NULL;
return newNode;
}

Queue* createQueue() {
Queue* queue = (Queue*)malloc(sizeof(Queue));
if (queue == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
queue->front = queue->rear = NULL;
```

```
return queue;
}

int isEmpty(Queue* queue) {
return (queue->front == NULL);
}

void enqueue(Queue* queue, int data) {
QueueNode* newNode = createQueueNode(data);
if (isEmpty(queue)) {
queue->front = queue->rear = newNode;
} else {
queue->rear->next = newNode;
queue->rear = newNode;
}
printf("Enqueued %d into the queue.\n", data);
}

int dequeue(Queue* queue) {
if (isEmpty(queue)) {
printf("Queue Underflow! Cannot dequeue element.\n");
return -1;
}
int dequeued = queue->front->data;
QueueNode* temp = queue->front;
queue->front = queue->front->next;
if (queue->front == NULL) {
queue->rear = NULL;
}
```

```c
free(temp);
return dequeued;
}

int peek(Queue* queue) {
if (isEmpty(queue)) {
printf("Queue is empty.\n");
return -1;
}
return queue->front->data;
}

void displayQueue(Queue* queue) {
if (isEmpty(queue)) {
printf("Queue is empty.\n");
return;
}
printf("Queue elements: ");
QueueNode* current = queue->front;
while (current != NULL) {
printf("%d ", current->data);
current = current->next;
}
printf("\n");
}

int main() {
Queue* queue = createQueue();
int choice, data;
```

```
do {
printf("\n1. Enqueue\n2. Dequeue\n3. Peek\n4. Display\n5. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);
switch (choice) {
case 1:
printf("Enter data to enqueue into the queue: ");
scanf("%d", &data);
enqueue(queue, data);
break;
case 2:
printf("Dequeued %d from the queue.\n", dequeue(queue));
break;
case 3:
printf("Front element of the queue: %d\n", peek(queue));
break;
case 4:
displayQueue(queue);
break;
case 5:
printf("Exiting...\n");
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 5);
return 0;
}
```

Output:

```
1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter data to push onto the stack: 6
Pushed 6 onto the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter data to push onto the stack: 5
Pushed 5 onto the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter data to push onto the stack: 3
Pushed 3 onto the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 2
Popped 3 from the stack.

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 3
Top element of the stack: 5

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 4
Stack elements: 5 6 2

1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 5
Exiting...

Process returned 0 (0x0)   execution time : 142.839 s
Press any key to continue.
```

Lab program 7:

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>


typedef struct Node {

int data;

struct Node* prev;

struct Node* next;

} Node;


Node* createNode(int data) {
```

```
Node*  newNode  =  (Node*)malloc(sizeof(Node));
if (newNode == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
newNode->data = data;
newNode->prev = NULL;
newNode->next = NULL;
return newNode;
}

void insertLeft(Node** head, Node* node, int data) {
Node* newNode = createNode(data);
newNode->next = node;
newNode->prev = node->prev;
if (node->prev != NULL) {
node->prev->next = newNode;
} else {
*head = newNode;
}
node->prev  =  newNode;
}

void deleteNode(Node** head, int key) {
Node* current = *head;
while (current != NULL) {
if (current->data == key) {
```

```
if (current->prev != NULL) {
current->prev->next = current->next;
} else {
*head = current->next;
}
if (current->next != NULL) {
current->next->prev = current->prev;
}
free(current);
return;
}
current = current->next;
}
printf("Node with value %d not found in the list.\n", key);
}

void displayList(Node* head) {
if (head == NULL) {
printf("List is empty.\n");
return;
}
printf("List elements: ");
while (head != NULL) {
printf("%d  ", head->data);
head = head->next;
}
printf("\n");
```

```
}

void freeList(Node* head) {
Node* current = head;
Node* temp;
while (current != NULL) {
temp = current;
current = current->next;
free(temp);
}
}

int main() {
Node* head = NULL;
int choice, data, value;

do {
printf("\n1. Create a Doubly Linked List\n2. Insert a new node to the left of a node\n3. Delete a node based on a specific value\n4. Display the contents of the list\n5. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);
switch (choice) {
case 1:
printf("Enter the number of elements to create the list: ");
scanf("%d", &data);
printf("Enter the elements: ");
for (int i = 0; i < data; ++i) {
int value;
```

```
scanf("%d", &value);
if (head == NULL) {
head = createNode(value);
} else {
Node* temp = head;
while (temp->next != NULL) {
temp = temp->next;
}
Node*  newNode  =  createNode(value);
temp->next = newNode;
newNode->prev = temp;
}
}
break;
case 2:
if (head == NULL) {
printf("List is empty. Create a list first.\n");
break;
}
printf("Enter the value of the node to the left of which you want to insert a new node: ");
scanf("%d", &value);
printf("Enter the data of the new node: ");
scanf("%d", &data);
Node* current = head;
while (current != NULL && current->data != value) {
current = current->next;
}
```

```
if (current == NULL) {
printf("Node with value %d not found in the list.\n", value);
} else {
insertLeft(&head, current, data);
}
break;
case 3:
if (head == NULL) {
printf("List is empty. Create a list first.\n");
break;
}
printf("Enter the value of the node you want to delete: ");
scanf("%d", &data);
deleteNode(&head, data);
break;
case 4:
displayList(head);
break;
case 5:
printf("Exiting...\n");
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 5);
freeList(head);
return 0;
```

}

Output:

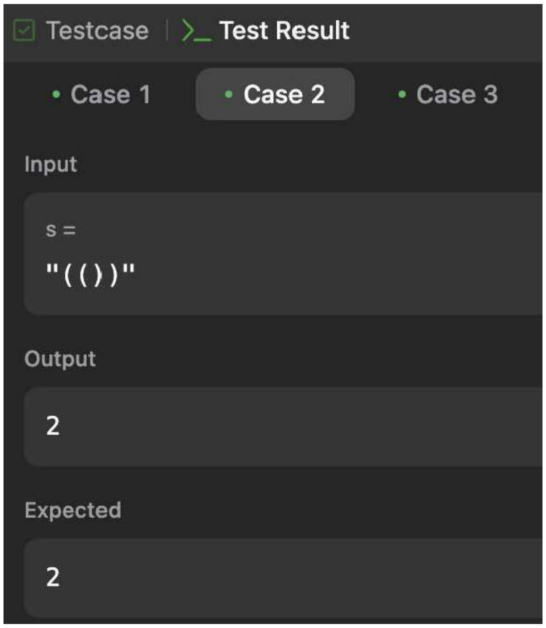
```
1. Create a Doubly Linked List
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 1
Enter the number of elements to create the list: 5
Enter the elements: 3
4
5
6
7

1. Create a Doubly Linked List
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 2
Enter the value of the node to the left of which you want to insert a new node: 7
Enter the data of the new node: 8

1. Create a Doubly Linked List
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 4
List elements: 3 4 5 6 8 7

1. Create a Doubly Linked List
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 3
Enter the value of the node you want to delete: 8

1. Create a Doubly Linked List
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 4
List elements: 3 4 5 6 7

1. Create a Doubly Linked List
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 5
Exiting...
```

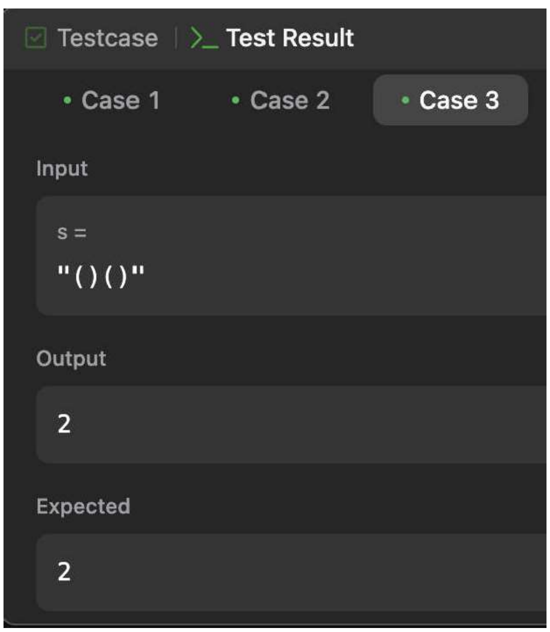
LeetCode Problem:

ScoreOfParentheses:

```
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 8:

Write a program

a) To construct a binary Search tree.

b) To traverse the tree using all the methods i.e., in-order, preorder andpost order

c) To display the elements in the tree.

```
#include <stdio.h>

#include <stdlib.h>


typedef struct TreeNode {

int data;

struct TreeNode* left;

struct TreeNode* right;

} TreeNode;


TreeNode* createNode(int data) {

TreeNode* newNode = (TreeNode*)malloc(sizeof(TreeNode));

if (newNode == NULL) {

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

exit(1);

}

newNode->data = data;

newNode->left = NULL;

newNode->right = NULL;

return newNode;

}


TreeNode* insertNode(TreeNode* root, int data) {

if (root == NULL) {
```

```
return createNode(data);
}
if (data < root->data) {
root->left = insertNode(root->left, data);
} else if (data > root->data) {
root->right = insertNode(root->right, data);
}
return root;
}

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

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

void postorderTraversal(TreeNode* root) {
```

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

void displayTree(TreeNode* root) {
printf("Elements in the tree (inorder traversal): ");
inorderTraversal(root);
printf("\n");
}

int main() {
TreeNode* root = NULL;
int choice, data;
do {
printf("\n1. Insert\n2. Inorder Traversal\n3. Preorder Traversal\n4. Postorder Traversal\n5. Display Tree\n6. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);
switch (choice) {
case 1:
printf("Enter data to insert into the tree: ");
scanf("%d", &data);
root = insertNode(root, data);
break;
case 2:
```

```
printf("Inorder Traversal: ");
inorderTraversal(root);
printf("\n");
break;
case 3:
printf("Preorder Traversal: ");
preorderTraversal(root);
printf("\n");
break;
case 4:
printf("Postorder  Traversal:  ");
postorderTraversal(root);
printf("\n");
break;
case 5:
displayTree(root);
break;
case 6:
printf("Exiting...\n");
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 6);
return 0;
}
```

Output:

```
1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 3

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 6

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 7

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 4

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 2
Inorder Traversal: 3 4 6 7

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 3
Preorder Traversal: 3 6 4 7
```

```
1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 4
Postorder Traversal: 4 7 6 3

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 5
Elements in the tree (inorder traversal): 3 4 6 7

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 6
Exiting...

Process returned 0 (0x0)   execution time : 19.580 s
Press any key to continue.
```

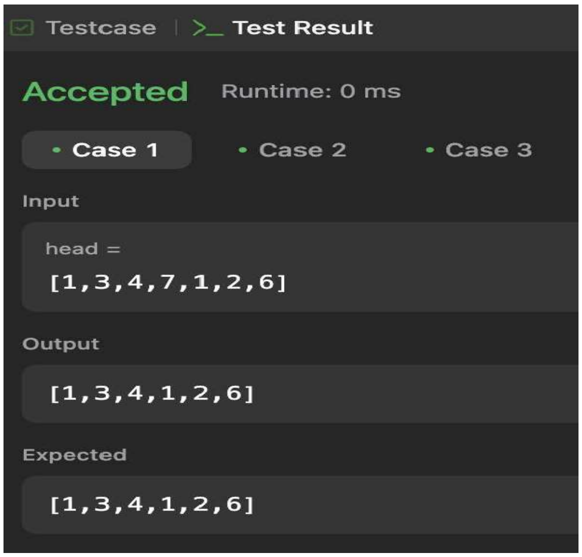
Leet Code Problem:

Delete the Middle Node Of a Linked List:

```
struct ListNode* deleteMiddle(struc ListNode* head) {
if (head == NULL) return NULL;
struct ListNode* prev = (struct Lis Node*)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->ne t;
free(prev);
return newHead;
}
```

Output:

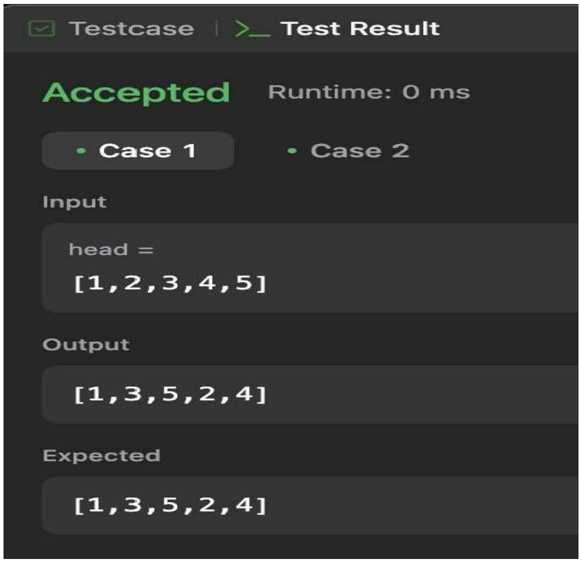


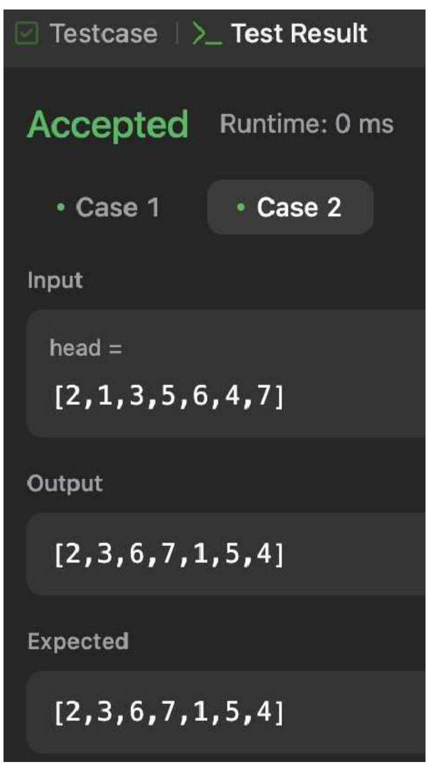
Odd Even Linked List

```
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 9:

Write a Program to traverse a graph using BFS method.

```
#include <stdio.h>


void bfs(int a[10][10], int n, int u) {

int f = 0, r = -1, q[10] = {0}, v, s[10] = {0};

printf("The nodes visited from %d: ", u);


q[++r] = u;

s[u] = 1;

printf("%d ", u);


while (f <= r) {

u = q[f++];


for (v = 0; v < n; v++) {

if (a[u][v] == 1 && s[v] == 0) {

printf("%d ", v);

s[v] = 1;

q[++r] = v;

}

}

}

printf("\n");

}


int main() {

int n, a[10][10], source, i, j;
```

```
printf("\nEnter the number of nodes: ");

scanf("%d", &n);

printf("\nEnter the adjacency matrix:\n");


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

for (j = 0; j < n; j++) {

scanf("%d",  &a[i][j]);

}

}


for (source = 0; source < n; source++) {

bfs(a, n, source);

}

return 0;

}
```

Output:

```
Enter the number of nodes: 4

Enter the adjacency matrix:
1 0 1 0
0 0 1 1
0 1 0 1
1 0 0 1
The nodes visited from 0: 0 2 1 3
The nodes visited from 1: 1 2 3 0
The nodes visited from 2: 2 1 3 0
The nodes visited from 3: 3 0 2 1

Process returned 0 (0x0)   execution time : 29.157 s
Press any key to continue.
```

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

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

```
}

#include <stdbool.h>

#define MAX_SIZE 100

int n;
int a[MAX_SIZE][MAX_SIZE];
int s[MAX_SIZE];

void dfs(int v) {
s[v] = 1;
for (int i = 1; i <= n; i++) {
if (a[v][i] && !s[i]) {
dfs(i);
}
}
}

int main() {
int i, j, count = 0;

printf("\nEnter number of vertices: ");
scanf("%d", &n);
for (i = 1; i <= n; i++) {
s[i] = 0;
for (j = 1; j <= n; j++) {
a[i][j] = 0;
}
```

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

Output:

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

Process returned 0 (0x0)   execution time : 24.628 s
Press any key to continue.
```

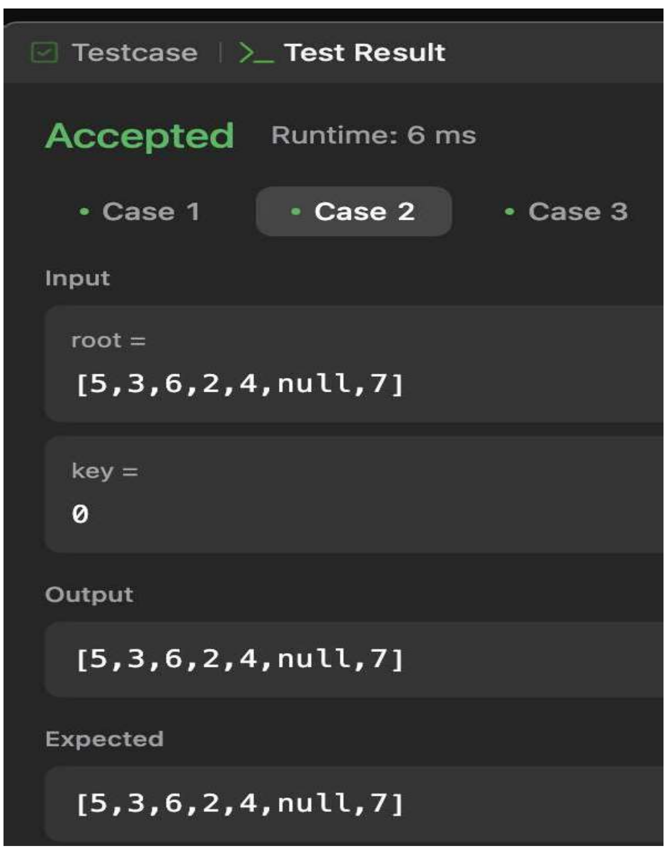
LeetCode Problem:

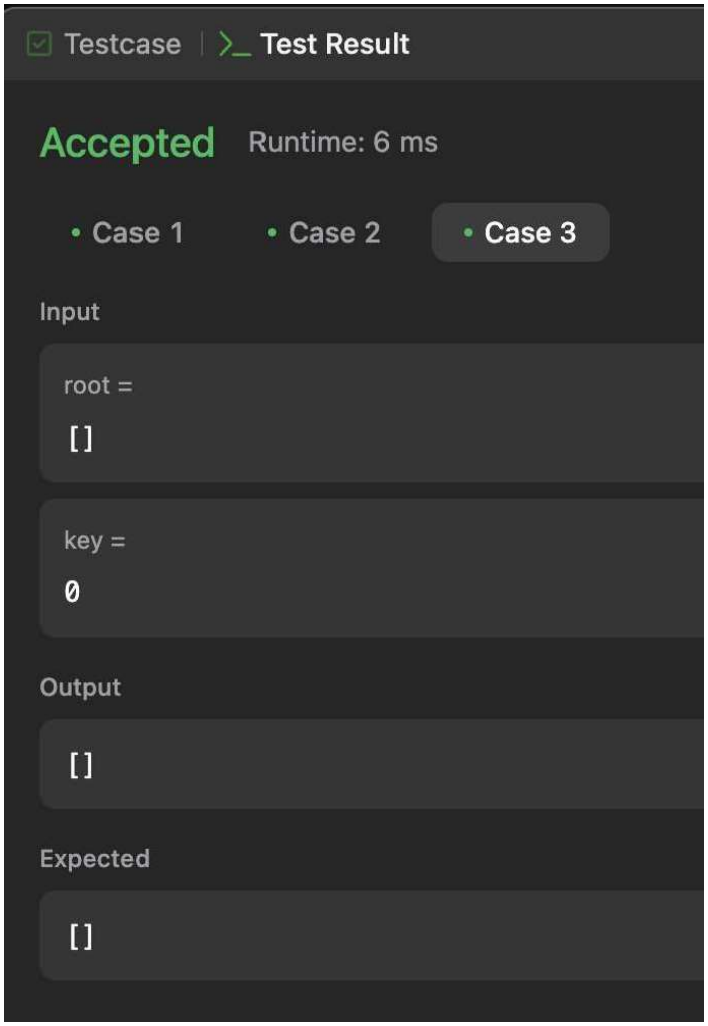
a)Delete Node In BST

```
struct TreeNode* deleteNode(struct reeNode* root, int key) {
if (root) {
if (key < root->val)
root->left = deleteNode(root->left, key);
else if (key > root->val)
root->right = deleteNode(root->righ , key);
else {
if (!root->left && !root->right)
return NULL;
if (!root->left || !root->right)
return root->left ? root->left : ro t->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:


Testcase
Test Result
Accepted
Runtime: 6 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]

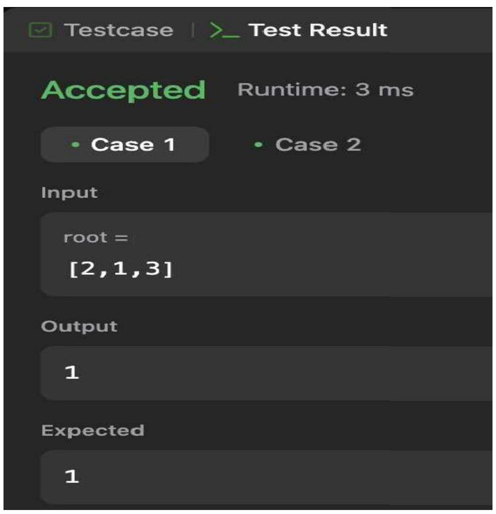

Testcase
Test Result
Accepted
Runtime: 6 ms
Case 1
Case 2
Case 3
Input
root =
[5,3,6,2,4,null,7]
key =
0
Output
[5,3,6,2,4,null,7]
Expected
[5,3,6,2,4,null,7]

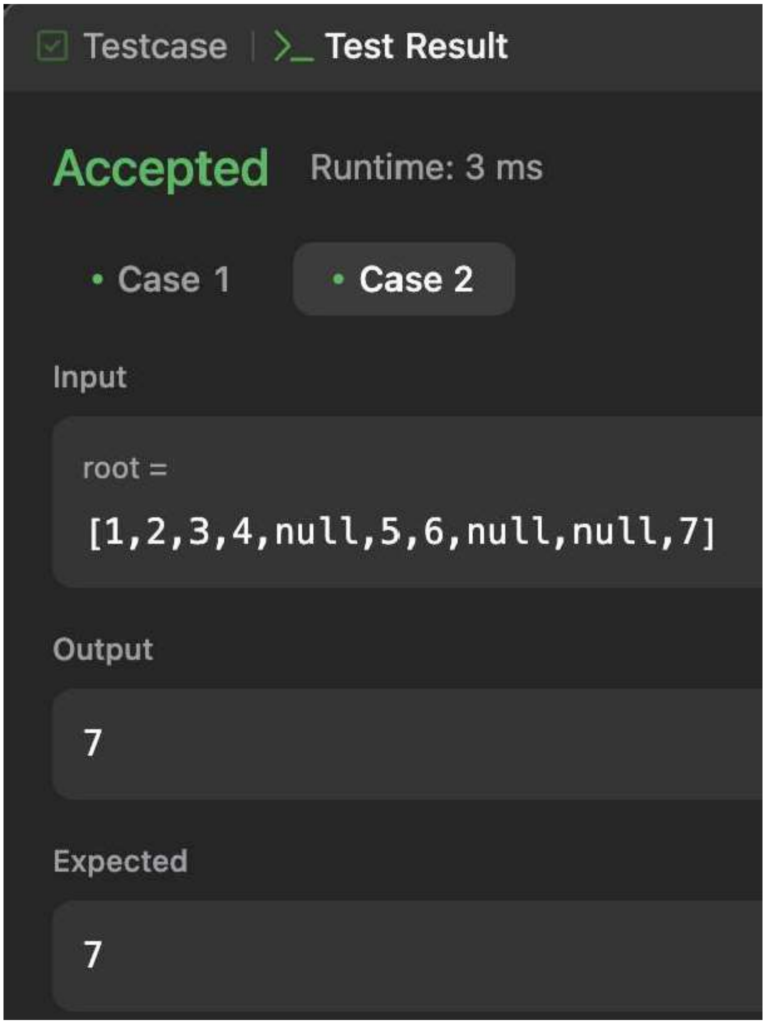

Testcase
Test Result
Accepted
Runtime: 6 ms
Case 1
Case 2
Case 3
Input
root =
[]
key =
0
Output
[]
Expected
[]

b)Find Bottom Left Tree Value

```
int findBottomLeftValue(struct Tree ode* root) {
int value=root->val;
int mdepth=0;
void transverse(struct TreeNode* p, nt 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:





Lab Program 10:

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 -> 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>


#define MAX_EMPLOYEES 100

#define HT_SIZE 10


typedef struct {

int key;

} Employee;


typedef struct {

Employee* entries[HT_SIZE];

} HashTable;


int hash(int key) {

return key % HT_SIZE;

}


void initHashTable(HashTable* ht) {

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

ht->entries[i] = NULL;
```

```
}

}

void insertEmployee(HashTable* ht, Employee* emp) {

int index = hash(emp->key);

while (ht->entries[index] != NULL) {

index = (index + 1) % HT_SIZE;

}

ht->entries[index] = emp;

}

void displayHashTable(HashTable* ht) {

printf("\nHash Table:\n");

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

if (ht->entries[i] != NULL) {

printf("Index %d: Key %d\n", i, ht->entries[i]->key);

} else {

printf("Index %d: Empty\n", i);

}

}

}

int main() {

HashTable ht;

initHashTable(&ht);
```

```c
int n;
printf("Enter the number of employee records: ");
scanf("%d", &n);

printf("Enter the employee keys:\n");
for (int i = 0; i < n; i++) {
Employee* emp =  (Employee*)malloc(sizeof(Employee));
if (emp == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
scanf("%d", &emp->key);
insertEmployee(&ht,  emp);
}
displayHashTable(&ht);
return 0;
}
```

Output:

```
Enter the number of employee records: 5
Enter the employee keys:
34
23
45
67
78

Hash Table:
Index 0: Empty
Index 1: Empty
Index 2: Empty
Index 3: Key 23
Index 4: Key 34
Index 5: Key 45
Index 6: Empty
Index 7: Key 67
Index 8: Key 78
Index 9: Empty

Process returned 0 (0x0)   execution time : 11.057 s
Press any key to continue.
```