RUSTAMJI INSTITUTE OF TECHNOLOGY

BSF ACADEMY, TEKANPUR

Lab File for
CS303 (Data Structure)

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TABLE OF CONTENTS

Section-A (Linked List)

Section-B (Stack)

Section-C (Queue)

Section-D (Trees)

Section-E (Sorting & Searching)

S. No.	Practical Description	Page Nos.	COs
1	Implementation of Sorting a. Bubble b. Selection c. Insertion d. Quick e. Merge	66 - 72	CO - 5
2	Implementation of Binary Search on a list of numbers stored in an Array	73 - 74	CO - 5
3	Implementation of Binary Search on a list of strings stored in an Array	75 - 76	CO - 5
4	Implementation of Linear Search on a list of strings stored in an Array	77 - 78	CO - 5
5	Implementation of Binary Search on a list of strings stored in a Single Linked List (optional)	79 - 81	CO - 5

Section-A (Linked List)

Experiment No : 1

Program Description:

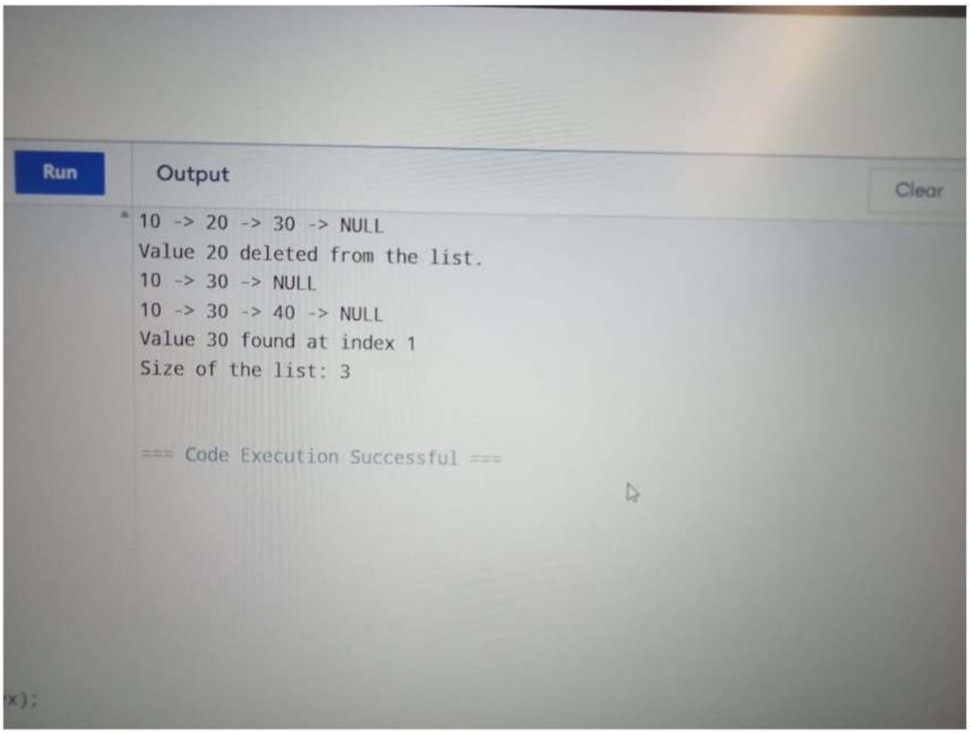
Implementation of Linked List using array.

```
#include<stdio.h>
#define MAXSIZE 100

typedef struct {
  int data[MAXSIZE];
  int next[MAXSIZE];
  int head;
  int freeIndex;
} ArrayLinkedList;

void initList(ArrayLinkedList *list) {
  list->head = -1;
  list->freeIndex = 0;
  for(int i = 0; i < MAXSIZE; i++) {
    list->next[i] = -1;
  }
}

void insert(ArrayLinkedList *list, int value) {
  if(list->freeIndex >= MAXSIZE) {
    printf("List is full\n");
    return;
  }
  int newIndex = list->freeIndex;
  list->data[newIndex] = value;
  list->next[newIndex] = -1;

  if(list->head == -1) {
    list->head = newIndex;
  } else {
    int current = list->head;
    while(list->next[current] != -1) {
      current = list->next[current];
    }
    list->next[current] = newIndex;
  }
  list->freeIndex++;
}

void deleteValue(ArrayLinkedList *list, int value) {
  int current = list->head;
```

```
{

int previous = -1;
 while(current != -1) {
 if(list->data[current] == value) {
 if(previous == -1) {
 list->head = list->next[current];
 } else {
 list->next[previous] = list->next[current];
 }
 list->next[current] = -1;
 printf("Value %d deleted from the list.\n", value);
 return;
 }
 previous = current;
 current = list->next[current];
 }
 printf("Value %d not found in the list.\n", value);
}
void display(ArrayLinkedList *list) {
 int current = list->head;
 while(current != -1) {
 printf("%d -> ", list->data[current]);
 current = list->next[current];
 }
 printf("NULL\n");
}
int search(ArrayLinkedList *list, int value) {
 int current = list->head;
 int index = 0;
 while(current != -1) {
 if(list->data[current] == value) {
 return index;
 }
 current = list->next[current];
 index++;
 }
 return -1;
}
int size(ArrayLinkedList *list) {
 int count = 0;
 int current = list->head;
 while(current != -1) {
 count++;
 current = list->next[current];
 }
 return count;
}
```

```
int main() {
ArrayLinkedList list;
initList(&list);

insert(&list, 10);
insert(&list, 20);
insert(&list, 30);
display(&list);

 deleteValue(&list, 20);
 display(&list);

 insert(&list, 40);
 display(&list);

 int value = 30;
 int index = search(&list, value);
if(index != -1) {
printf("Value %d found at index %d\n", value, index);
 } else {
 printf("Value %d not found in the list\n", value);
 }

 printf("Size of the list: %d\n", size(&list));
 return 0;
```

Output:



Experiment No: 2

Program Description :

Implementation of Linked List using Pointers.

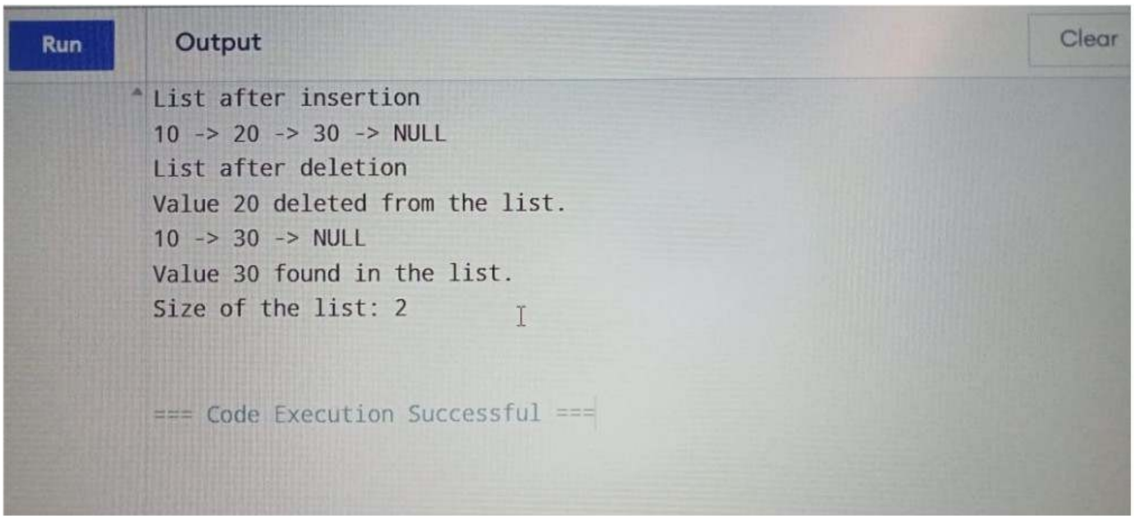
Solution:

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

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

typedef struct {
   Node* head;
} LinkedList;

void initList(LinkedList *list) {
   list->head = NULL;
}

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

void insert(LinkedList *list, int value) {
   Node* newNode = createNode(value);
   if(list->head == NULL) {
      list->head = newNode;
   } else {
      Node* current = list->head;
      while(current->next != NULL) {
         current = current->next;
      }
      current->next = newNode;
   }
}

void deleteValue(LinkedList *list, int value) {
   Node* current = list->head;
```

```
 Node* previous = NULL;
 while(current != NULL) {
 if(current->data == value) {
 if(previous == NULL) {
 list->head = current->next;
 } else {
 previous->next = current->next;
 }
 free(current);
 printf("Value %d deleted from the list.\n", value);
 return;
 }
 previous = current;
 current = current->next;
 }
 printf("Value %d not found in the list.\n", value);
}
void display(LinkedList *list) {
 Node* current = list->head;
 while(current != NULL) {
 printf("%d -> ", current->data);
 current = current->next;
 }
 printf("NULL\n");
}
Node* search(LinkedList *list, int value) {
 Node* current = list->head;
 while(current != NULL) {
 if(current->data == value) {
 return current;
 }
 current = current->next;
 }
 return NULL;
}
int size(LinkedList *list) {
 int count = 0;
 Node* current = list->head;
 while(current != NULL) {
 count++;
 current = current->next;
 }
 return count;
}
int main() {
 LinkedList list;
```

```c
initList(&list);

 printf("List after insertion\n");
 insert(&list, 10);
 insert(&list, 20);
 insert(&list, 30);
 display(&list);

 printf("List after deletion\n");
 deleteValue(&list, 20);
 display(&list);

 int searchValue = 30;
 Node* foundNode = search(&list, searchValue);
 if(foundNode) {
 printf("Value %d found in the list.\n", searchValue);
 } else {
 printf("Value %d not found in the list.\n", searchValue);
 }

 printf("Size of the list: %d\n", size(&list));
 return 0;
}
```

Output :



Experiment No : 3

Program Description:

Implementation of Doubly Linked List using Pointers.

Solution:

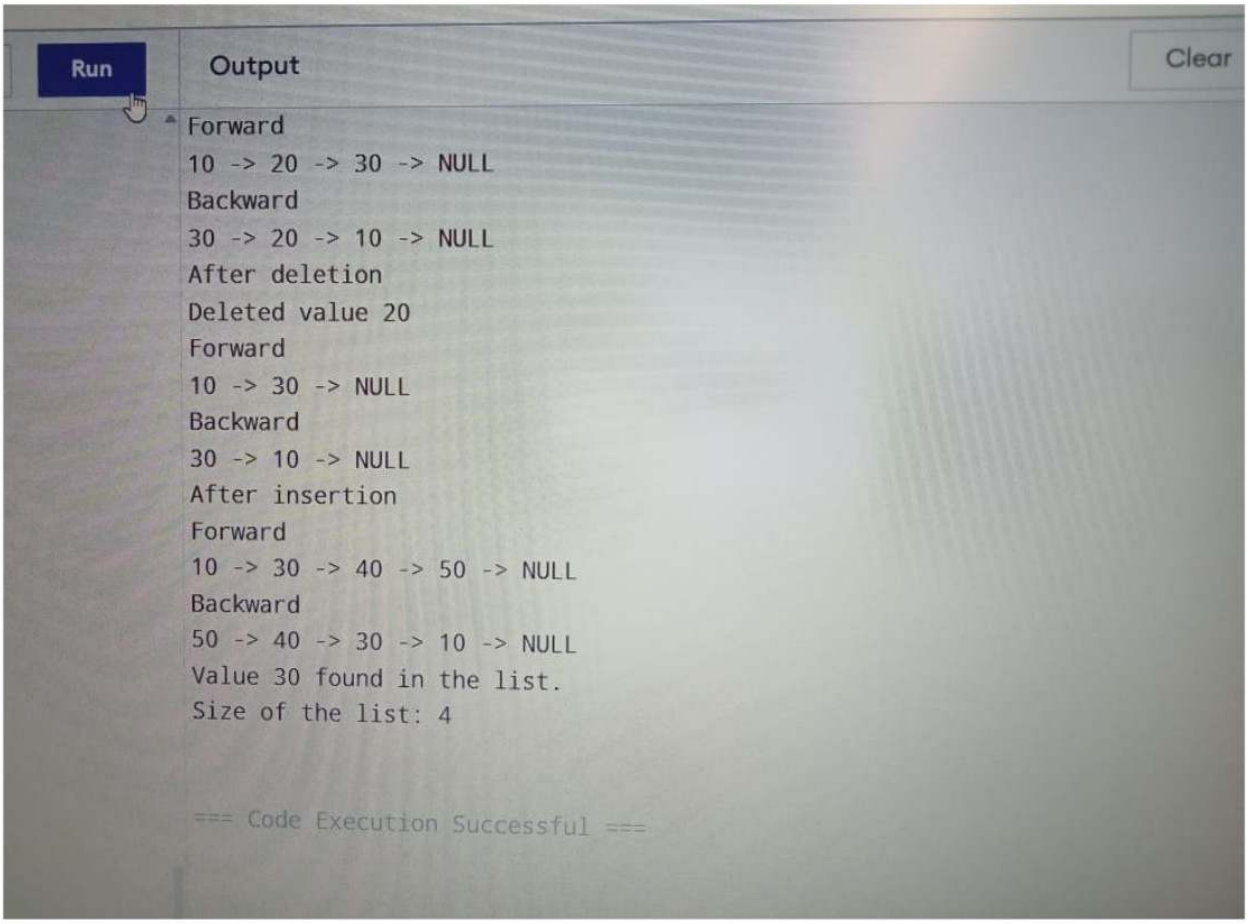
```
#include<stdio.h>
#include<stdlib.h>

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

typedef struct {
   Node* head;
} DoublyLinkedList;

void initList(DoublyLinkedList *list) {
   list->head = NULL;
}

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

void insert(DoublyLinkedList *list, int value) {
   Node* newNode = createNode(value);
   if(list->head == NULL) {
      list->head = newNode;
   } else {
      Node* current = list->head;
      while(current->next != NULL) {
         current = current->next;
      }
      current->next = newNode;
      newNode->prev = current;
   }
}

void deleteValue(DoublyLinkedList *list, int value) {
```

```
}
 Node* current = list->head;
 while(current != NULL) {
 if(current->data == value) {
 if(current->prev != NULL) {
 current->prev->next = current->next;
 } else {
 list->head = current->next;
 }
 if(current->next != NULL) {
 current->next->prev = current->prev;
 }
 free(current);
 printf("Deleted value %d\n", value);
 return;
 }
 current = current->next;
 }
 printf("Value %d not found in the list.\n", value);
}
void displayForward(DoublyLinkedList *list) {
 Node* current = list->head;
 while(current != NULL) {
 printf("%d -> ", current->data);
 current = current->next;
 }
 printf("NULL\n");
}
void displayBackward(DoublyLinkedList *list) {
 if(list->head == NULL) {
 printf("NULL\n");
 return;
 }
 Node* current = list->head;
 while(current->next != NULL) {
 current = current->next;
 }
 while(current != NULL) {
 printf("%d -> ", current->data);
 current = current->prev;
 }
 printf("NULL\n");
}
Node* search(DoublyLinkedList *list, int value) {
 Node* current = list->head;
 while(current != NULL) {
 if(current->data == value) {
 return current;
 }
```

```
current = current->next;
 }
 return NULL;
}
int size(DoublyLinkedList *list) {
 int count = 0;
 Node* current = list->head;
 while(current != NULL) {
 count++;
 current = current->next;
 }
 return count;
}
int main() {
 DoublyLinkedList list;
 initList(&list);

 printf("Forward\n");
 insert(&list, 10);
 insert(&list, 20);
 insert(&list, 30);
 displayForward(&list);

 printf("Backward\n");
 displayBackward(&list);

 printf("After deletion\n");
 deleteValue(&list, 20);
 printf("Forward\n");
 displayForward(&list);
 printf("Backward\n");
 displayBackward(&list);

 insert(&list, 40);
 insert(&list, 50);
 printf("After insertion\n");
 printf("Forward\n");
 displayForward(&list);
 printf("Backward\n");
 displayBackward(&list);

 Node* found = search(&list, 30);
 if(found) {
 printf("Value 30 found in the list.\n");
 } else {
 printf("Value not found.\n");
 }
```

```
printf("Size of the list: %d\n", size(&list));
return 0;
```

Output :



Experiment No : 4

Program Description:

Implementation of Circular Single Linked List using Pointers.

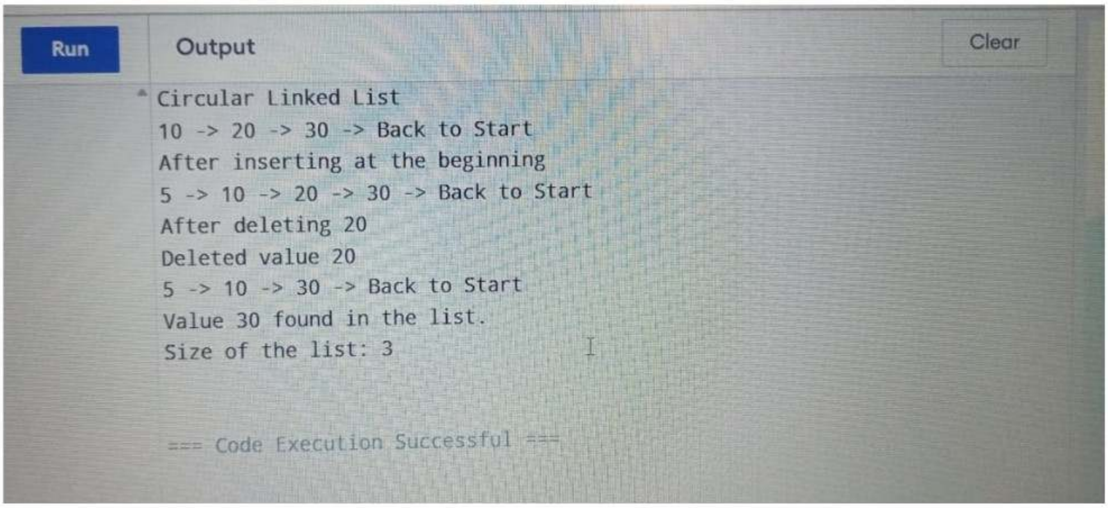
Solution:

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

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

typedef struct {
   Node* last;
} CircularLinkedList;

void initList(CircularLinkedList *list) {
   list->last = NULL;
}

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

void insertAtEnd(CircularLinkedList *list, int value) {
   Node* newNode = createNode(value);
   if(list->last == NULL) {
      newNode->next = newNode;
      list->last = newNode;
   } else {
      newNode->next = list->last->next;
      list->last->next = newNode;
      list->last = newNode;
   }
}

void insertAtBeginning(CircularLinkedList *list, int value) {
   Node* newNode = createNode(value);
   if(list->last == NULL) {
      newNode->next = newNode;
      list->last = newNode;
   } else {
```

```
newNode->next = list->last->next;
 list->last->next = newNode;
 }
}
void deleteValue(CircularLinkedList *list, int value) {
 if(list->last == NULL) {
 printf("List is empty.\n");
 return;
 }
 Node* current = list->last->next;
 Node* previous = list->last;

 do {
 if(current->data == value) {
 if(current == list->last->next) {
 if(list->last->next == list->last) {
 list->last = NULL;
 } else {
 list->last->next = current->next;
 }
 } else {
 previous->next = current->next;
 }
 free(current);
 printf("Deleted value %d\n", value);
 return;
 }
 previous = current;
 current = current->next;
 } while(current != list->last->next);

 printf("Value %d not found in the list.\n", value);
}
void display(CircularLinkedList *list) {
 if(list->last == NULL) {
 printf("List is empty.\n");
 return;
 }
 Node* current = list->last->next;
 do {
 printf("%d -> ", current->data);
 current = current->next;
 } while(current != list->last->next);
 printf("Back to Start\n");
}
Node* search(CircularLinkedList *list, int value) {
 if(list->last == NULL) return NULL;
 Node* current = list->last->next;
```

```
do {
 if(current->data == value) return current;
 current = current->next;
 } while(current != list->last->next);
 return NULL;
}
int size(CircularLinkedList *list) {
 if(list->last == NULL) return 0;
 int count = 0;
 Node* current = list->last->next;
 do {
 count++;
 current = current->next;
 } while(current != list->last->next);
 return count;
}
int main() {
 CircularLinkedList list;
 initList(&list);

 printf("Circular Linked List\n");
 insertAtEnd(&list, 10);
 insertAtEnd(&list, 20);
 insertAtEnd(&list, 30);
 display(&list);

 printf("After inserting at the beginning\n");
 insertAtBeginning(&list, 5);
 display(&list);

 printf("After deleting 20\n");
 deleteValue(&list, 20);
 display(&list);

 Node* found = search(&list, 30);
 if(found) {
 printf("Value 30 found in the list.\n");
 } else {
 printf("Value 30 not found.\n");
 }

 printf("Size of the list: %d\n", size(&list));
 return 0;
}
```

Output :



```
Circular Linked List
10 -> 20 -> 30 -> Back to Start
After inserting at the beginning
5 -> 10 -> 20 -> 30 -> Back to Start
After deleting 20
Deleted value 20
5 -> 10 -> 30 -> Back to Start
Value 30 found in the list.
Size of the list: 3


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

Experiment No : 5

Program Description:

Implementation of Circular Doubly Linked List using Pointers.

Solution:

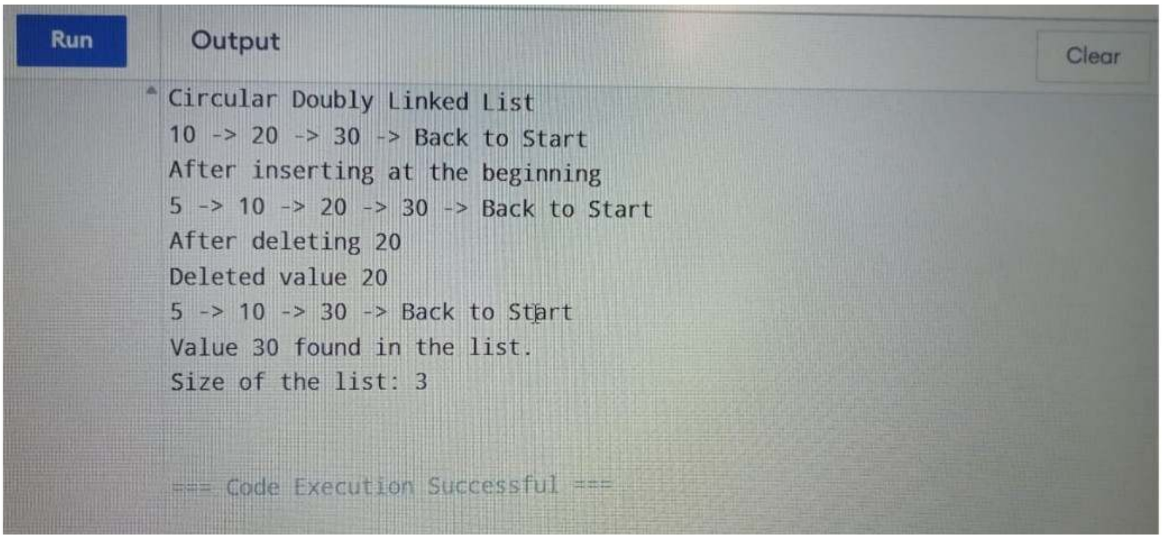
```
#include<stdio.h>
#include<stdlib.h>

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

typedef struct {
    Node* last;
} CircularDoublyLinkedList;

void initList(CircularDoublyLinkedList *list) {
    list->last = NULL;
}

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

void insertAtEnd(CircularDoublyLinkedList *list, int value) {
    Node* newNode = createNode(value);
    if(list->last == NULL) {
        list->last = newNode;
    } else {
        Node* first = list->last->next;
        newNode->next = first;
        newNode->prev = list->last;
        list->last->next = newNode;
        first->prev = newNode;
        list->last = newNode;
    }
}

void insertAtBeginning(CircularDoublyLinkedList *list, int value) {
    Node* newNode = createNode(value);
```

```
 if(list->last == NULL) {
 list->last = newNode;
 } else {
 Node* first = list->last->next;
 newNode->next = first;
 newNode->prev = list->last;
 list->last->next = newNode;
 first->prev = newNode;
 }
}
void deleteValue(CircularDoublyLinkedList *list, int value) {
 if(list->last == NULL) {
 printf("List is empty.\n");
 return;
 }
 Node* current = list->last->next;
 do {
 if(current->data == value) {
 if(current == list->last->next) {
 if(list->last->next == list->last) {
 list->last = NULL;
 } else {
 list->last->next = current->next;
 current->next->prev = list->last;
 }
 } else if(current == list->last) {
 list->last = current->prev;
 current->prev->next = list->last->next;
 list->last->next->prev = list->last;
 } else {
 current->prev->next = current->next;
 current->next->prev = current->prev;
 }
 free(current);
 printf("Deleted value %d\n", value);
 return;
 }
 current = current->next;
 } while(current != list->last->next);

 printf("Value %d not found in the list.\n", value);
}
void display(CircularDoublyLinkedList *list) {
 if(list->last == NULL) {
 printf("List is empty.\n");
 return;
 }
```

```
Node* current = list->last->next;
 do {
 printf("%d -> ", current->data);
 current = current->next;
 } while(current != list->last->next);
 printf("Back to Start\n");
}
Node* search(CircularDoublyLinkedList *list, int value) {
 if(list->last == NULL) return NULL;
 Node* current = list->last->next;
 do {
 if(current->data == value) return current;
 current = current->next;
 } while(current != list->last->next);
 return NULL;
}
int size(CircularDoublyLinkedList *list) {
 if(list->last == NULL) return 0;
 int count = 0;
 Node* current = list->last->next;
 do {
 count++;
 current = current->next;
 } while(current != list->last->next);
 return count;
}
int main() {
 CircularDoublyLinkedList list;
 initList(&list);

 printf("Circular Doubly Linked List\n");
 insertAtEnd(&list, 10);
 insertAtEnd(&list, 20);
 insertAtEnd(&list, 30);
 display(&list);

 printf("After inserting at the beginning\n");
 insertAtBeginning(&list, 5);
 display(&list);

 printf("After deleting 20\n");
 deleteValue(&list, 20);
 display(&list);

 Node* found = search(&list, 30);
 if(found) {
```

```
printf("Value 30 found in the list.\n");
} else {
printf("Value 30 not found.\n");
}

printf("Size of the list: %d\n", size(&list));
return 0;
```

Output :



Section-B (Stack)

Experiment No: 1

Program Description:

Implementation of Stack using Array.

Solution:

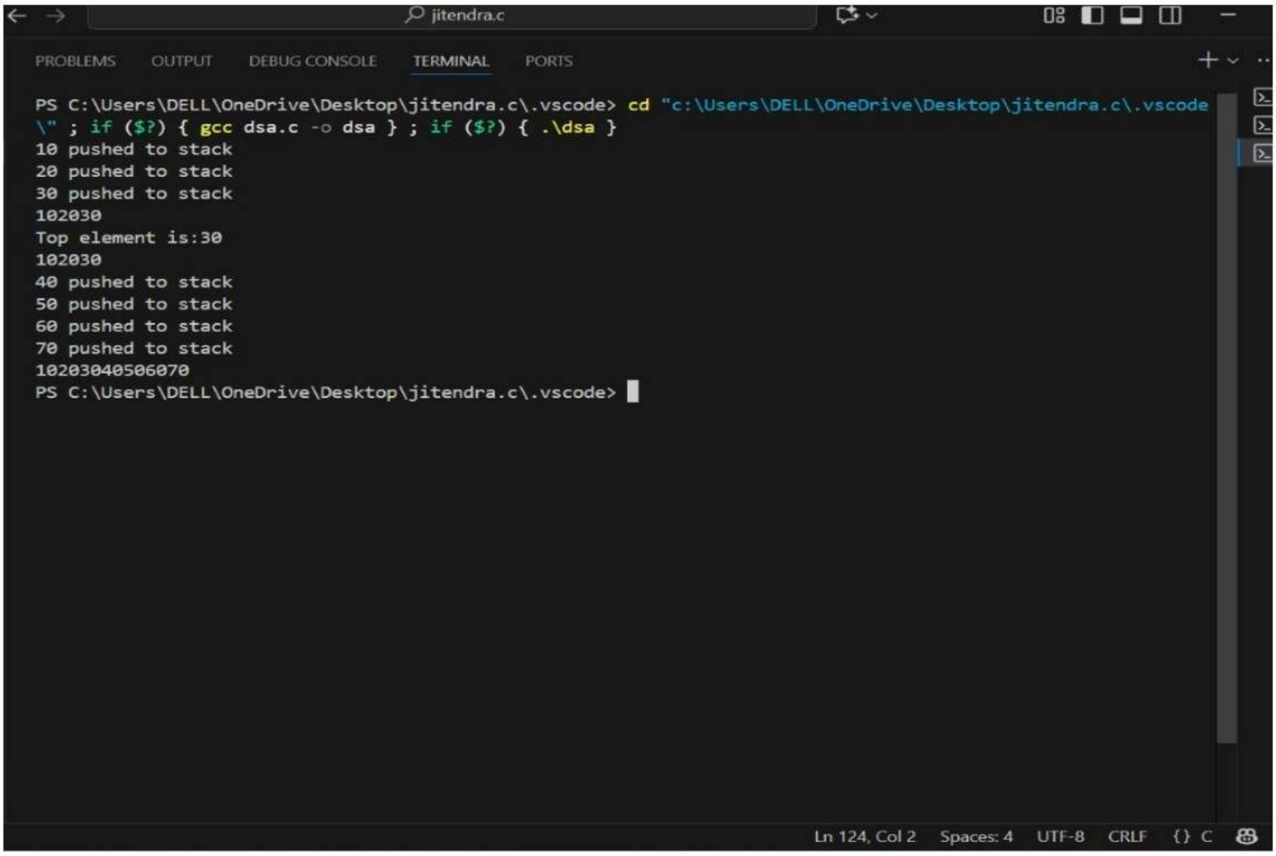
```
#include<stdio.h>

#include<stdlib.h>


#define MAX 100


typedef struct Stack{

   int arr[MAX];

   int top;


}Stack;


void initStack(Stack* stack){


   stack->top =-1;


}


intisEmpty(Stack* stack){


   return stack->top ==-1;

}


intisFull(Stack* stack){

   return stack->top == MAX-1;

}
```

```
voidpush(Stack* stack, int item){

    if(isFull(stack)){

        printf("Stack Overflow! Cannot push %d\n", item);

        return;
    }

    stack->arr[++stack->top] = item;

    printf("%d pushed to stack\n", item);

}

intpop(Stack* stack){

    if(isEmpty(stack)){

        printf("Stack Underflow! Cannot pop from an empty stack\n");

        return -1;
    }

    return stack->arr[stack->top];

}

intpeek(Stack* stack){

    if(isEmpty(stack)){
```

```
        printf("Stack is empty! Cannot peek\n");
        return -1;
    }
    return stack->arr[stack->top];
}
voiddisplay(Stack* stack){
    if(isEmpty(stack)){
        printf("Stack is empty!\n");
        return;
    }
    for(int i = 0; i<=stack->top; i++){
        printf("%d", stack->arr[i]);
    }
    printf("\n");
}
```

```
intmain(){
   Stack stack;
   initStack(&stack);
   push(&stack, 10);
   push(&stack, 20);
   push(&stack, 30);
   display(&stack);
   printf("Top element is:%d\n",peek(&stack));
   display(&stack);
   push(&stack,40);
   push(&stack,50);
   push(&stack,60);
   push(&stack,70);
   display(&stack);
   return 0;
}
```

OUTPUT:


jitendra.c
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
PS C:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode> cd "c:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode\" ; if ($?) { gcc dsa.c -o dsa } ; if ($?) { .\dsa }
10 pushed to stack
20 pushed to stack
30 pushed to stack
102030
Top element is:30
102030
40 pushed to stack
50 pushed to stack
60 pushed to stack
70 pushed to stack
10203040506070
PS C:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode>
Ln 124, Col 2
Spaces: 4
UTF-8
CRLF
{} C

EXPERIMENT No : 2

Program Description:

Implementation of Stack using Pointers.

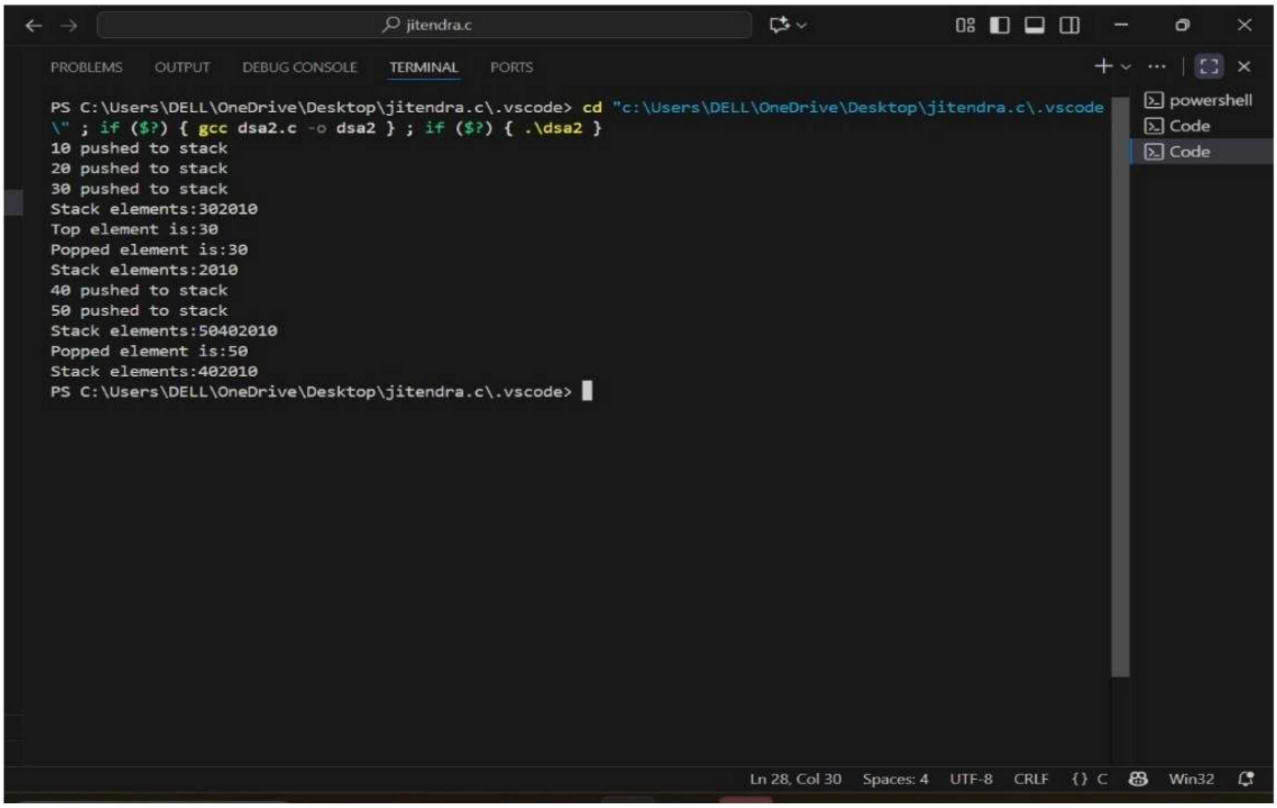
Solution:

```
#include<stdio.h>

#include<stdlib.h>


typedef struct Node {

   int data;

   struct Node* next;


}Node;


typedef struct Stack{

   Node* top;


}Stack;


Stack* createStack(){

   Stack* stack = (Stack*)malloc(sizeof(Stack));

   stack->top = NULL;

   return stack;


}


intisEmpty(Stack* stack){

   return stack->top == NULL;


}


void push(Stack* stack, int item){
```

```
    Node* newNode = (Node*)malloc(sizeof(Node));
    newNode->data = item;
    newNode->next =stack->top;
    stack->top = newNode;
    printf("%d pushed to stack\n", item);

}

intpop(Stack* stack){
    if(isEmpty(stack)){
        printf("Stack Underflow! Cannot pop from an empty stack\n");
        return -1;
    }
    Node* temp = stack->top;
    intpopped = temp->data;
    stack->top = stack->top->next;
    free(temp);
    return popped;
}

 intpeek(Stack* stack){
    if(isEmpty(stack)){
        printf("Stack is empty! Cannot peek\n");
        return -1;

    }

    return stack->top->data;

}
```

```
voiddisplay(Stack* stack){
  if(isEmpty(stack)){
    printf("Stack is empty!\n");
    return;
  }
  Node* current = stack->top;
  printf("Stack elements:");
  while (current!= NULL){
    printf("%d", current->data);
    current = current->next;
  }
  printf("\n");
  }
  intmain(){
    Stack* stack = createStack();
    push(stack, 10);
    push(stack, 20);
    push(stack, 30);
    display(stack);
    printf("Top element is:%d\n", peek (stack));
    printf("Popped element is:%d\n",pop(stack));
    display(stack);
    push(stack, 40);
    push(stack, 50);
    display(stack);
    printf("Popped element is:%d\n", pop(stack));
    display(stack);
    return 0;
     }
```

OUTPUT:


jitendra.c
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
PS C:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode> cd "c:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode\" ; if ($?) { gcc dsa2.c -o dsa2 } ; if ($?) { .\dsa2 }
10 pushed to stack
20 pushed to stack
30 pushed to stack
Stack elements:302010
Top element is:30
Popped element is:30
Stack elements:2010
40 pushed to stack
50 pushed to stack
Stack elements:50402010
Popped element is:50
Stack elements:402010
PS C:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode>
powershell
Code
Code
Ln 28, Col 30
Spaces: 4
UTF-8
CRLF
{} C
Win32

EXPERIMENT No : 3

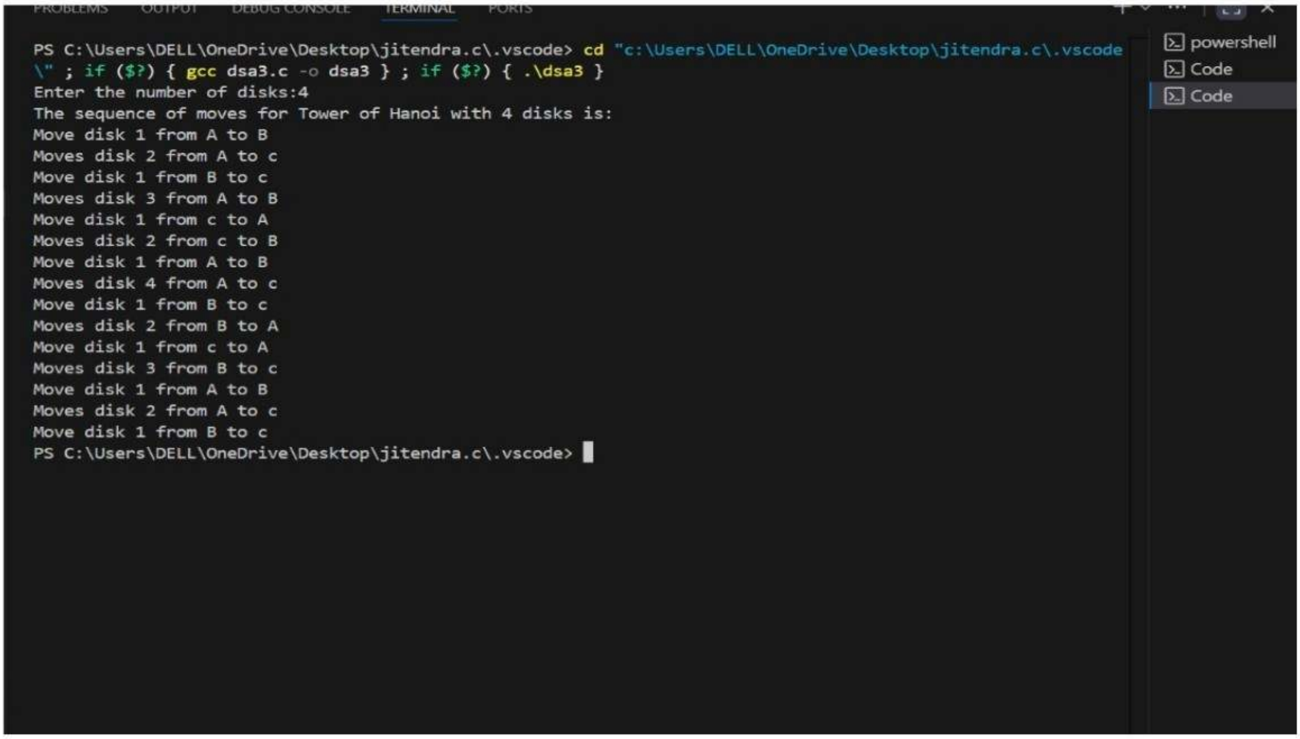
Program Description:

Program for Tower of Hanoi using recursion.

Solution:

```
#include<stdio.h>


voidtowerOfHanoi(int n, char source, char destination, char auxiliary){
  if(n==1){
    printf("Move disk 1 from %c to %c\n", source, destination);
    return;

  }

  towerOfHanoi(n-1, source, auxiliary, destination);
  printf("Moves disk %d from %c to %c\n",n, source,destination);
  towerOfHanoi(n-1, auxiliary, destination, source);

}

intmain(){
  intn;
  printf("Enter the number of disks:");
  scanf("%d",&n);
  printf("The sequence of moves for Tower of Hanoi with %d disks is:\n",n);
  towerOfHanoi(n,'A','c','B');
  return 0;
}
```

OUTPUT:



```
PS C:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode> cd "c:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode\" ; if ($?) { gcc dsa3.c -o dsa3 } ; if ($?) { .\dsa3 }
Enter the number of disks:4
The sequence of moves for Tower of Hanoi with 4 disks is:
Move disk 1 from A to B
Moves disk 2 from A to c
Move disk 1 from B to c
Moves disk 3 from A to B
Move disk 1 from c to A
Moves disk 2 from c to B
Move disk 1 from A to B
Moves disk 4 from A to c
Move disk 1 from B to c
Moves disk 2 from B to A
Move disk 1 from c to A
Moves disk 3 from B to c
Move disk 1 from A to B
Moves disk 2 from A to c
Move disk 1 from B to c
PS C:\Users\DELL\OneDrive\Desktop\jitendra.c\.vscode>
```

EXPERIMENT No : 4

Program Description:

Program to find out factorial of given number using recursion. Also show the various states of stack using in this program.

Solution:

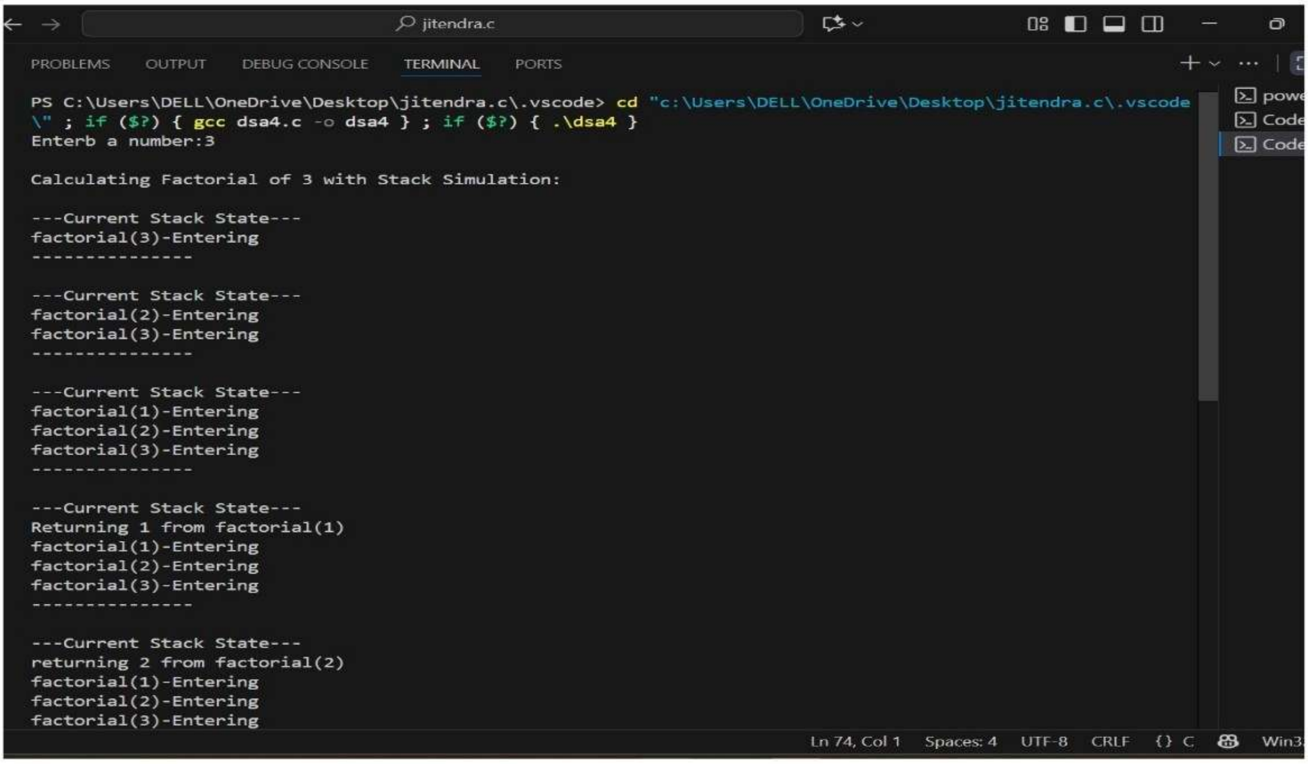
```
#include<stdio.h>

#include<stdlib.h>

#include<string.h>


typedef struct Stack {


   char stackState[100][100];

   int top;


}Stack;


void initStack(Stack* stack){

   stack->top = -1;


}


voidpush(Stack* stack, const char* state){

   if(stack->top<99){

      strcpy(stack->stackState[++stack->top],state);


   }

}


voidpop(Stack* stack){

    if(stack->top>-1){

       stack->top--;
```

```
    }
}

voiddisplayStack(Stack* stack){
    if(stack->top == -1){
        printf("Stack is empty\n");
        return;

    }

    printf("\n---Current Stack State---\n");
    for(int i = stack->top;i>=0;i--){
        printf("%s\n",stack->stackState[i]);

    }

    printf("---------------\n");

}

intfactorial(int n, Stack* stack){
    char state[100];
    sprintf(state,"factorial(%d)-Entering",n);
    push(stack, state);
    displayStack(stack);

    if(n==0||n==1){
        sprintf(state,"Returning 1 from factorial(%d)",n);
        push(stack, state);
        displayStack(stack);
```

```
      pop(stack);
      return 1;
   }

   intresult = n * factorial(n-1,stack);
   sprintf(state,"returning %d from factorial(%d)", result,n);
   push(stack, state);
   displayStack(stack);
   pop(stack);
   return result;

}

intmain(){
intnum;   Stack
stack;

   initStack(&stack);

   printf("Enterb a number:");
   scanf("%d",&num);

   if(num<0){

      printf("Factorial is not defined for negative numbers.\n");
      return 0;
   }

   printf("\nCalculating Factorial of %d with Stack Simulation:\n",num);
   intresult = factorial(num,&stack);
   printf("\nFactorial of %d is\n", num, result);
```

```
    return 0;
}
```

Output :



Section-C (QUEUE)

ExperimentNo : 1

Program Description:

Implementation of queue using an array.

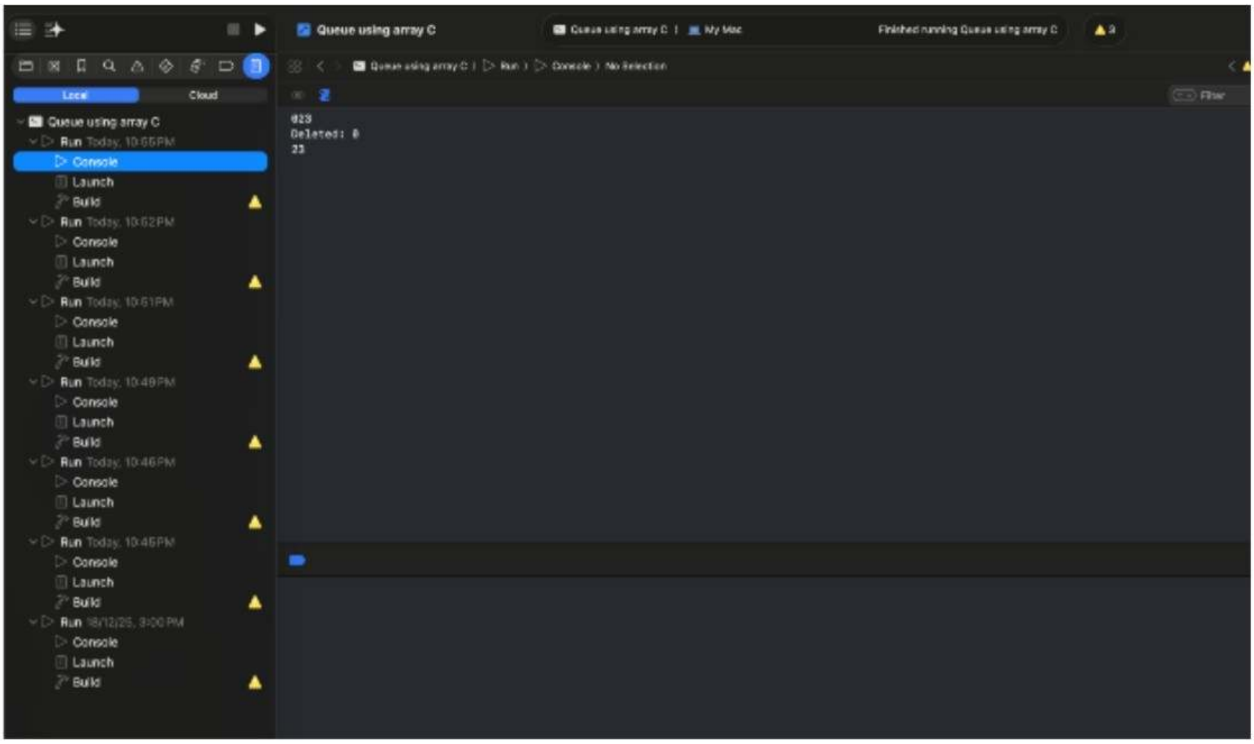
Solution:

```
#include <stdio.h>

#define MAX 5 int

queue[MAX]; int

front=-1; int

rear=-1; void

enqueue(int x) {


   if((rear+1)%MAX==front)

   {

      printf("Overflow condition\n");

   }

   else if(front==-1)

   {

      front=rear=0;

   }

   else

   {

      rear=(rear+1)%MAX;

      queue[rear]=x;
    }

    }


    void dequeue()

    {
```

```
 }
}



  if(front==-1)
  {
    printf("Underflow condition\n");
  }
  else
  {
    printf("Deleted: %d\n", queue[front]);
    if(front==rear)
    {
      front=rear=-1;
    }
    else
      front=(front+1)%MAX;
  }
}

voiddisplay()
{
  if(front==-1)
  {
    printf("Queue is empty\n");

}
else
{
```

```
inti=front;
while(1)
{

   printf("%d", queue[i]);

         if(i==rear)
            break;
         i=(i+1)%MAX;
      }
      printf("\n");
   }
}

intmain()
{
   enqueue(1);
   enqueue(2);
   enqueue(3);
   display();
   dequeue();
   display();
   return 0;
   }
```

Output:


Queue using array C
Local
Cloud
023
Deleted: 0
23
Console
Launch
Build

Experiment No : 2

Program Description:

Implementation of queue using pointers.

Solution:

```
#include <stdio.h>


#include<stdlib.h>


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


}Node;


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


}Queue;


void initializeQueue(Queue*q){
   q->front=NULL;
   q->rear=NULL;
}


intempty(Queue*q){
   return q->front==NULL;


}
```

```
void enqueue(Queue*q, int value){
   Node*newNode=(Node*)malloc(sizeof(Node));

   if(newNode==NULL)
   {
      printf("Memory allocation FAILED. Cannot enqueue%d\n", value);
      return;
   }

   newNode->data=value;
   newNode->next=NULL;

   if(q->rear==NULL)
   {
      q->front=q->rear=newNode;
   }
   else
   {
      q->rear->next=newNode;
      q->rear=newNode;
   }

     printf("Equeud:%d\n", value);
  }

  int dequeue(Queue*q){
     if(empty(q))
     {
        printf("Queue underflow. Cannot dequeue\n ");
        return -1;
```

```
    }

    Node*temp=q->front;
    intvalue=temp->data;

    q->front=q->front->next;

    if(q->front==NULL)
    {
      q->rear=NULL;
    }
    free(temp);
    return value;
}

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

    void displayQueue(Queue*q)
    {
      if(empty(q))
      {
```

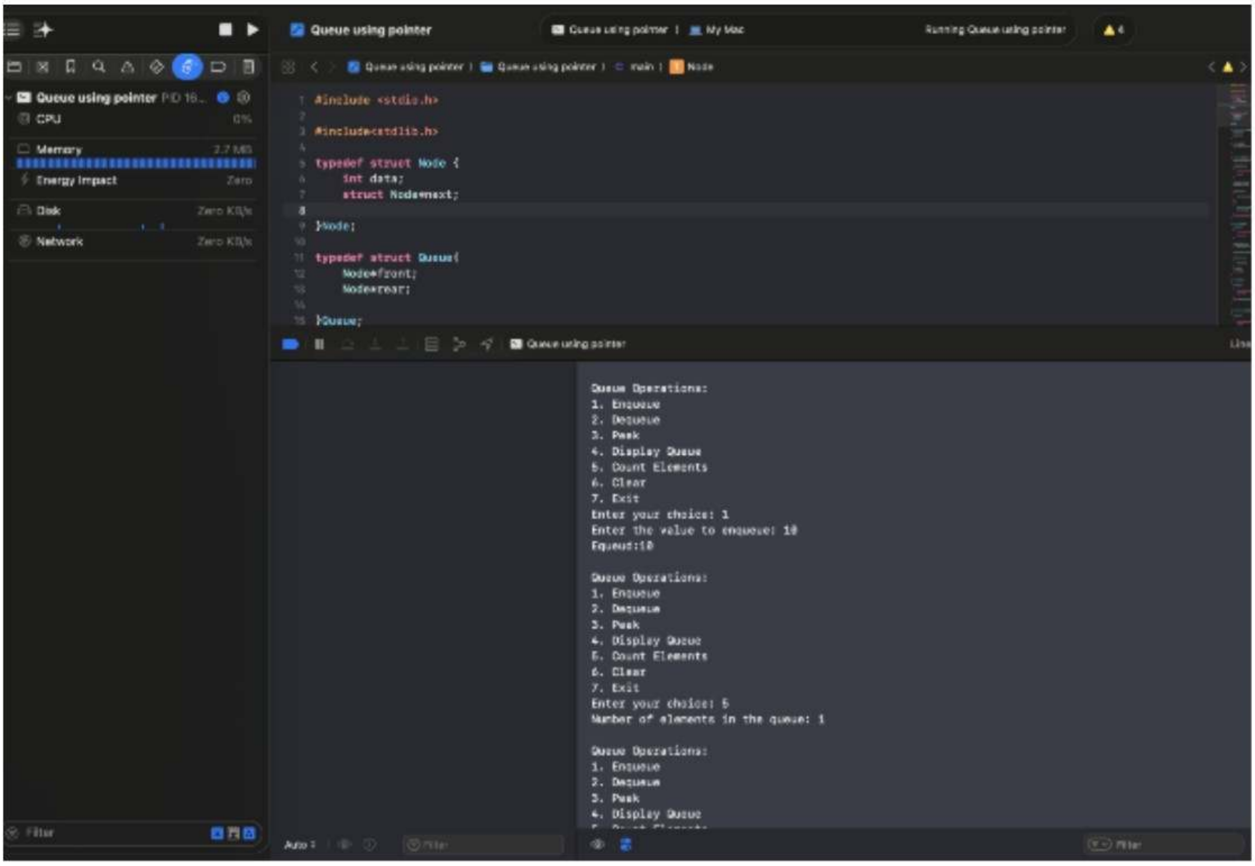
```
        printf("Queue is Empty\n");
        return;
    }
    Node*current=q->front;
    printf("Queue elements: ");

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


int countElements(Queue*q)
{
    if(empty(q))
    {
        return 0;
    }

    intcount=0;
    Node*current=q->front;

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

        }
        return count;
    }
```

```
void clearQueue(Queue*q)
{
   while(!empty(q))
   {
      dequeue(q);
   }
   printf("Queue is cleared successfully.\n");
}

void menu()

{


   printf("\nQueue   Operations:\n");
   printf("1. Enqueue\n");
   printf("2. Dequeue\n");
   printf("3. Peek\n");
   printf("4.    Display    Queue\n");
   printf("5.    Count    Elements\n");
   printf("6. Clear\n");
   printf("7. Exit\n");
   printf("Enter your choice: ");


}

intmain(){

Queue q1,q2;
initializeQueue(&q1);
initializeQueue(&q2);
intchoice,value, position;

while(1)
{
```

```
menu();
scanf("%d", &choice);

switch(choice)
{
   case1:
      printf("Enter the value to enqueue: ");
      scanf("%d", &value);
      enqueue(&q1,value);
      break;

   case2:
      value=dequeue(&q1);
      if(value!=-1)
      {
         printf("Dequeue: %d\n", value);
      }
      break;

   case3:
      value=peek(&q1);
      if(value!=-1);
      {
         printf("Front element: %d\n", value);
      }
      break;

   case4:
      displayQueue(&q1);
      break;
```

```
        case 5:
            printf("Number of elements in the queue: %d\n ", countElements(&q1));
            break;


        case 6:
            clearQueue(&q1);
            break;
            exit(0);

       }case 7:
           printf("Exit from program\n");




        default:
            printf("Invalid operation\n");

    }
    return0;
}
```

Output:


Queue Operations:
1. Enqueue
2. Dequeue
3. Peek
4. Display Queue
5. Count Elements
6. Clear
7. Exit
Enter your choice: 1
Enter the value to enqueue: 10
Equeud:10
Queue Operations:
1. Enqueue
2. Dequeue
3. Peek
4. Display Queue
5. Count Elements
6. Clear
7. Exit
Enter your choice: 5
Number of elements in the queue: 1

Experiment No : 3

Program Description:

Implementation of circular queue using array.

Solution:

```
#include<stdio.h>

#include<stdlib.h>


#define MAX 100


typedef struct CircularQueue{


   int data[MAX];

  int   front;   int

  rear;

  int size;

}CircularQueue;


void initializeQueue(CircularQueue*q){

  q->front=-1;

  q->rear=-1;

  q->size=0;

}


int isFull(CircularQueue*q)

{
```

```
 return q->size==MAX;
}
int empty(CircularQueue*q){
  return q->size==0;
}

void enqueue(CircularQueue*q, int value)
{
  if(isFull(q))
  {
    printf("Queue Oveerflow. Cannot dequeue\n");
    return;
  }

  if(q->front==-1)
  {
    q->front=0;
    q->rear=(q->rear+1)%MAX;
    q->data[q->rear]=value;
    q->size++;
    printf("Enqueued: %d\n", value);
  }
}

int dequeue(CircularQueue*q)
{
  if(empty(q))
  {
    printf("Queue Underflow. Cannot dequeue\n");
```

```
    return -1;
  }

  int value=q->data[q->front];
  q->front=(q->front+1)%MAX;
  q->size--;
  if(q->size==0)
  {
    q->front=-1;
    q->rear=-1;
  }
  return value;
}

int peek(CircularQueue*q)
{
  if(empty(q))
  {
    printf("Queue is Empty\n");
    return -1;
  }
  return q->data[q->front];
}

void dispalyQueue(CircularQueue*q)
{
  if(empty(q))
  {
    printf("Queue is Empty\n");
```

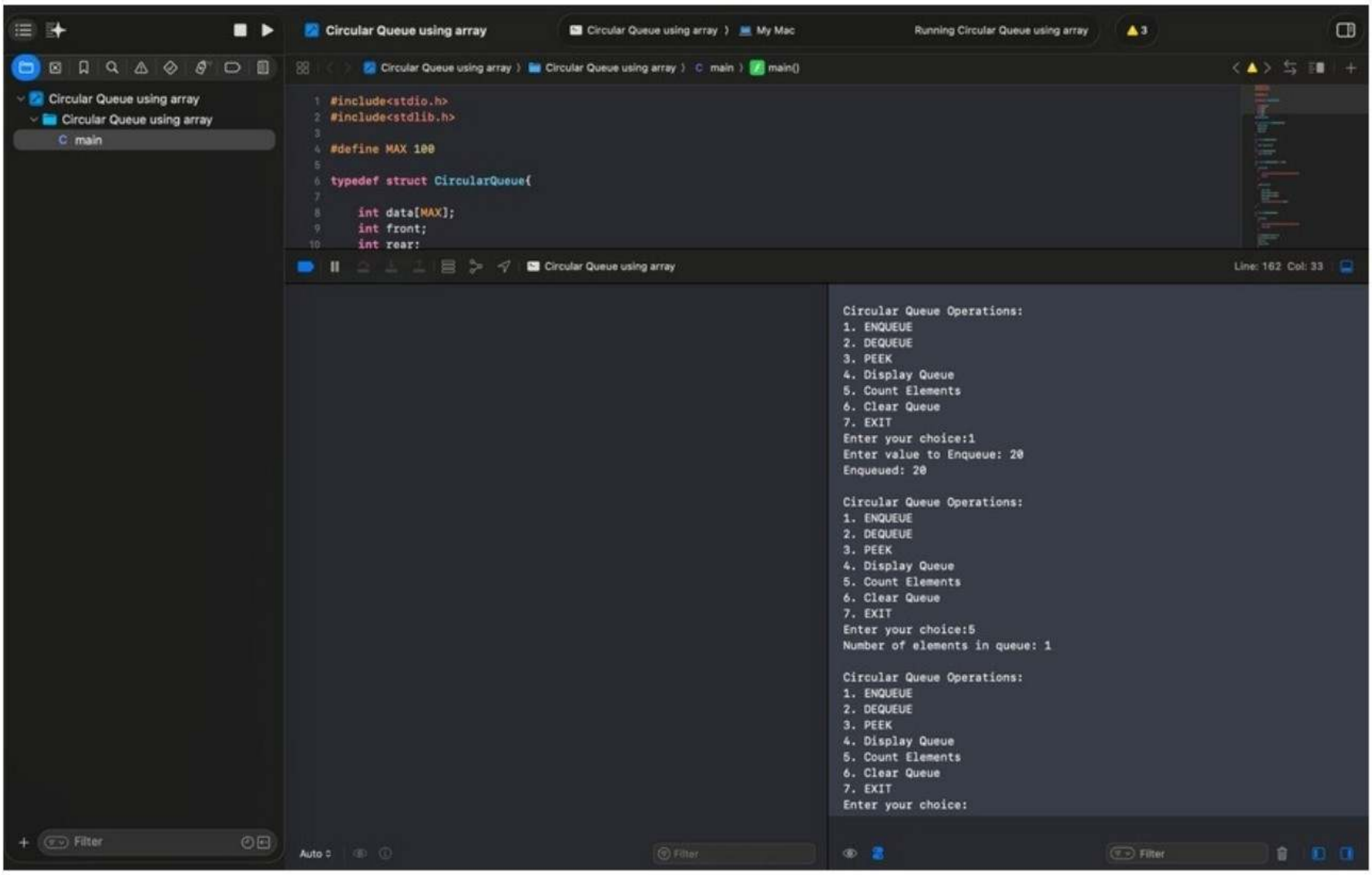
```
        return;
    }

    printf("Queue elements: ");
    for(int i=0, index=q->front; i<q->size; i++, index=(index+1)%MAX)
    {
        printf("%d", q->data[index]);
    }
    printf("\n");
}

int countElements(CircularQueue*q)
{
    return q->size;
}

void clearQueue(CircularQueue*q)
{
    q->front=-1;
    q->rear=-1;
    q->size=0;
 printf("Queue is cleared successfully\n");
}

void menu()
{
    printf("\nCircular Queue Operations:\n");
 printf("1. ENQUEUE\n");
printf("2. DEQUEUE\n");
    printf("3. PEEK\n");
```

```
printf("4. Display Queue\n");
printf("5. Count Elements\n");
printf("6. Clear Queue\n");
  printf("7. EXIT\n");
  printf("Enter your choice:");
}

int main()
{
  CircularQueue    q1,    q2;
  initializeQueue(&q1);
  initializeQueue(&q2);
  intchoice, value, position;

  while(1)
  {
    menu();
    scanf("%d", &choice);

    switch(choice)
    {
      case 1:
        printf("Enter value to Enqueue: ");
        scanf("%d", &value);
        enqueue(&q1, value);
        break;

      case 2:
        value=dequeue(&q1);
```

```
  if(value!=-1)
  {
    printf("Dequeue operation successful %d\n", value);
  }
  break;

case 3:
  value=peek(&q1);
  if(value!=-1)
  {
    printf("Front element: %d\n", value);
  }
  break;

case 4:
  dispalyQueue(&q1);
  break;

case 5:
  printf("Number of elements in queue: %d\n",countElements(&q1));
  break;

case 6:
  clearQueue(&q1);
  break;

case 7:
  printf("Exit from program\n");
```

```
          exit(0);


        default:

          printf("Invalid operation\n");




      }

    }

    return 0;

}
```

Output:



Section-D (Trees)

ExperimentNo : 1

Program Description:

Implementation of binary search tree .

Solution:

```
#include<stdio.h>

#include<stdlib.h>


struct Node{

int data;

struct Node*left;

struct Node*right;


};


struct Node*createNode(int data)

{

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

 newNode->data=data;

 newNode->left=NULL;

 newNode->right=NULL;

return newNode;

}


struct Node*insert(struct Node*root, int data)

{

   if(root==NULL)

   {
```

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

struct Node*search(struct Node*root, int key)
{
    if(root==NULL || root->data==key)
    {
        return root;
    }
    if(key<root->data)
    {
        return search(root->left, key);
    }
    else
    {
        return search(root->right, key);
    }
}

struct Node*findMin(struct Node*root)
```

```
{
  while(root!=NULL && root->left!=NULL)
  {
    root=root->left;
  }
  return root;
}

struct Node*findMax(struct Node*root)
{
  while(root!=NULL && root->right!=NULL)
  {
    root=root->right;
  }
  return root;
}

struct Node*deleteNode(struct Node*root, int key)
{
  if (root==NULL)
  {
    return root;
  }

  if (key<root->data)
  {
    root->left=deleteNode(root->left, key);
  }

  else if(key>root->data)
```

```
  {
    root->right=deleteNode(root->right, key);
  }
  else
  {
    if(root->left==NULL)
    {
      struct Node*temp=root->right;
      free(root);
      return temp;
    }
    else if(root->right==NULL)
    {
      struct Node*temp=root->left;
      free(root);
      return temp;
    }

    struct Node*temp=findMin(root->right);
    root->data=temp->data;
    root->right=deleteNode(root->right, temp->data);
  }
  return root;
}

void inOrder(struct Node*root)
{
  if (root!=NULL)
  {
    inOrder(root->left);
```

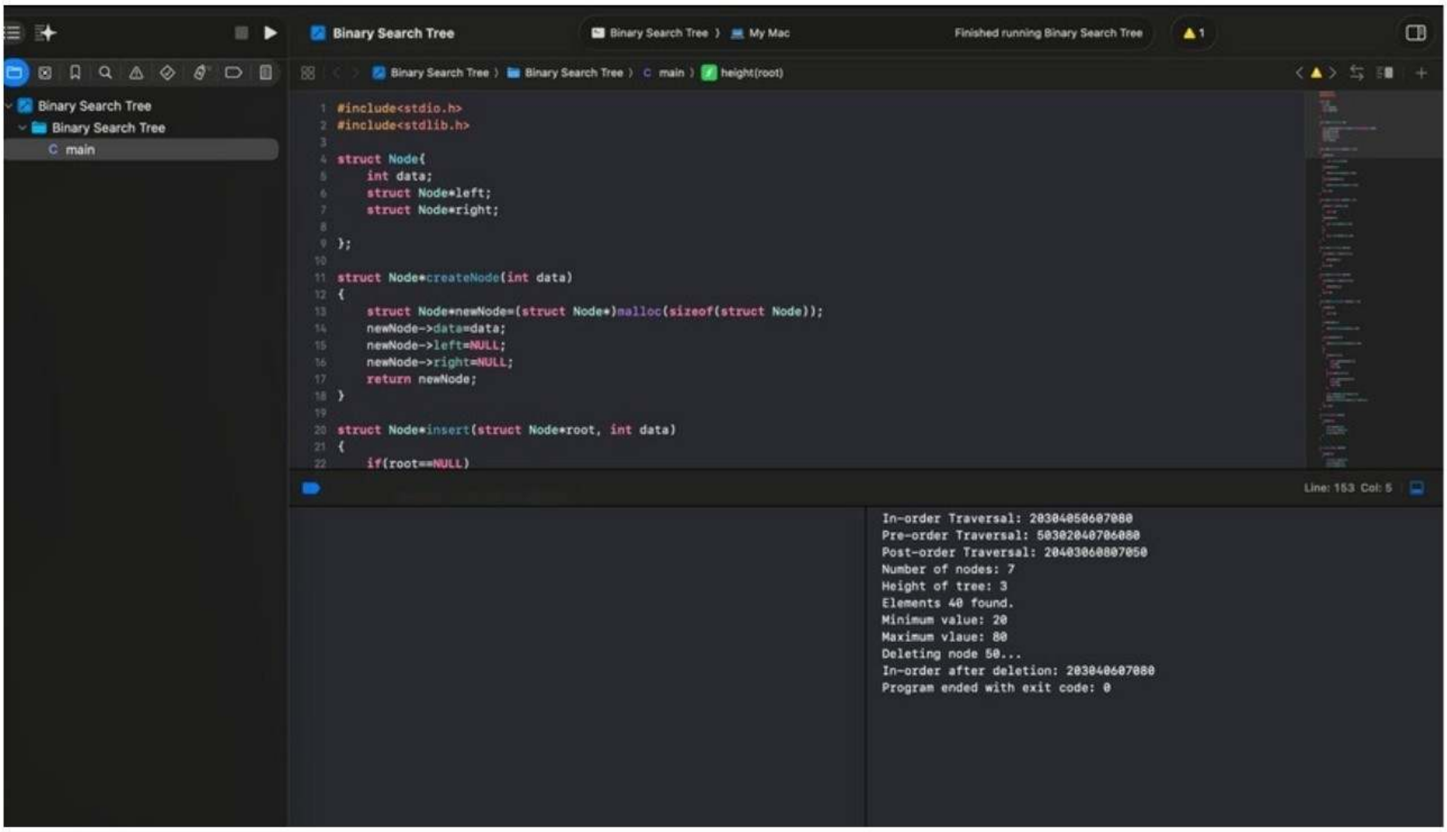
```
        printf("%d", root->data);
        inOrder(root->right);
    }
}


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

    }
}

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

int countNodes(struct Node*root)
{
    if(root==NULL)
```

```
        return 0;
        return 1+countNodes(root->left)+countNodes(root->right);

}

int height(struct Node*root)
{
    if(root==NULL)

        return 0;
        int leftHeight=height(root->left);
        int rightHeight=height(root->right);
        return (leftHeight > rightHeight ? leftHeight:rightHeight)+1;

}


int main()
{
    struct Node*root=NULL;
    root=insert(root,50);
    root=insert(root,30);
    root=insert(root,70);
    root=insert(root,20);
    root=insert(root,40);
    root=insert(root,60);
    root=insert(root,80);

    printf("In-order Traversal: ");
```

```
inOrder(root);
printf("\n");



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



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

printf("Number of nodes: %d\n", countNodes(root));
printf("Height of tree: %d\n", height(root));

int key=40;
struct Node*found=search(root,key);
if(found!=NULL)
{
   printf("Elements %d found.\n", key);
}
else
{
   printf("Elements %dnot found.\n", key);
}

struct Node*minNode=findMin(root);
struct Node*maxNode=findMax(root);
```

```c
    printf("Minimum value: %d\n",minNode->data);

    printf("Maximum vlaue: %d\n",maxNode->data);


    printf("Deleting node 50...\n");

    root=deleteNode(root, 50);


    printf("In-order after deletion: ");

    inOrder(root);

    printf("\n");


    return 0;


}
```

Output:



Experiment No : 2

Program Description:

Solution:

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

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

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

struct Node* buildBSTFromPreOrderUtil(int preOrder[], int* preIndex, int key, int min, int max, int n)

{
   if(*preIndex >= n)
       return NULL;
```

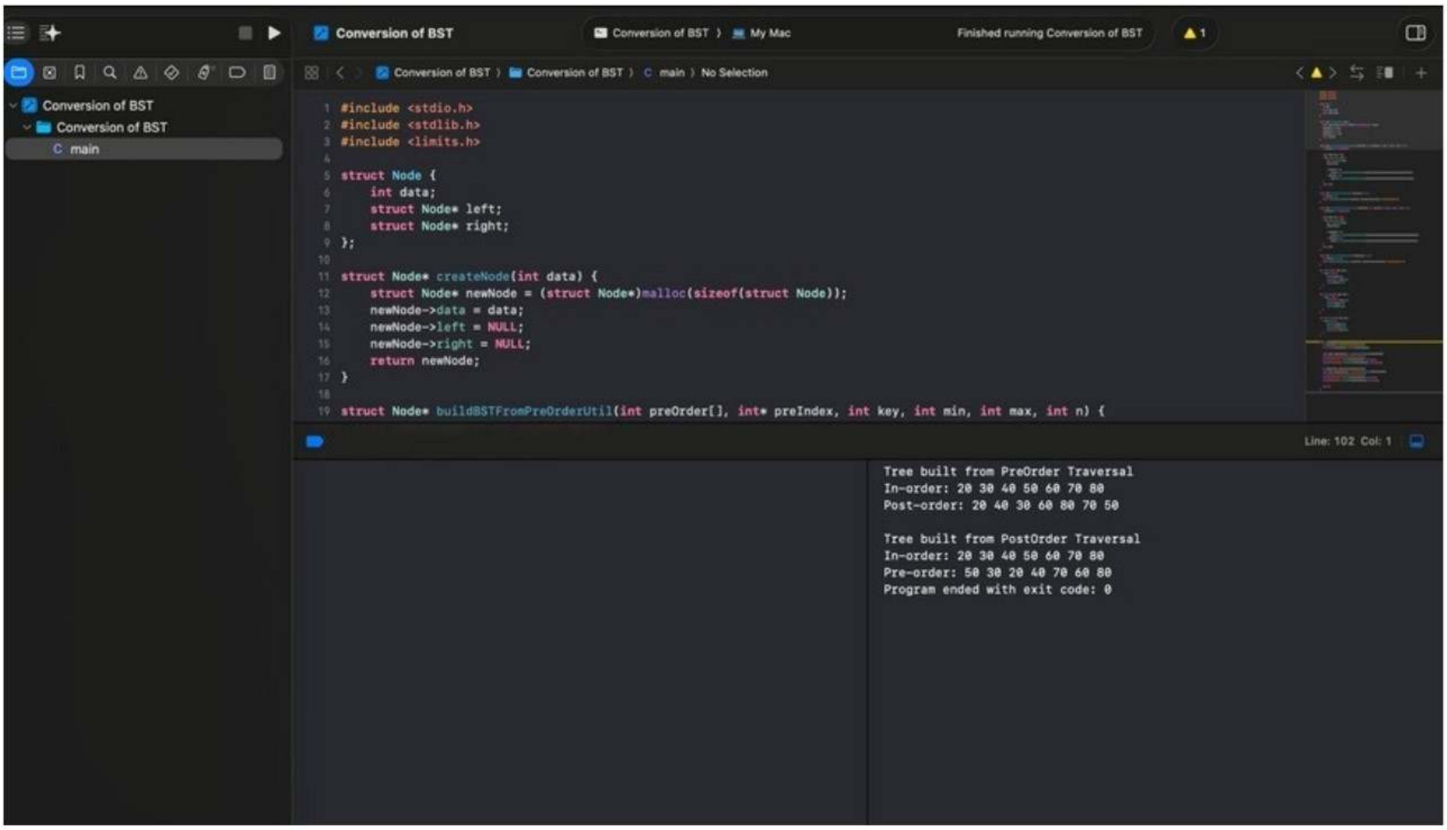
```
    struct Node* root = NULL;
    if(key > min && key < max)
    {
        root = createNode(key);
        (*preIndex)++;

        if(*preIndex < n)
        {
            root->left = buildBSTFromPreOrderUtil(preOrder, preIndex, preOrder[*preIndex], min, key, n);
        }
        if(*preIndex < n)
        {
            root->right = buildBSTFromPreOrderUtil(preOrder, preIndex, preOrder[*preIndex], key, max, n);
        }
    }
    return root;
}

struct Node* buildBSTFromPreOrder(int preOrder[], int n)

{
    int preIndex = 0;
    return buildBSTFromPreOrderUtil(preOrder, &preIndex, preOrder[0], INT_MIN, INT_MAX, n);
}


struct Node* buildBSTFromPostOrderUtil(int postOrder[], int* postIndex, int key, int min, int max, int n)

{
```

```
    if(*postIndex < 0) return NULL;

    struct Node* root = NULL;
    if(key > min && key < max)
    {
        root = createNode(key);
        (*postIndex)--;

        if(*postIndex >= 0)
        {
            root->right = buildBSTFromPostOrderUtil(postOrder, postIndex, postOrder[*postIndex], key, max, n);
        }
        if(*postIndex >= 0)
        {
            root->left = buildBSTFromPostOrderUtil(postOrder, postIndex, postOrder[*postIndex], min, key, n);
        }
    }
    return root;
}

struct Node* buildBSTFromPostOrder(int postOrder[], int n)
{
    int postIndex = n - 1;
 return buildBSTFromPostOrderUtil(postOrder, &postIndex, postOrder[n-1], INT_MIN, INT_MAX, n);
}

void inOrder(struct Node* root)
{
    if (root != NULL)
    {
```

```
        inOrder(root->left);

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

        inOrder(root->right);

    }

}


void preOrder(struct Node* root) {

    if (root != NULL)

    {

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

        preOrder(root->left);

        preOrder(root->right);

    }

}


void postOrder(struct Node* root) {

    if (root != NULL)

    {

        postOrder(root->left);

        postOrder(root->right);

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

    }

}


int main()

{

    int preOrderArr[] = {50, 30, 20, 40, 70, 60, 80};

    int n = sizeof(preOrderArr) / sizeof(preOrderArr[0]);


    struct Node* rootFromPreOrder = buildBSTFromPreOrder(preOrderArr, n);
```

```c
    printf("Tree built from PreOrder Traversal\n");

    printf("In-order: "); inOrder(rootFromPreOrder); printf("\n");

    printf("Post-order: "); postOrder(rootFromPreOrder); printf("\n\n");


    int postOrderArr[] = {20, 40, 30, 60, 80, 70, 50};

    struct Node* rootFromPostOrder = buildBSTFromPostOrder(postOrderArr, n);



    printf("Tree built from PostOrder Traversal\n");

    printf("In-order: "); inOrder(rootFromPostOrder); printf("\n");

    printf("Pre-order: "); preOrder(rootFromPostOrder); printf("\n");


    return 0;

}
```

Output:



Section-E (Sorting & Searching)

Experiment No : 1

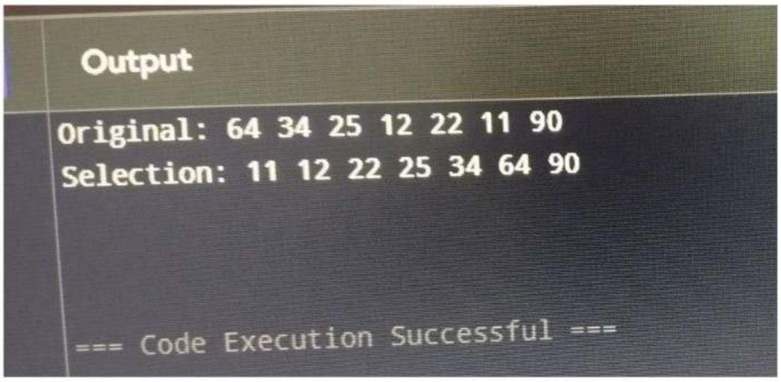
Program description:

1). SELECTION-

Solution:

```
#include <stdio.h>

void selection_sort(int arr[], int n) {
  for (int i = 0; i < n-1; i++) {
    int min_idx = i;
    for (int j = i+1; j < n; j++) {
      if (arr[j] < arr[min_idx]) {
        min_idx = j;
      }
    }
    int temp = arr[min_idx];
    arr[min_idx] = arr[i];
    arr[i] = temp;
  }
}

int main() {
  int arr[] = {64, 34, 25, 12, 22, 11, 90};
  int n = sizeof(arr)/sizeof(arr[0]);

  printf("Original: ");
  for (int i = 0; i < n; i++) printf("%d ", arr[i]);
  printf("\n");

  int copy[] = {64, 34, 25, 12, 22, 11, 90};
  selection_sort(copy, n);

  printf("Selection: ");
  for (int i = 0; i < n; i++) printf("%d ", copy[i]);
  printf("\n\n");
  return 0;
}
```

Output:


Output
Original: 64 34 25 12 22 11 90
Selection: 11 12 22 25 34 64 90
=== Code Execution Successful ===

Experiment No : 2

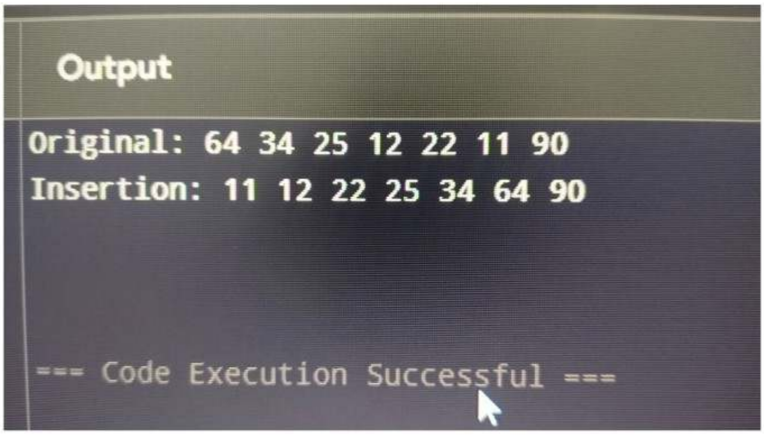
Program description

2.) INSERTION SORT PROGRAM

Solution:

```
#include <stdio.h>

void insertion_sort(int arr[], int n) {
    for (int i = 1; i < n; i++) {
        int key = arr[i];
        int j = i - 1;
        while (j >= 0 && arr[j] > key) {
            arr[j + 1] = arr[j];
            j--;
        }
        arr[j + 1] = key;
    }
}

int main() {
    int arr[] = {64, 34, 25, 12, 22, 11, 90};
    int n = sizeof(arr)/sizeof(arr[0]);

    printf("Original: ");
    for (int i = 0; i < n; i++) printf("%d ", arr[i]);
    printf("\n");

    int copy[] = {64, 34, 25, 12, 22, 11, 90};
    insertion_sort(copy, n);

    printf("Insertion: ");
    for (int i = 0; i < n; i++) printf("%d ", copy[i]);
    printf("\n\n");
    return 0;
}
```

Output:



Experiment No : 3

Program description

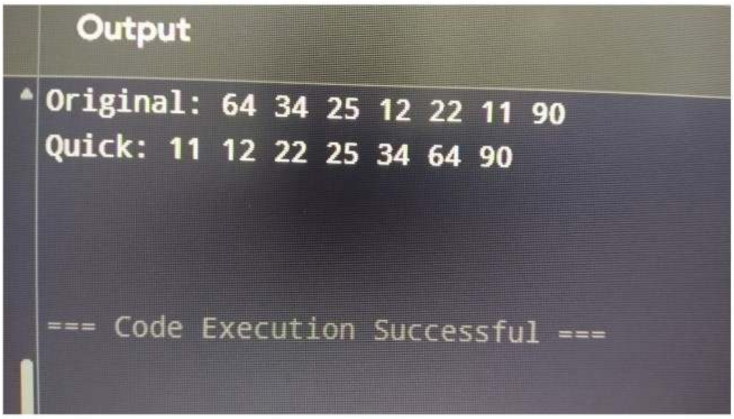
3.) QUICK SORT PROGRAM

Solution :

```
#include <stdio.h>

int partition(int arr[], int low, int high) {
   int pivot = arr[high];
   int i = low - 1;

   for (int j = low; j < high; j++) {
      if (arr[j] <= pivot) {
         i++;
         int temp = arr[i];
         arr[i] = arr[j];
         arr[j] = temp;
      }
   }
   int temp = arr[i + 1];
   arr[i + 1] = arr[high];
   arr[high] = temp;
   return i + 1;
}

void quick_sort(int arr[], int low, int high) {
   if (low < high) {
      int pi = partition(arr, low, high);
      quick_sort(arr, low, pi - 1);
      quick_sort(arr, pi + 1, high);
   }
}

int main() {
   int arr[] = {64, 34, 25, 12, 22, 11, 90};
   int n = sizeof(arr)/sizeof(arr[0]);

   printf("Original: ");
   for (int i = 0; i < n; i++) printf("%d ", arr[i]);
   printf("\n");

   int copy[] = {64, 34, 25, 12, 22, 11, 90};
   quick_sort(copy, 0, n-1);
```

```
printf("Quick: ");
for (int i = 0; i < n; i++) printf("%d ", copy[i]);
printf("\n\n");
return 0;
}
```

Output



Experiment No : 4

Program description

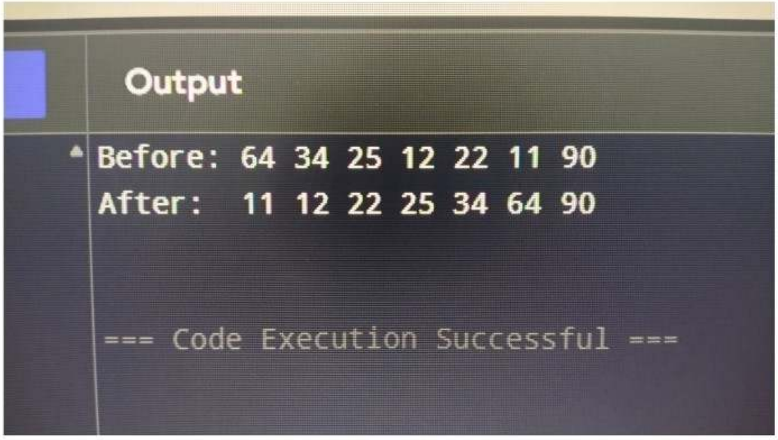
4.) MERGE SORT PROGRAM :

Solution :

```
#include <stdio.h>

void merge(int arr[], int left, int mid, int right) {
    int n1 = mid - left + 1;
    int n2 = right - mid;

    int L[n1], R[n2];
    for (int i = 0; i < n1; i++) L[i] = arr[left + i];
    for (int j = 0; j < n2; j++) R[j] = arr[mid + 1 + j];

    int i = 0, j = 0, k = left;
    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }
    while (i < n1) {
        arr[k] = L[i];
        i++; k++;
    }

 while (j < n2) {
 arr[k] = R[j];
 j++; k++;
 }
}

 if (arr[mid] == key)
 return mid;

 if (arr[mid] < key)
 low = mid + 1;
 else
 high = mid - 1;
 }
```

```
return -1;
}

int main() {
int arr[] = {11, 12, 22, 25, 34, 64, 90};
int n = sizeof(arr)/sizeof(arr[0]);
int key = 25;

printf("Sorted array: ");
for (int i = 0; i < n; i++) printf("%d ", arr[i]);
printf("\n");

int result = binary_search(arr, n, key);

if (result != -1)
printf("Element %d found at index %d\n", key, result);
else
printf("Element %d not found\n", key);

return 0;
}
void merge_sort(int arr[], int left, int right) {
if (left < right) {
int mid = left + (right - left) / 2;
merge_sort(arr, left, mid);
merge_sort(arr, mid + 1, right);
merge(arr, left, mid, right);
}
}
int main() {
int arr[] = {64, 34, 25, 12, 22, 11, 90};
int n = sizeof(arr)/sizeof(arr[0]);

printf("Original: ");
for (int i = 0; i < n; i++) printf("%d ", arr[i]);
printf("\n");

int copy[] = {64, 34, 25, 12, 22, 11, 90};
merge_sort(copy, 0, n-1);

printf("Merge: ");
for (int i = 0; i < n; i++) printf("%d ", copy[i]);
printf("\n");
return 0;
}
```

Output:


Output
Before: 64 34 25 12 22 11 90
After: 11 12 22 25 34 64 90
=== Code Execution Successful ===

Experiment No : 5

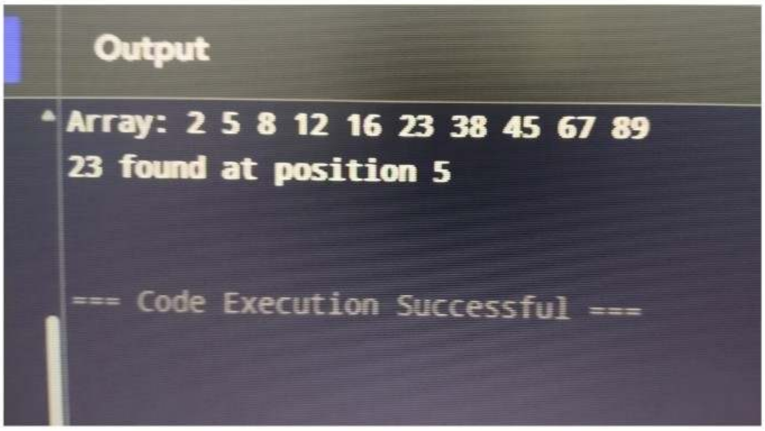
Program description

implementation of Binary Search on a list of numbers stored in an Array.

Solution :

```
#include <stdio.h>

int binary_search(int arr[], int n, int x) {
 int l = 0, r = n - 1;

 while (l <= r) {
 int m = l + (r - l) / 2;

     if (arr[m] == x) return m;
     if (arr[m] < x) l = m + 1;
     else r = m - 1;
   }
   return -1;
}

int main() {
   int a[] = {2, 5, 8, 12, 16, 23, 38, 45, 57};
   int n = 9;

   printf("Array: ");
   for(int i=0; i<n; i++) printf("%d ", a[i]);
   printf("\n");

   int found = binary_search(a, n, 23);
   if(found != -1) printf("23 found at %d\n", found);
   else printf("Not found\n");

   return 0;
}
```

Output:


Output
Array: 2 5 8 12 16 23 38 45 67 89
23 found at position 5
=== Code Execution Successful ===

Experiment No : 6

Program Description

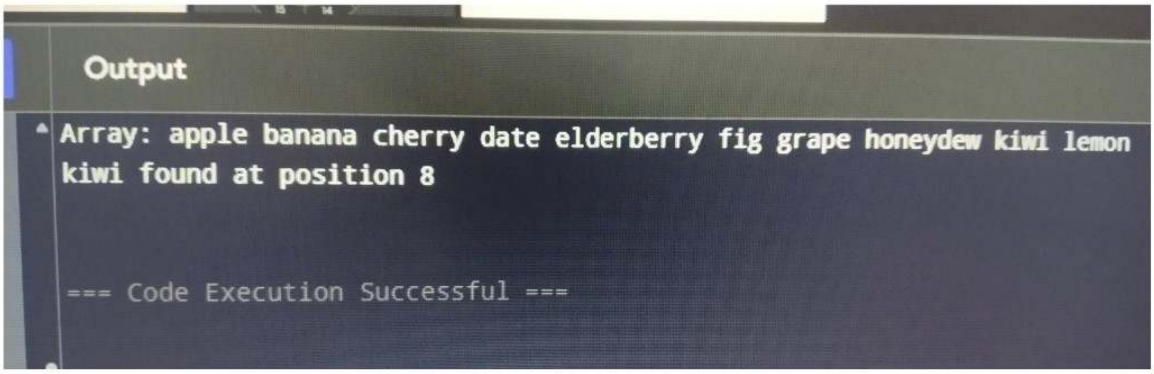
Implementation of Binary Search on a list of strings stored in an Array

Solution:

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

int binary_search_str(char *arr[], int size, char *target) {
   int low = 0;
   int high = size - 1;
while (low <= high) {
 int mid = low + (high - low) / 2;

 if (strcmp(arr[mid], target) == 0)
 return mid;

 if (strcmp(arr[mid], target) < 0)
 low = mid + 1;
 else
 high = mid - 1;
 }

 return -1;
}

int main() {
 char *words[] = {"apple", "banana", "cherry", "date", "elderberry",
 "fig", "grape", "honeydew", "kiwi", "lemon"};
int count = 10;
 char *search_word = "kiwi";

 printf("Array: ");


 for (int i = 0; i < count; i++)
 printf("%s ", words[i]);
 printf("\n");

 int position = binary_search_str(words, count, search_word);

 if (position != -1)
 printf("%s found at position %d\n", search_word, position);
```

```
else
 printf("%s not found\n", search_word);

 return 0;
}
```

Output:



Experiment No : 7

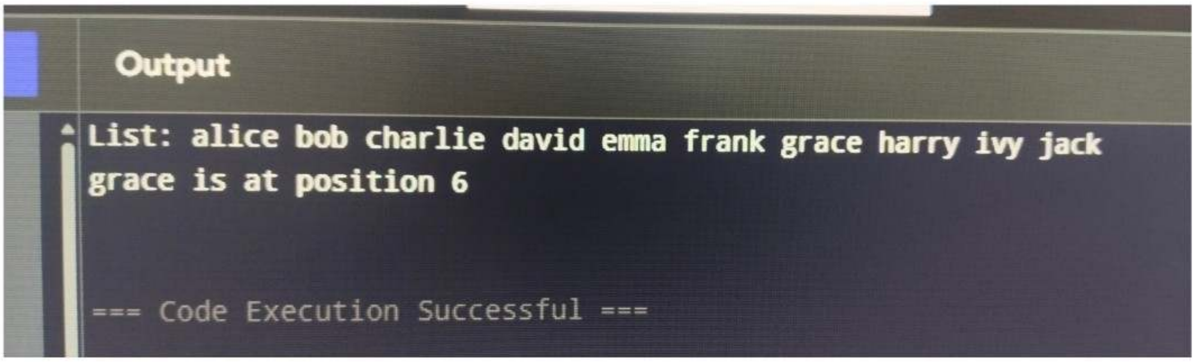
Program Description

Implementation of Binary Search on a list of strings stored in an Array.

Solution:

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

int bin_search_str(char *arr[], int n, char *key) {
   int left = 0, right = n - 1;

   while (left <= right) {
      int middle = left + (right - left) / 2;

      if (strcmp(arr[middle], key) == 0)
         return middle;

      if (strcmp(arr[middle], key) < 0)
         left = middle + 1;
      else
         right = middle - 1;
   }
   return -1;
}

int main() {
   char *names[] = {"alice", "bob", "charlie", "david", "emma",
                "frank", "grace", "harry", "ivy", "jack"};
   int size = 10;
   char *find_name = "grace";

   printf("List: ");
   for (int i = 0; i < size; i++)
      printf("%s ", names[i]);
   printf("\n");

   int found = bin_search_str(names, size, find_name);

   if (found != -1)
      printf("%s is at position %d\n", find_name, found);
   else
      printf("%s not in list\n", find_name);

   return 0;
}
```

Output:


Output
List: alice bob charlie david emma frank grace harry ivy jack
grace is at position 6
=== Code Execution Successful ===

Experiment No : 8

Program Description

Implementation of Binary Search on a list of strings stored in a Single Linked List (optional).

Solution:

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

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

struct Node* head = NULL;

void insert(char *str) {
   struct Node* newnode = (struct Node*)malloc(sizeof(struct Node));
   newnode->data = str;
   newnode->next = head;
   head = newnode;
}

int binary_search_str(struct Node* head, int n, char *key) {
   struct Node* left = head;
   struct Node* right = head;
   int left_count = 0;

   while (right->next) {
      right = right->next;
      if (left_count % 2 == 0 && left->next)
         left = left->next;
      left_count++;
   }
struct Node* l_ptr = head;
 struct Node* r_ptr = right;
 int l_idx = 0;
```

```
    while (l_idx <= n/2) {
    struct Node* mid_ptr = l_ptr;
    int steps = (n/2 - l_idx) / 2;
    for (int i = 0; i < steps; i++) {
      if (mid_ptr && mid_ptr->next) mid_ptr = mid_ptr->next;
    }

    if (strcmp(mid_ptr->data, key) == 0)
      return l_idx + steps;

    if (strcmp(mid_ptr->data, key) < 0) {
      l_ptr = mid_ptr->next;
      l_idx += steps + 1;
    } else {
      r_ptr = mid_ptr;
      n = l_idx + steps;
    }
  }
  return -1;
}

int main() {
  insert("zebra");
  insert("yellow");
  insert("xray");
  insert("wolf");
  insert("violet");
  insert("uncle");
  insert("tiger");
  insert("snake");
  insert("rabbit");
  insert("queen");

printf("List: ");
  struct Node* temp = head;
  int count = 0;
  while (temp) {
    printf("%s ", temp->data);
    temp = temp->next;
    count++;
 }
 printf("\n");
```

```
    int pos = binary_search_str(head, count, "snake");
    if (pos != -1)
        printf("snake found at position %d\n", pos);
    else
        printf("snake not found\n");

    return 0;
}
```

Output: