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Lab File for

CS303 (Data Structure)

Submitted by

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Section-A (Linked List)

Practical No.: 1

Program Description: Implementation of Linked List using array.

Solution:

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
#define MAX 10

struct
{
   int list[MAX];
   int element;
   int pos;
   int length;
};
enum boolean
{
   true, false
};
typedef enum boolean boolean;

int menu(void);
void create(void);
void insert(int, int);
void delet(int);
void find(int);
void display(void);
boolean islistfull(void);
boolean islistempty(void);


int menu()
{
   int ch;
   //clrscr();
   printf("1. Create\n2. Insert\n3. Delete\n4. Count\n5. Find\n6. Display\n7.Exit\n\n Enter your choice :
");
   scanf("%d", &ch);
   printf("\n\n");
   return ch;
}
void create(void)
{
   int element;
```

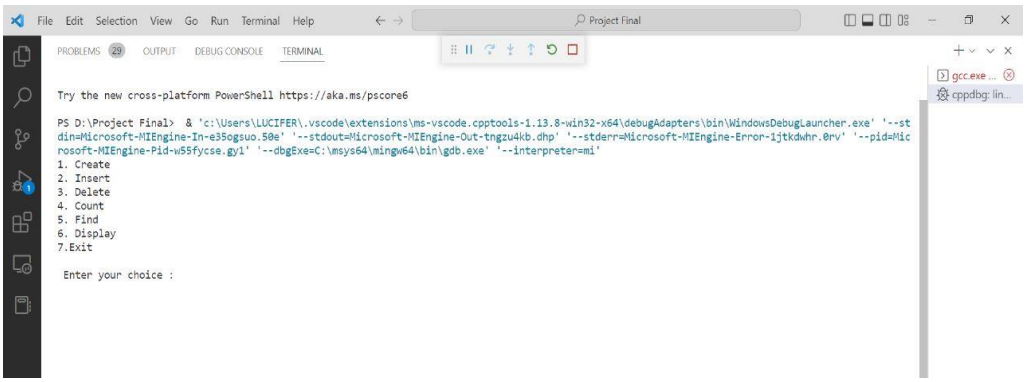
```
   int flag=1;
   while(flag==1)
   {
      printf("Enter element : ");
      scanf("%d", &element);
      l.list[l.length] = element;
      l.length++;
      printf("To insert another element press '1' : ");
      scanf("%d", &flag);
   }
}
void display(void)
{
   int i;
   for (i=0; i<l.length; i++)
      printf("Element %d : %d \n", i+1, l.list[i]);
   printf("Press any key to continue...");
   getch();
}
void insert(int element, int pos)
{
   int i;
   if (pos == 0)
   {
      printf("\nCannot insert an element at 0th position");
      getch();
      return;
   }

   if (pos-1 > l.length)
   {
      printf("\nOnly %d elements exit. Cannot insert at %d position", l.length, pos);
      printf("\n Press any key to continue...");
      getch();
   }
   else
   {
      for (i=l.length; i>=pos-1; i--)
      {
         l.list[i+1] = l.list[i];
      }
      l.list[pos-1] = element;
      l.length++;
   }
}
void delet(int pos)
{
   int i;
```

```
    if(pos == 0)
    {
       printf("\nCannot delete at an element 0th position");
       getch();
       return;
    }
    if (pos > l.length)
    {
       printf("\n\n Only %d elements exit. Cannot delete", l.length, pos);
       printf("\n Press any key to continue...");
       getch();
       return;
    }
    for (i=pos-1; i<l.length; i++)
    {
       l.list[i] = l.list[i+1];
    }
    l.length--;
}

void find(int element)
{
    int i;
    int flag = 1;

    for (i=0; i<l.length; i++)
    {
       if(l.list[i] == element)
       {
          printf ("%d exists at %d position",element, i+1);
          flag = 0;
          printf("\n Press any key to continue...");
          getch();
          break;
       }
    }
    if(flag == 1)
    {
       printf("Element not found.\n Press any key to continue...");
       getch();
    }
}
boolean islistfull(void)
{
    if (l.length == MAX)
       return true;
    else
       return false }
```

```
boolean islistempty(void)
{
   if (l.length == 0)
      return true;
   else
      return false;
}

int main()
{
   int ch;
   int element;
   int pos;
   l.length = 0;
   while(1)
   {
      ch = menu();
      switch (ch)
      {
         case 1:   l.length = 0;
         create();
         break;
         case 2:
         if (islistfull() != true)
         {
            printf("Enter New element: ");
            scanf("%d", &element);
            printf("Enter the Position : ");
            scanf("%d", &pos);
            insert(element, pos);
         }
         else
         {
            printf("List is Full. Cannot insert the element");
            printf("\n Press any key to continue...");
            getch();
         }
         break;
         case 3:
         if (islistempty() != true)
         {
            printf("Enter the position of element to be deleted : ");
            scanf("%d", &pos);
            delet(pos);      }
         else
         {
            printf("List is Empty.");
            printf("\n Press any key to continue...");
```

```
        getch();
         }
         break;
         case 4:
         printf("No of elements in the list is %d", l.length);
         printf("\n Press any key to continue...");
         getch();
         break;
         case 5:
         printf("Enter the element to be searched : ");
         scanf("%d", &element);
         find(element);
         break;
         case 6:
         display();
         break;
         case 7:
         printf("Exit");
         exit(0);
         break;
         default:  printf("Invalid Choice");
         printf("\n Press any key to continue...");
         getch();
      }
   }
}      //function to display the list of elements
```

Output:



Practical No.: 2

Program Description: Implementation of Linked List using pointers.

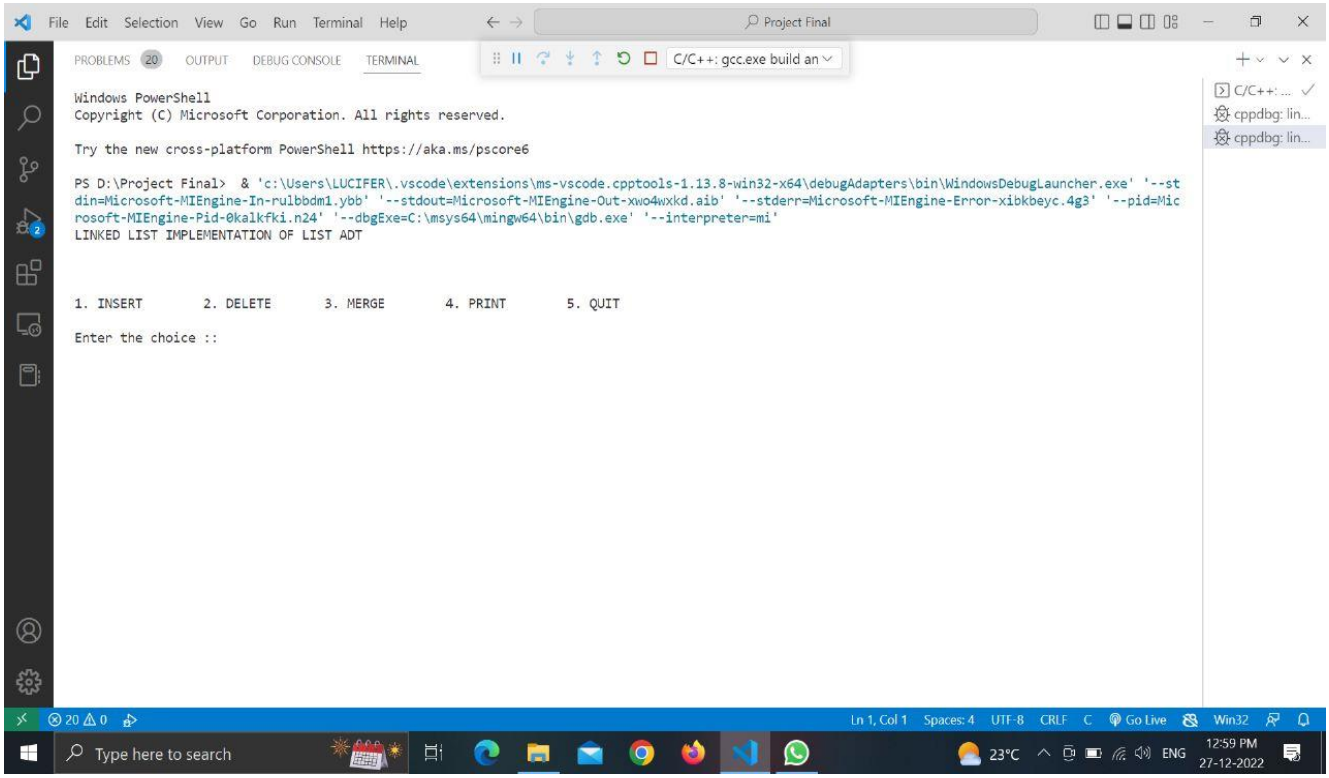
Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct Node;
typedef struct Node * PtrToNode;
typedef PtrToNode List;
typedef PtrToNode Position;

struct Node
{
   int e;
   Position next;
};

void Insert(int x, List l, Position p)
{
   Position TmpCell;
   TmpCell = (struct Node*) malloc(sizeof(struct Node));
   if(TmpCell == NULL)
      printf("Memory out of space\n");
   else
   {
      TmpCell->e = x;
      TmpCell->next = p->next;
      p->next = TmpCell;
   }
}

int isLast(Position p)
{
   return (p->next == NULL);
}

Position FindPrevious(int x, List l)
{
   Position p = l;
   while(p->next != NULL && p->next->e != x)
      p = p->next;
   return p;
}

void Delete(int x, List l)
{
   Position p, TmpCell;
   p = FindPrevious(x, l);
```

```
  if(!isLast(p))
  {
     TmpCell = p->next;
     p->next = TmpCell->next;
     free(TmpCell);
  }
  else
     printf("Element does not exist!!!\n");
}

void Display(List l)
{
  printf("The list element are :: ");
  Position p = l->next;
  while(p != NULL)
  {
     printf("%d -> ", p->e);
     p = p->next;
  }
}

void Merge(List l, List l1)
{
  int i, n, x, j;
  Position p;
  printf("Enter the number of elements to be merged :: ");
  scanf("%d",&n);

  for(i = 1; i <= n; i++)
  {
     p = l1;
     scanf("%d", &x);
     for(j = 1; j < i; j++)
        p = p->next;
     Insert(x, l1, p);
  }
  printf("The new List :: ");
  Display(l1);
  printf("The merged List ::");
  p = l;
  while(p->next != NULL)
  {
     p = p->next;
  }
  p->next = l1->next;
  Display(l);
}
```

```
int main()
{
   int x, pos, ch, i;
   List l, l1;
   l = (struct Node *) malloc(sizeof(struct Node));
   l->next = NULL;
   List p = l;
   printf("LINKED LIST IMPLEMENTATION OF LIST ADT\n\n");
   do
   {
      printf("\n\n1. INSERT\t 2. DELETE\t 3. MERGE\t 4. PRINT\t 5. QUIT\n\nEnter the choice :: ");
      scanf("%d", &ch);
      switch(ch)
      {
      case 1:
         p = l;
         printf("Enter the element to be inserted :: ");
         scanf("%d",&x);
         printf("Enter the position of the element :: ");
         scanf("%d",&pos);

         for(i = 1; i < pos; i++)
         {
            p = p->next;
         }
         Insert(x,l,p);
         break;

      case 2:
         p = l;
         printf("Enter the element to be deleted :: ");
         scanf("%d",&x);
         Delete(x,p);
         break;

      case 3:
         l1 = (struct Node *) malloc(sizeof(struct Node));
         l1->next = NULL;
         Merge(l, l1);
         break;

      case 4:
         Display(l);
         break;
      }
   }
   while(ch<5);
   return 0;}
```

Output:


File Edit Selection View Go Run Terminal Help
Project Final
PROBLEMS 20 OUTPUT DEBUG CONSOLE TERMINAL
C/C++: gcc.exe build an
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS D:\Project Final> & 'c:\Users\LUCIFER\.vscode\extensions\ms-vscode.cpptools-1.13.8-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-rulbbdm1.ybb' '--stdout=Microsoft-MIEngine-Out-xwo4wxkd.aib' '--stderr=Microsoft-MIEngine-Error-xibkbeyc.4g3' '--pid=Microsoft-MIEngine-Pid-0kalkfki.n24' '--dbgExe=C:\msys64\mingw64\bin\gdb.exe' '--interpreter=mi'
LINKED LIST IMPLEMENTATION OF LIST ADT
1. INSERT 2. DELETE 3. MERGE 4. PRINT 5. QUIT
Enter the choice ::
C/C++:...
cppdbg: lin...
cppdbg: lin...
Ln 1, Col 1 Spaces: 4 UTF-8 CRLF C Go Live Win32
Type here to search
23°C ENG 12:59 PM 27-12-2022

Practical No.: 3

Program Description: Implementation of Doubly Linked List using Pointers

Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
   struct node *prev;
   struct node *next;
   int data;
};
struct node *head;
void insertionFirst();
void insertionLast();
void insertionLoc();
void deleteFirst();
void deleteLast();
void deleteLoc();
void printList();
void searchList();
int main()
{
   int choice =0;
   while(choice != 9)
   {
      printf("\nDoubly Linked ListMenu\n");
      printf("\n1.Insert at begining\n");
      printf("2.Insert at last\n");
      printf("3.Insert at any random location\n");
      printf("4.Delete from Beginning\n");
      printf("5.Delete from last\n");
      printf("6.Delete the node after the given data\n");
      printf("7.Search\n");
      printf("8.Show\n");
      printf("9.Exit\n");
      printf("\nEnter your choice?\n");
      scanf("\n%d",&choice);
      switch(choice)
      {
         case 1:
            insertionFirst();
            break;
         case 2:
            insertionLast();
            break;
         case 3:
            insertionLoc();
```

```
            break;
        case 4:
            deleteFirst();
            break;
        case 5:
            deleteLast();
            break;
        case 6:
            deleteLoc();
            break;
        case 7:
            searchList();
            break;
        case 8:
            printList();
            break;
        case 9:
            exit(0);
            break;
        default:
            printf("Invalid Choice!!! Please try again....");
      }
   }
   return 0;
}
void insertionFirst()
{
  struct node *ptr;
  int item;
  ptr = (struct node *)malloc(sizeof(struct node));
  if(ptr == NULL)
  {
     printf("\nOVERFLOW!!!");
  }
  else
  {
   printf("\nEnter value to insert: ");
   scanf("%d",&item);

  if(head==NULL)
  {
     ptr->next = NULL;
     ptr->prev=NULL;
     ptr->data=item;
     head=ptr;
  }
  else
  {
```

```
    ptr->data=item;
    ptr->prev=NULL;
    ptr->next = head;
    head->prev=ptr;
    head=ptr;
  }
  printf("\nNode inserted successfully....\n");
}

}
void insertionLast()
{
  struct node *ptr,*temp;
  int item;
  ptr = (struct node *) malloc(sizeof(struct node));
  if(ptr == NULL)
  {
    printf("\nOVERFLOW!!!");
  }
  else
  {
    printf("\nEnter value to insert: ");
    scanf("%d",&item);
     ptr->data=item;
    if(head == NULL)
    {
      ptr->next = NULL;
      ptr->prev = NULL;
      head = ptr;
    }
    else
    {
      temp = head;
      while(temp->next!=NULL)
      {
        temp = temp->next;
      }
      temp->next = ptr;
      ptr ->prev=temp;
      ptr->next = NULL;
      }

    }
   printf("\nNode inserted successfully\n");
  }
void insertionLoc()
{
  struct node *ptr,*temp;
```

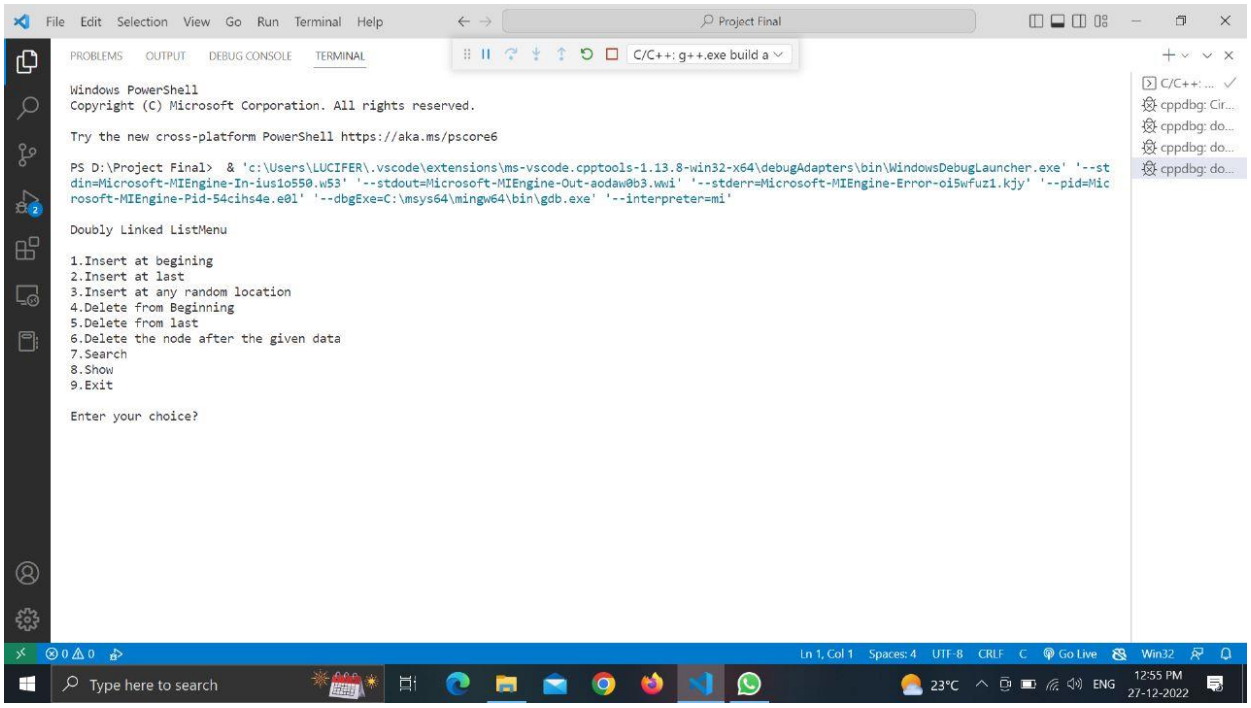
```
  int item,loc,i;
  ptr = (struct node *)malloc(sizeof(struct node));
  if(ptr == NULL)
  {
     printf("\n OVERFLOW!!!");
  }
  else
  {
     temp=head;
     printf("Enter the location: ");
     scanf("%d",&loc);
     for(i=0;i<loc;i++)
     {
        temp = temp->next;
        if(temp == NULL)
        {
           printf("\nThere are less than %d elements\n", loc);
           return;
        }
     }
     printf("Enter value: ");
     scanf("%d",&item);
     ptr->data = item;
     ptr->next = temp->next;
     ptr -> prev = temp;
     temp->next = ptr;
     temp->next->prev=ptr;
     printf("\nNode inserted successfully...\n");
  }
}
void deleteFirst()
{
   struct node *ptr;
   if(head == NULL)
   {
      printf("\nUNDERFLOW!!!");
   }
   else if(head->next == NULL)
   {
      head = NULL;
      free(head);
      printf("\nNode deleted successfully....\n");
   }
   else
   {
      ptr = head;
      head = head -> next;
      head -> prev = NULL;
```

```
        free(ptr);
        printf("\nNode deleted successfully....\n");
    }

}
void deleteLast()
{
    struct node *ptr;
    if(head == NULL)
    {
        printf("\nUNDERFLOW!!!");
    }
    else if(head->next == NULL)
    {
        head = NULL;
        free(head);
        printf("\nNode deleted successfully...\n");
    }
    else
    {
        ptr = head;
        if(ptr->next != NULL)
        {
            ptr = ptr -> next;
        }
        ptr -> prev -> next = NULL;
        free(ptr);
        printf("\nNode deleted successfully...\n");
    }
}
void deleteLoc()
{
    struct node *ptr, *temp;
    int val;
    printf("\nEnter the data after which the node is to be deleted : ");
    scanf("%d", &val);
    ptr = head;
    while(ptr -> data != val)
    ptr = ptr -> next;
    if(ptr -> next == NULL)
    {
        printf("\nCan't delete....\n");
    }
    else if(ptr -> next -> next == NULL)
    {
        ptr ->next = NULL;
    }
    else
```

```
    {
        temp = ptr -> next;
        ptr -> next = temp -> next;
        temp -> next -> prev = ptr;
        free(temp);
        printf("\nNode deleted successfully...\n");
    }
}
void printList()
{
    struct node *ptr;
    printf("\nThe Doubly Linked List is\nSTART %c ",29);
    ptr = head;
    while(ptr != NULL)
    {
        printf("%d %c ",ptr->data,29);
        ptr=ptr->next;
    }
    printf("NULL\n\n");
}
void searchList()
{
    struct node *ptr;
    int item,i=0,flag;
    ptr = head;
    if(ptr == NULL)
    {
        printf("\nEmpty List\n");
    }
    else
    {
        printf("\nEnter item which you want to search?\n");
        scanf("%d",&item);
        while (ptr!=NULL)
        {
            if(ptr->data == item)
            {
                printf("\nItem %d found at location %d ",item, i+1);
                flag=0;
                break;
            }
            else
            {
                flag=1;
            }
            i++;
            ptr = ptr -> next;
        }
```

```
    if(flag==1)
    {
       printf("\nItem %d not found\n",item);
    }
  }

}
```

Output:



Practical No.: 4

Program Description: Implementation of Circular Single Linked List using Pointers.

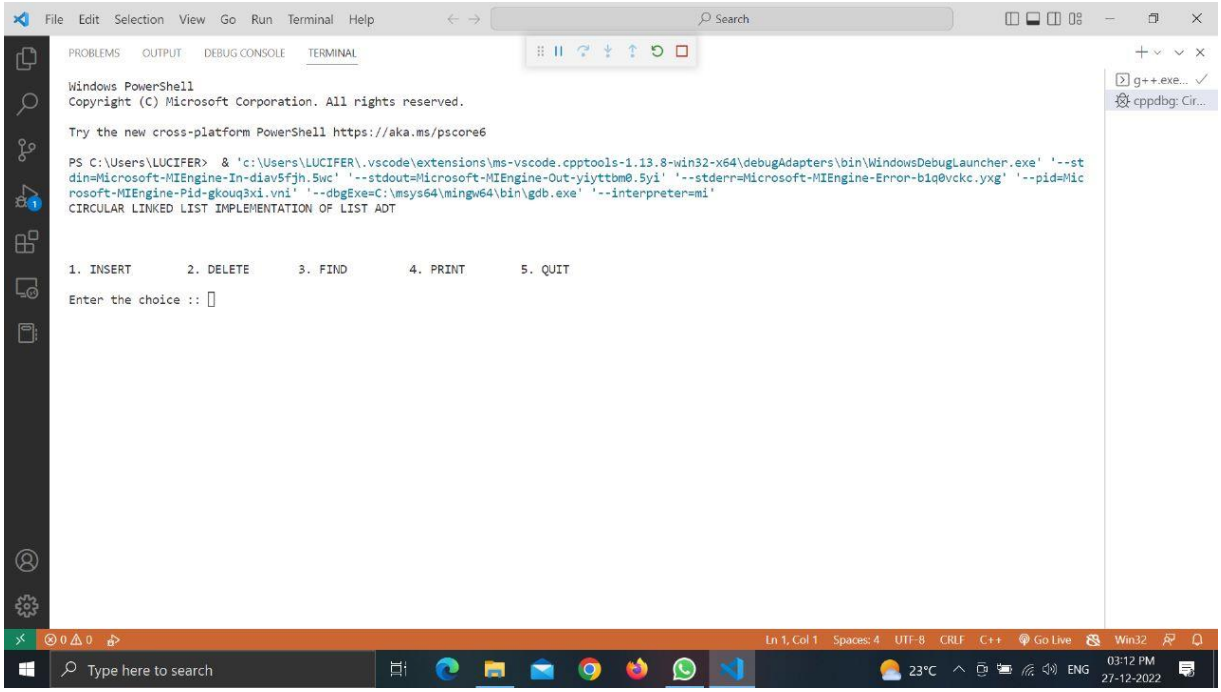
Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct Node;
typedef struct Node * PtrToNode;
typedef PtrToNode List;
typedef PtrToNode Position;

struct Node
{
   int e;
   Position next;
};

void Insert(int x, List l, Position p)
{
   Position TmpCell;
   TmpCell = (struct Node*) malloc(sizeof(struct Node));
   if(TmpCell == NULL)
      printf("Memory out of space\n");
   else
   {
      TmpCell->e = x;
      TmpCell->next = p->next;
      p->next = TmpCell;
   }
}
int isLast(Position p, List l)
{
   return (p->next == l);
}
Position FindPrevious(int x, List l)
{
   Position p = l;
   while(p->next != l && p->next->e != x)
      p = p->next;
   return p;
}

Position Find(int x, List l)
{
   Position p = l->next;
   while(p != l && p->e != x)
      p = p->next;
   return p; }
```

```
void Delete(int x, List l)
{
   Position p, TmpCell;
   p = FindPrevious(x, l);
   if(!isLast(p, l))
   {
      TmpCell = p->next;
      p->next = TmpCell->next;
      free(TmpCell);
   }
   else
      printf("Element does not exist!!!\n");
}

void Display(List l)
{
   printf("The list element are :: ");
   Position p = l->next;
   while(p != l)
   {
      printf("%d -> ", p->e);
      p = p->next;
   }
}

int main()
{
   int x, pos, ch, i;
   List l, l1;
   l = (struct Node *) malloc(sizeof(struct Node));
   l->next = l;
   List p = l;
   printf("CIRCULAR LINKED LIST IMPLEMENTATION OF LIST ADT\n\n");
   do
   {
      printf("\n\n1. INSERT\t 2. DELETE\t 3. FIND\t 4. PRINT\t 5. QUIT\n\nEnter the choice :: ");
      scanf("%d", &ch);
      switch(ch)
      {
         case 1:
            p = l;
            printf("Enter the element to be inserted :: ");
            scanf("%d",&x);
            printf("Enter the position of the element :: ");
            scanf("%d",&pos);
            for(i = 1; i < pos; i++)
            {
               p = p->next;
```

```
            }
            Insert(x,l,p);
            break;

        case 2:
            p = l;
            printf("Enter the element to be deleted :: ");
            scanf("%d",&x);
            Delete(x,p);
            break;

        case 3:
            p = l;
            printf("Enter the element to be searched :: ");
            scanf("%d",&x);
            p = Find(x,p);
            if(p == l)
               printf("Element does not exist!!!\n");
            else
               printf("Element exist!!!\n");
            break;

        case 4:
            Display(l);
            break;
      }
   }while(ch<5);
   return 0;
}
```

Output:



Practical No.: 5

Program Description: Implementation of Circular Doubly Linked List using Pointers.

Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
   struct node *prev;
   struct node *next;
   int data;
};
struct node *head;
void insertion_beginning();
void insertion_last();
void deletion_beginning();
void deletion_last();
void display();
void search();
int main ()
{
int choice =0;
   while(choice != 9)
   {
      printf("\n*********Main Menu*********\n");
      printf("\nChoose one option from the following list ...\n");
      printf("\n===============================================\n");
      printf("\n1.Insert in Beginning\n2.Insert at last\n3.Delete from Beginning\n4.Delete from
last\n5.Search\n6.Show\n7.Exit\n");
      printf("\nEnter your choice?\n");
      scanf("\n%d",&choice);
      switch(choice)
      {
         case 1:
         insertion_beginning();
         break;
         case 2:
               insertion_last();
         break;
         case 3:
         deletion_beginning();
         break;
         case 4:
         deletion_last();
         break;
         case 5:
         search();
         break;
```

```
            case 6:
            display();
            break;
            case 7:
            exit(0);
            break;
            default:
            printf("Please enter valid choice..");
        }
    }
}
void insertion_beginning()
{
   struct node *ptr,*temp;
   int item;
   ptr = (struct node *)malloc(sizeof(struct node));
   if(ptr == NULL)
   {
      printf("\nOVERFLOW");
   }
   else
   {
    printf("\nEnter Item value");
    scanf("%d",&item);
    ptr->data=item;
   if(head==NULL)
   {
     head = ptr;
     ptr -> next = head;
     ptr -> prev = head;
   }
   else
   {
      temp = head;
    while(temp -> next != head)
    {
       temp = temp -> next;
    }
    temp -> next = ptr;
    ptr -> prev = temp;
    head -> prev = ptr;
    ptr -> next = head;
    head = ptr;
   }
   printf("\nNode inserted\n");
}

}
```

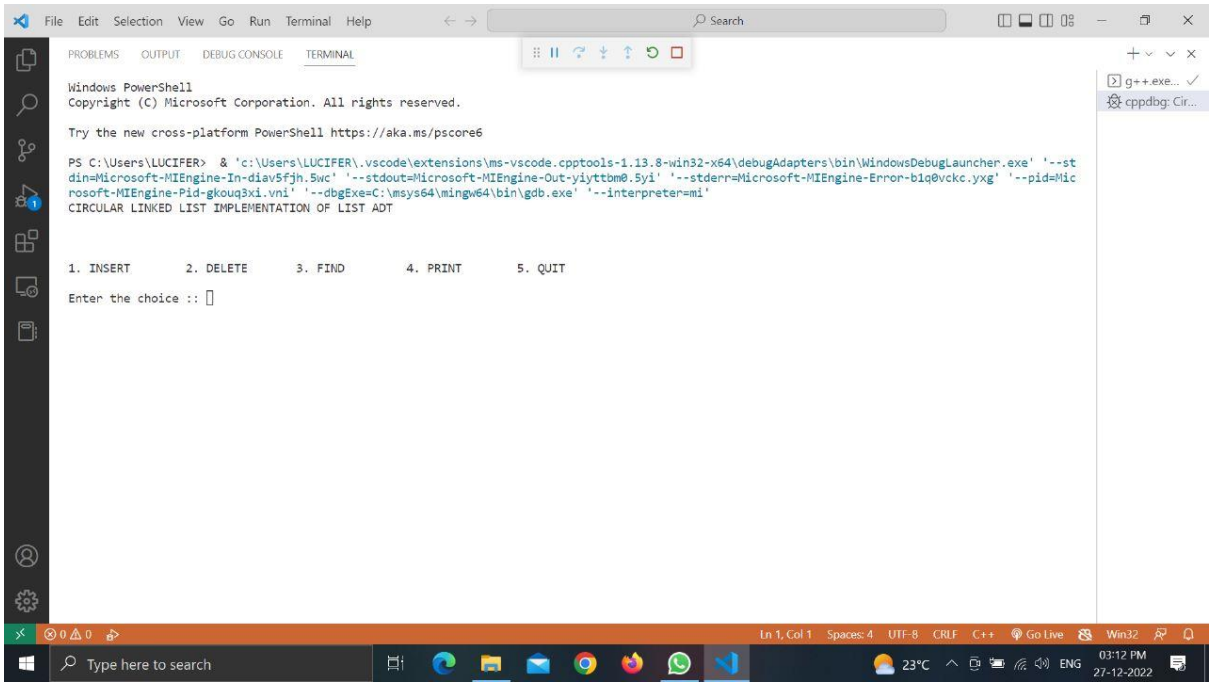
```
void insertion_last()
{
  struct node *ptr,*temp;
  int item;
  ptr = (struct node *) malloc(sizeof(struct node));
  if(ptr == NULL)
  {
     printf("\nOVERFLOW");
  }
  else
  {
     printf("\nEnter value");
     scanf("%d",&item);
      ptr->data=item;
     if(head == NULL)
     {
        head = ptr;
        ptr -> next = head;
        ptr -> prev = head;
     }
     else
     {
       temp = head;
       while(temp->next !=head)
       {
          temp = temp->next;
       }
       temp->next = ptr;
       ptr ->prev=temp;
       head -> prev = ptr;
    ptr -> next = head;
      }
  }
    printf("\nnode inserted\n");
}

void deletion_beginning()
{
   struct node *temp;
   if(head == NULL)
   {
      printf("\n UNDERFLOW");
   }
   else if(head->next == head)
   {
      head = NULL;
      free(head);
      printf("\nnode deleted\n");
```

```
    }
    else
    {
        temp = head;
        while(temp -> next != head)
        {
            temp = temp -> next;
        }
        temp -> next = head -> next;
        head -> next -> prev = temp;
        free(head);
        head = temp -> next;
    }

}
void deletion_last()
{
    struct node *ptr;
    if(head == NULL)
    {
        printf("\n UNDERFLOW");
    }
    else if(head->next == head)
    {
        head = NULL;
        free(head);
        printf("\nnode deleted\n");
    }
    else
    {
        ptr = head;
        if(ptr->next != head)
        {
            ptr = ptr -> next;
        }
        ptr -> prev -> next = head;
        head -> prev = ptr -> prev;
        free(ptr);
        printf("\nnode deleted\n");
    }
}

void display()
{
    struct node *ptr;
    ptr=head;
    if(head == NULL)
    {
```

```
        printf("\nnothing to print");
    }
    else
    {
        printf("\n printing values ... \n");

        while(ptr -> next != head)
        {

            printf("%d\n", ptr -> data);
            ptr = ptr -> next;
        }
        printf("%d\n", ptr -> data);
    }

}

void search()
{
    struct node *ptr;
    int item,i=0,flag=1;
    ptr = head;
    if(ptr == NULL)
    {
        printf("\nEmpty List\n");
    }
    else
    {
        printf("\nEnter item which you want to search?\n");
        scanf("%d",&item);
        if(head ->data == item)
        {
        printf("item found at location %d",i+1);
        flag=0;
        }
        else
        {
        while (ptr->next != head)
        {
            if(ptr->data == item)
            {
                printf("item found at location %d ",i+1);
                flag=0;
                break;
            }
            else
            {
                flag=1;
```

```
        }
        i++;
        ptr = ptr -> next;
      }
      }
      if(flag != 0)
      {
        printf("Item not found\n");
      }
   }

}
```

Output:



Section-B (Stack)

Practical No.: 1

Program Description: Implementation of stack using array.

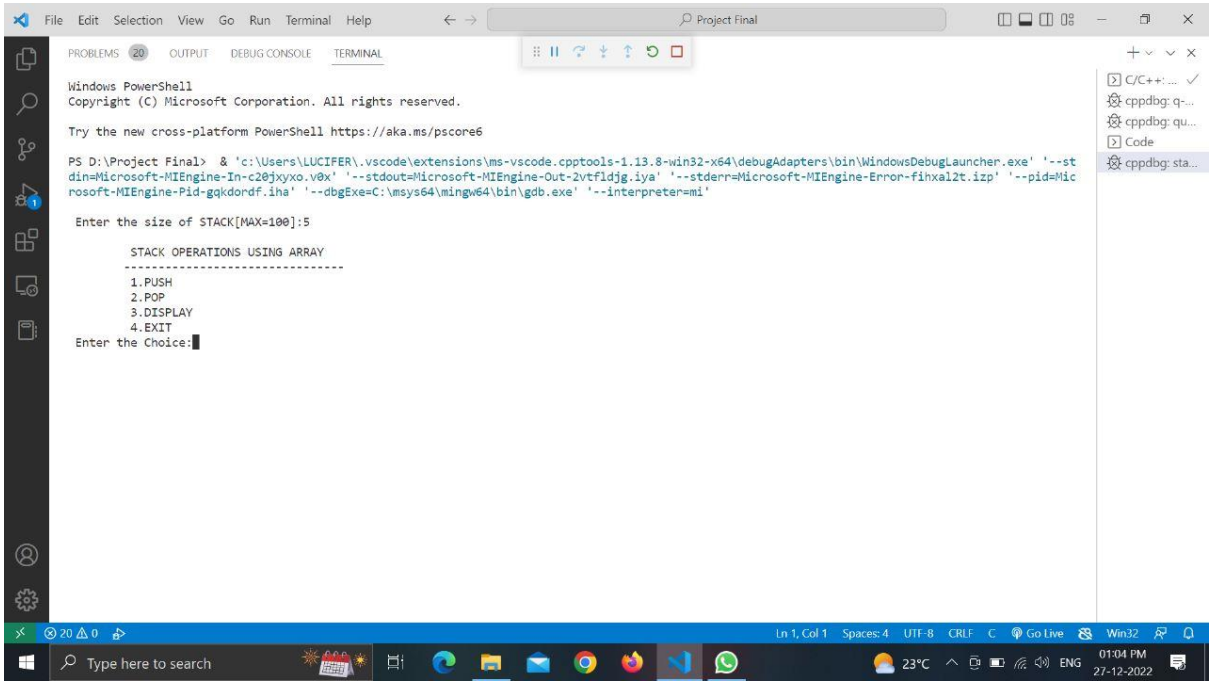
Solution:

```
#include<stdio.h>
int stack[100],choice,n,top,x,i;
void push(void);
void pop(void);
void display(void);

void push()
{
   if(top>=n-1)
   {
      printf("\n\tSTACK is over flow");

   }
   else
   {
      printf(" Enter a value to be pushed:");
      scanf("%d",&x);
      top++;
      stack[top]=x;
   }
}
void pop()
{
   if(top<=-1)
   {
      printf("\n\t Stack is under flow");
   }
   else
   {
      printf("\n\t The popped elements is %d",stack[top]);
      top--;
   }
}
void display()
{
   if(top>=0)
   {
      printf("\n The elements in STACK \n");
      for(i=top; i>=0; i--)
         printf("\n%d",stack[i]);
      printf("\n Press Next Choice");
```

```
    }
    else
    {
        printf("\n The STACK is empty");
    }

}

int main()
{
    //clrscr();
    top=-1;
    printf("\n Enter the size of STACK[MAX=100]:");
    scanf("%d",&n);
    printf("\n\t STACK OPERATIONS USING ARRAY");
    printf("\n\t--------------------------------");
    printf("\n\t 1.PUSH\n\t 2.POP\n\t 3.DISPLAY\n\t 4.EXIT");
    do
    {
        printf("\n Enter the Choice:");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1:
            {
                push();
                break;
            }
            case 2:
            {
                pop();
                break;
            }
            case 3:
            {
                display();
                break;
            }
            case 4:
            {
                printf("\n\t EXIT POINT ");
                break;
            }
            default:
            {
                printf ("\n\t Please Enter a Valid Choice(1/2/3/4)");
            }
                }
```

```
    }
    while(choice!=4);
    return 0;
}
```

Output:



Practical No.: 2

Program Description: Implementation of Stack using Pointers.

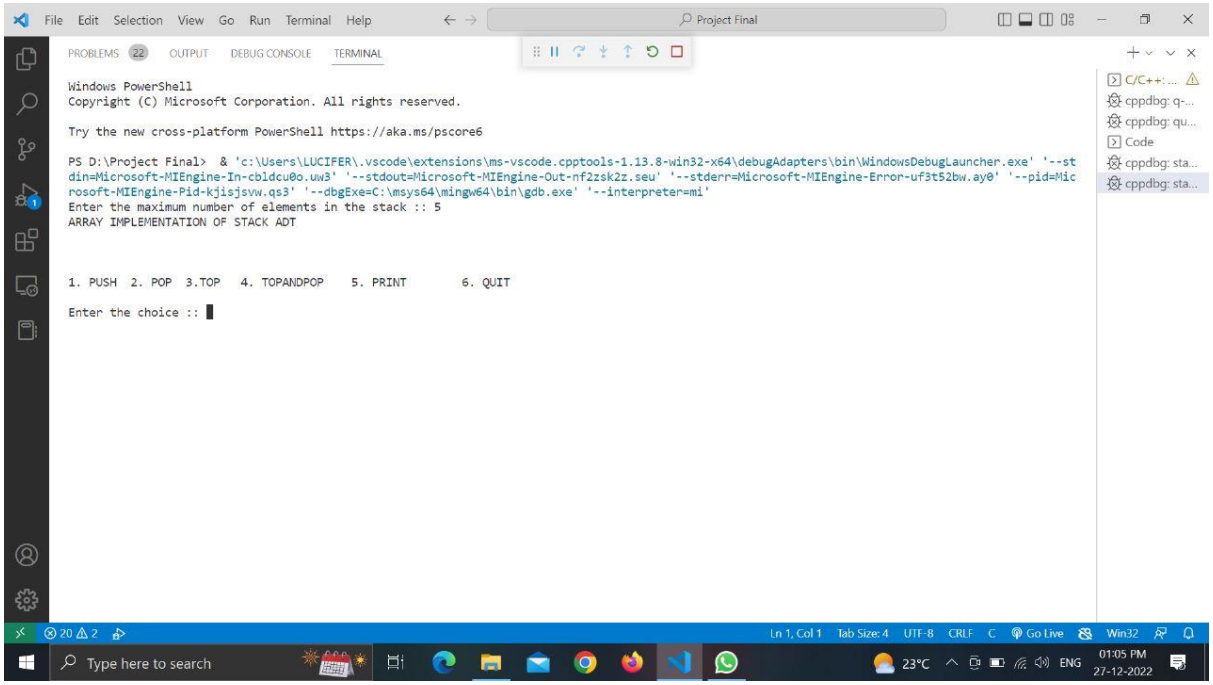
Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct stackarr;
typedef struct stackarr * Stack;

struct stackarr
{
   int Capacity;
   int TopOfStack;
   int *Array;
};

void MakeEmpty(Stack s)
{
   s->TopOfStack = -1;
}

Stack CreateStack(int MaxElements)
{
   Stack s;
   s = (struct stackarr*) malloc(sizeof(struct stackarr));
   s->Array = (int *)malloc(sizeof(int) * MaxElements);
   s->Capacity = MaxElements;
   MakeEmpty(s);
   return s;
}

void DisposeStack(Stack s)
{
   if(s != NULL)
   {
      free(s->Array);
      free(s);
   }
}

int isFull(Stack s)
{
   return s->TopOfStack == s->Capacity - 1;
}

int isEmpty(Stack s)
{
   return s->TopOfStack == -1;
```

```
}

void Push(int x, Stack s)
{
   if(isFull(s))
      printf("Full Stack\n\n");
   else
      s->Array[++s->TopOfStack] = x;
}

void Pop(Stack s)
{
   if(isEmpty(s))
      printf("Empty Stack\n\n");
   else
      s->TopOfStack--;
}

int Top(Stack s)
{
   if(isEmpty(s))
      printf("Empty Stack\n\n");
   else
      return s->Array[s->TopOfStack];
}

int TopAndPop(Stack s)
{
   if(isEmpty(s))
      printf("Empty Stack\n\n");
   else
      return s->Array[s->TopOfStack--];
}

void Display(Stack s)
{
   int i;
   if(isEmpty(s))
      printf("Empty Stack\n\n");
   else
   {
      printf("The Stack Elements are :: ");
      for(i=s->TopOfStack; i >= 0; i--)
         printf("%d  ",s->Array[i]);
      printf("\n\n");
   }
}
```

```c
int main()
{
   int n, x, ch, i;
   Stack s;
   printf("Enter the maximum number of elements in the stack :: ");
   scanf("%d", &n);
   s = CreateStack(n);
   printf("ARRAY IMPLEMENTATION OF STACK ADT\n\n");
   do
   {
      printf("\n\n1. PUSH\t 2. POP\t 3.TOP \t 4. TOPANDPOP\t 5. PRINT\t 6. QUIT\n\nEnter the choice :: ");
      scanf("%d", &ch);
      switch(ch)
      {
         case 1:
            printf("Enter the element to be pushed :: ");
            scanf("%d",&x);
            Push(x,s);
            break;

         case 2:
            Pop(s);
            break;

         case 3:
            printf("The Top element in the stack :: %d\n\n", Top(s));
            break;

         case 4:
            printf("The popped top element in the stack :: %d\n\n", TopAndPop(s));
            break;

         case 5:
            Display(s);
            break;
      }
   }while(ch<6);
   DisposeStack(s);
   return 0;
}
```

OUTPUT:


File Edit Selection View Go Run Terminal Help
Project Final
PROBLEMS 22 OUTPUT DEBUG CONSOLE TERMINAL
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS D:\Project Final> & 'c:\Users\LUCIFER\.vscode\extensions\ms-vscode.cpptools-1.13.8-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-cbldcu0o.uw3' '--stdout=Microsoft-MIEngine-Out-nf2zsk2z.seu' '--stderr=Microsoft-MIEngine-Error-uf3t52bw.ay0' '--pid=Microsoft-MIEngine-Pid-kjisjsvw.qs3' '--dbgExe=C:\msys64\mingw64\bin\gdb.exe' '--interpreter=mi'
Enter the maximum number of elements in the stack :: 5
ARRAY IMPLEMENTATION OF STACK ADT
1. PUSH 2. POP 3.TOP 4. TOPANDPOP 5. PRINT 6. QUIT
Enter the choice ::
C/C++:...
cppdbg: q-...
cppdbg: qu...
Code
cppdbg: sta...
cppdbg: sta...
Ln 1, Col 1 Tab Size: 4 UTF-8 CRLF C Go Live Win32
Type here to search
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27-12-2022

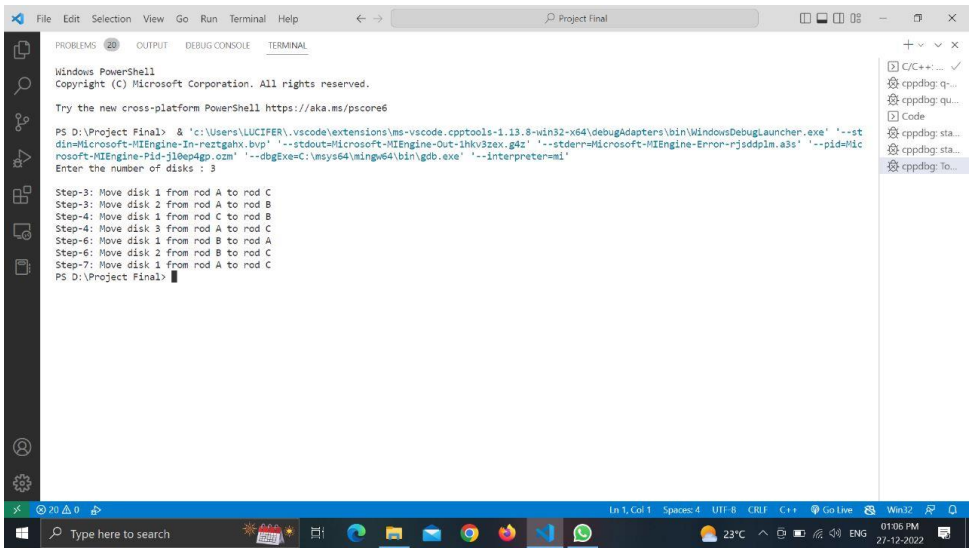
Practical No.: 3

Program Description: Program for Tower of Hanoi using recursion.

Solution:

```c
#include<stdio.h>
int step=0;
// C recursive function to solve tower of hanoi puzzle
void towerOfHanoi(int n, char from_rod, char to_rod, char aux_rod)
{
   step++;
   if (n == 1)
   {
      printf("\nStep-%d: Move disk 1 from rod %c to rod %c", step,from_rod, to_rod);
      return;
   }
   towerOfHanoi(n-1, from_rod, aux_rod, to_rod);
   printf("\nStep-%d: Move disk %d from rod %c to rod %c", step,n, from_rod, to_rod);
   towerOfHanoi(n-1, aux_rod, to_rod, from_rod);
}

int main()
{
   int n; // Number of disks
   printf("Enter the number of disks : ");
   scanf("%d",&n);
   towerOfHanoi(n, 'A', 'C', 'B');  // A, B and C are names of rods
   return 0;
}
```

Output:



File Submitted by: *Neeraj Verma (0902CS231061)*

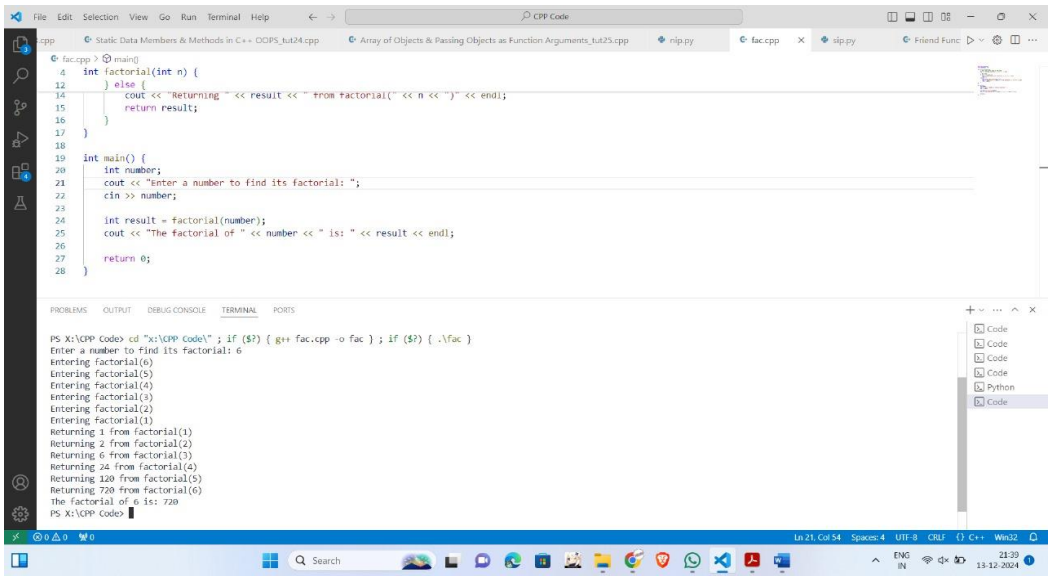
Practical No.: 4

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 <iostream>

using namespace std;


int factorial(int n) {
   // Print the current state of the stack
   cout << "Entering factorial(" << n << ")" << endl;
   // Base case
   if (n == 0 || n == 1) {
      cout << "Returning 1 from factorial(" << n << ")" << endl;
      return 1;
   } else {
      int result = n * factorial(n - 1);
      cout << "Returning " << result << " from factorial(" << n << ")" << endl;
      return result;
   }
}
int main() {
   int number;
   cout << "Enter a number to find its factorial: ";
   cin >> number;


   int result = factorial(number);
   cout << "The factorial of " << number << " is: " << result << endl;


   return 0;
}
```

OUTPUT:


int factorial(int n) {
} else {
cout << "Returning " << result << " from factorial(" << n << ")" << endl;
return result;
}
}
int main() {
int number;
cout << "Enter a number to find its factorial: ";
cin >> number;
int result = factorial(number);
cout << "The factorial of " << number << " is: " << result << endl;
return 0;
}
PS X:\CPP Code> cd "x:\CPP Code\" ; if ($?) { g++ fac.cpp -o fac } ; if ($?) { .\fac }
Enter a number to find its factorial: 6
Entering factorial(6)
Entering factorial(5)
Entering factorial(4)
Entering factorial(3)
Entering factorial(2)
Entering factorial(1)
Returning 1 from factorial(1)
Returning 2 from factorial(2)
Returning 6 from factorial(3)
Returning 24 from factorial(4)
Returning 120 from factorial(5)
Returning 720 from factorial(6)
The factorial of 6 is: 720
PS X:\CPP Code>

Section-C (Queue)

Practical No.: 1

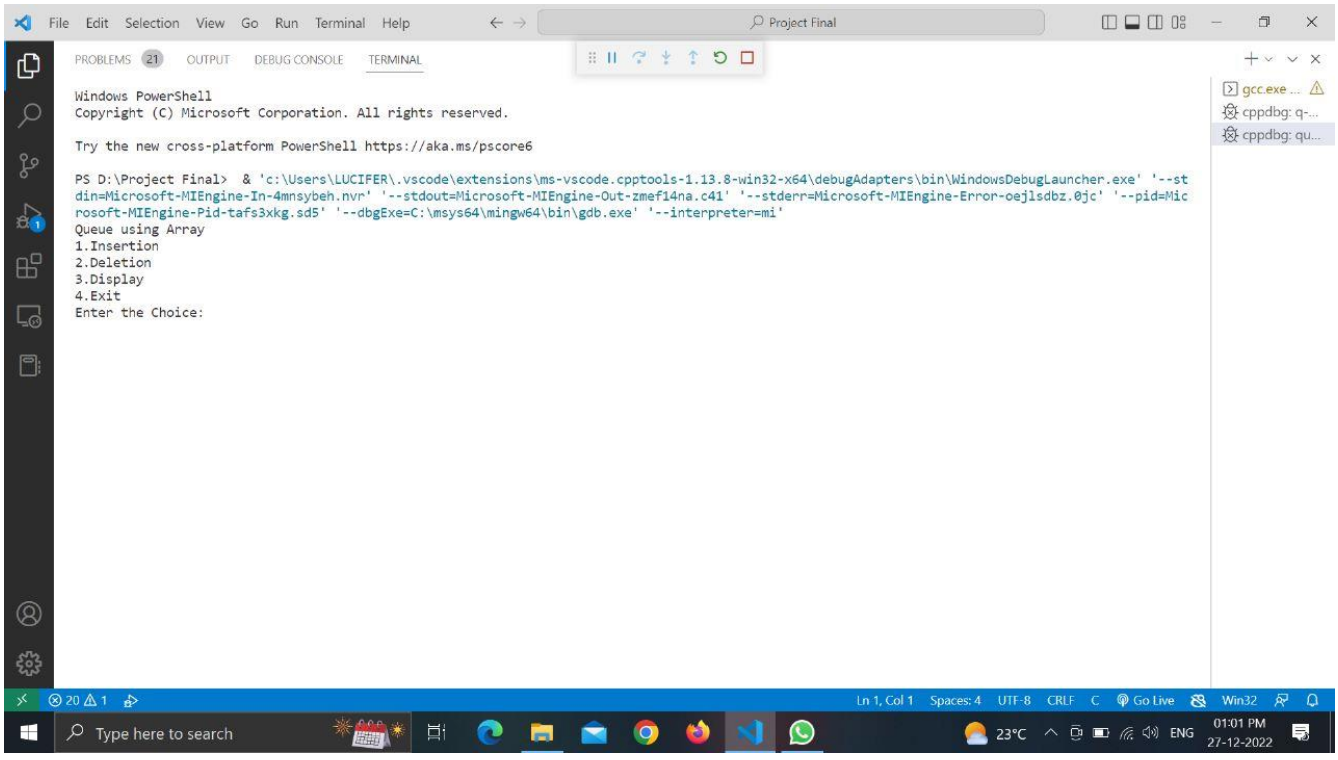
Program Description: Implementation of Queue using Array.

Solution:

```
#include<stdio.h>
#define n 5
int main()
{
   int queue[n],ch=1,front=0,rear=0,i,j=1,x=n;
   printf("Queue using Array");
   printf("\n1.Insertion \n2.Deletion \n3.Display \n4.Exit");
   while(ch)
   {
      printf("\nEnter the Choice:");
      scanf("%d",&ch);
      switch(ch)
      {
      case 1:
         if(rear==x)
            printf("\n Queue is Full");
         else
         {
            printf("\n Enter no %d:",j++);
            scanf("%d",&queue[rear++]);
         }
         break;
      case 2:
         if(front==rear)
         {
            printf("\n Queue is empty");
         }
         else
         {
            printf("\n Deleted Element is %d",queue[front++]);
            x++;
         }
         break;
      case 3:
         printf("\nQueue Elements are:\n ");
         if(front==rear)
            printf("\n Queue is Empty");
         else
         {
            for(i=front; i<rear; i++)
            {
```

```
            printf("%d",queue[i]);
            printf("\n");
          }
          break;
        case 4:
          exit(0);
        default:
          printf("Wrong Choice: please see the options");
        }
      }
  }
  return 0;
}
```

Output:



Practical No.: 2

Program Description: Implementation of queue using pointers.

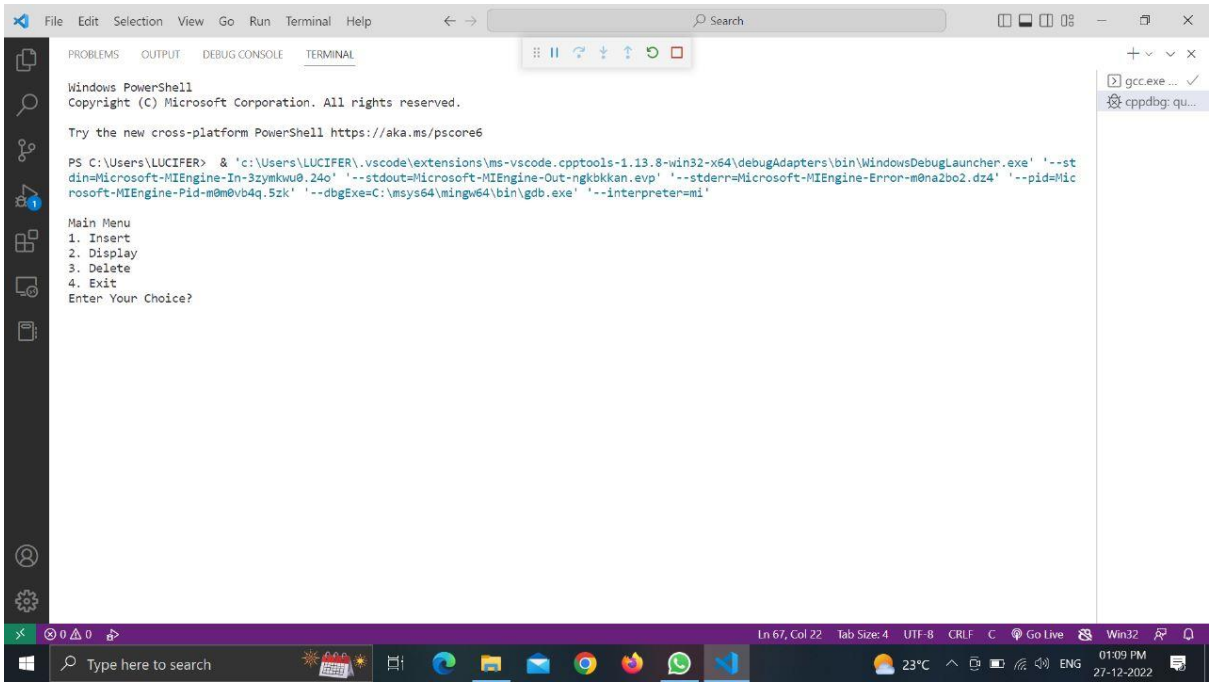
Solution:

```
#include<stdio.h>
#include<malloc.h>
typedef struct queue
{
   int data;
   struct queue *next;
}NODE;

NODE * insert(NODE *rear,int data)
{
   NODE *temp;
   temp=(NODE*)malloc(sizeof(NODE));
   temp->data=data;
   temp->next=NULL;
   if(rear==NULL)
   {
     rear=temp;
   }
   else
   {
     rear->next=temp;
     rear=temp;

   }
}

NODE* delete(NODE*front)
{
   NODE *temp;
   if(front==NULL)
   {
      printf("Queue is empty\n");
   }
   else
   {
      temp=front;
      front=front->next;
      free(temp);
   }
   return(front);
}

void display(NODE *front)
{
```

```
   NODE *t;
   if(front==NULL)
  {
      printf("Queue is empty\n");
  }
  else
   {
      t=front;
      while(t)
      {
         printf("%d,",t->data);
         t=t->next;
      }
   }
}

void main()
{
   NODE *front=NULL,*rear=NULL;
   int ch,data;
   do{
    printf("\nMain Menu\n1] Insert\n2] Display\n3] Delete\n4] Exit\n");
    printf("Enter Ur Choice?");
    scanf("%d",&ch);
    switch(ch)
    {
      case 1:
         printf("Enter Data:");
         scanf("%d",&data);
         rear=insert(rear,data);
         if(front==NULL)
         { front=rear;
         }
         break;
      case 2:
         display(front);
         break;
      case 3:
         front=delete(front);
         if(front==NULL)
         { rear=NULL;
         }
         break;
      case 4:
         printf("Exit");
         break;
      default:
         printf("Wrong Option");   }
```

```
    printf("\n");
  }while(ch!=4);
}
```

Output:



Practical No.: 3

Program Description: Implementation of Circular Queue using Array.

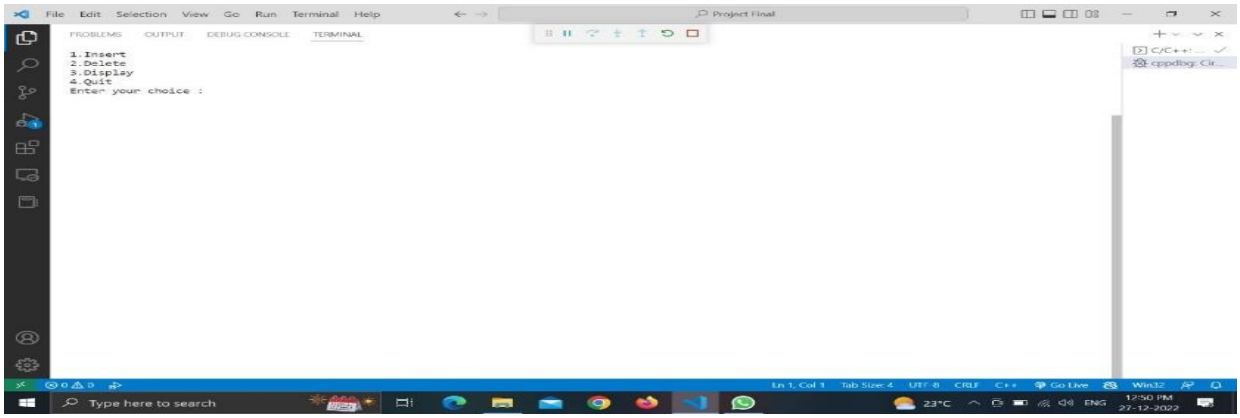
Solution:

```
# include<stdio.h>
# define MAX 5

int cqueue_arr[MAX];
int front = -1;
int rear = -1;

/*Begin of insert*/
void insert(int item)
{
   if((front == 0 && rear == MAX-1) || (front == rear+1))
   {
      printf("Queue Overflow \n");
      return;
   }
   if (front == -1)  /*If queue is empty */
   {
      front = 0;
      rear = 0;
   }
   else
   {
      if(rear == MAX-1)   /*rear is at last position of queue */
         rear = 0;
      else
         rear = rear+1;
   }
   cqueue_arr[rear] = item ;
}
/*End of insert*/

/*Begin of del*/
void del()
{
   if (front == -1)
   {
      printf("Queue Underflow\n");
      return ;
   }
   printf("Element deleted from queue is : %d\n",cqueue_arr[front]);
   if(front == rear) /* queue has only one element */
   {
      front = -1;
      rear=-1;}
```

```
    else
    {
        if(front == MAX-1)
            front = 0;
        else
            front = front+1;
    }
}
/*End of del() */

/*Begin of display*/
void display()
{
    int front_pos = front,rear_pos = rear;
    if(front == -1)
    {
        printf("Queue is empty\n");
        return;
    }
    printf("Queue elements :\n");
    if( front_pos <= rear_pos )
        while(front_pos <= rear_pos)
        {
            printf("%d ",cqueue_arr[front_pos]);
            front_pos++;
        }
    else
    {
        while(front_pos <= MAX-1)
        {
            printf("%d ",cqueue_arr[front_pos]);
            front_pos++;
        }
        front_pos = 0;
        while(front_pos <= rear_pos)
        {
            printf("%d ",cqueue_arr[front_pos]);
            front_pos++;
        }
    }
    printf("\n");
}
/*End of display*/

/*Begin of main*/
int main()
{
    int choice,item;
```

```
    do
    {
        printf("1.Insert\n");
        printf("2.Delete\n");
        printf("3.Display\n");
        printf("4.Quit\n");

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

        switch(choice)
        {
            case 1 :
                printf("Input the element for insertion in queue : ");
                scanf("%d", &item);

                insert(item);
                break;
            case 2 :
                del();
                break;
            case 3:
                display();
                break;
            case 4:
                break;
                default:
                printf("Wrong choice\n");
        }
    }while(choice!=4);

    return 0;
}
/*End of main*/
```

Output:



Section-D (Trees)

Practical No.: 1

Program Description: Implementation of Binary Search Tree.

Solution:

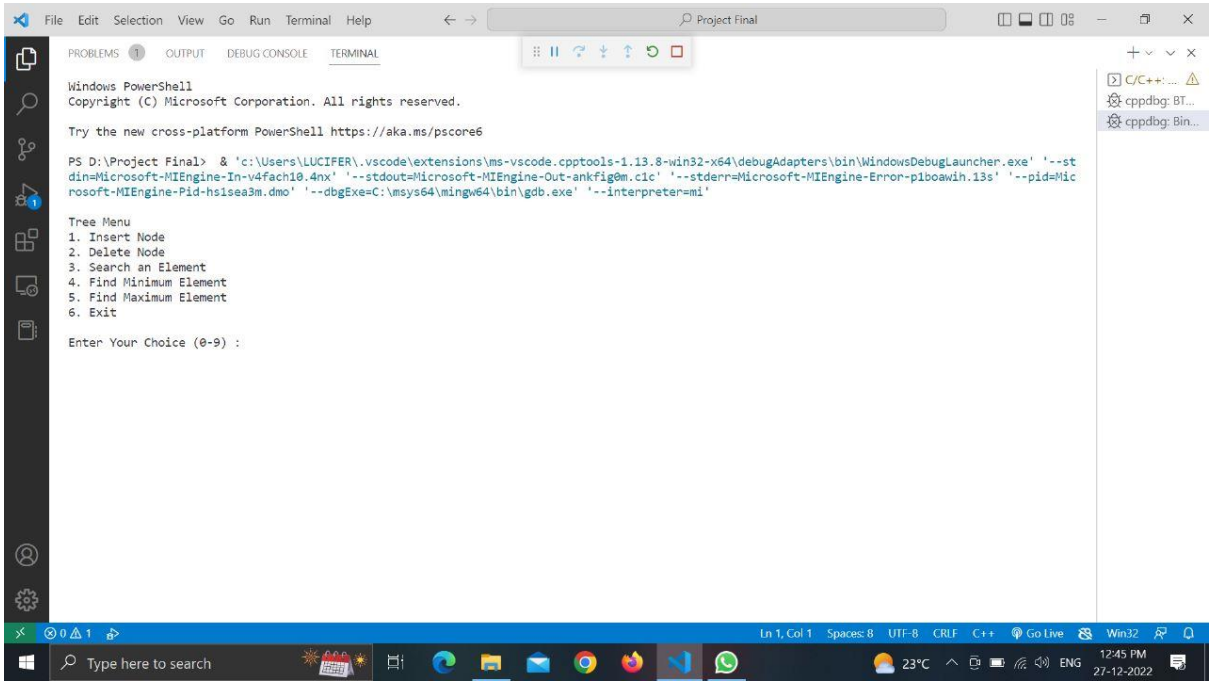
```
#include<stdio.h>
#include<stdlib.h>

typedef struct treeNode
{
	int data;
	struct treeNode *left;
	struct treeNode *right;

}treeNode;

treeNode* FindMin(treeNode *node)
{
	if(node==NULL)
	{
		return NULL;
	}
	if(node->left)
		return FindMin(node->left);
	else
		return node;
}
treeNode* FindMax(treeNode *node)
{
	if(node==NULL)
   {
	return NULL;
   }
   if(node->right)
	FindMax(node->right);
   else
	return node;
}

treeNode * Insert(treeNode *node,int data)
{
	if(node==NULL)
	{
		treeNode *temp;
		temp = (treeNode *)malloc(sizeof(treeNode));
		temp -> data = data;
```

```
        temp -> left = temp -> right = NULL;
            return temp;
        }

        if(data >(node->data))
        {
            node->right = Insert(node->right,data);
        }
        else if(data < (node->data))
        {
            node->left = Insert(node->left,data);
        }
        printf("\nInsertion Successful....\n");
        return node;
}

treeNode * Delete(treeNode *node, int data)
{
        treeNode *temp;
        if(node==NULL)
        {
            printf("Element Not Found");
        }
        else if(data < node->data)
        {
            node->left = Delete(node->left, data);
        }
        else if(data > node->data)
        {
            node->right = Delete(node->right, data);
        }
        else
        {
            if(node->right && node->left)
            {
                temp = FindMin(node->right);
                node -> data = temp->data;
           node -> right = Delete(node->right,temp->data);
            }
            else
            {
                temp = node;
                if(node->left == NULL)
                    node = node->right;
                else if(node->right == NULL)
                    node = node->left;
                free(temp);
            }     }
```

```
        return node;

}

treeNode * Find(treeNode *node, int data)
{
        if(node==NULL)
       }
                return NULL;
        }
        if(data > node->data)
        {
                return Find(node->right,data);
        }
        else if(data < node->data)
        {
                return Find(node->left,data);
        }
        else
        {
                return node;
        }
}



int main()
{
        treeNode *root = NULL;
    treeNode * temp;
    int choice,val;
    while(1)
    {
                printf("\nTree Menu");
                printf("\n1. Insert Node");
                printf("\n2. Delete Node");
                printf("\n3. Search an Element");
                printf("\n4. Find Minimum Element");
                printf("\n5. Find Maximum Element");
                printf("\n6. Exit");
                printf("\n\nEnter Your Choice (0-9) : ");
                scanf("%d",&choice);
                switch(choice)
                {
                        case 1:
                                printf("\nInserting Node in Binary Search Tree\n");
                               printf("Enter value to insert in new node : ");
                                scanf("%d",&val);
                               root=Insert(root,val);
```

```
                break;
            case 2:
                printf("\nDeleting a Node in Binary Search Tree\n");
                printf("Enter value of node to Delete : ");
                scanf("%d",&val);
                root=Delete(root,val);
                break;
            case 3:
                printf("\nSearch a Node");
                printf("\nEnter value to search : ");
                scanf("%d",&val);
                temp = Find(root,val);
                if(temp==NULL)
                {
                    printf("Element %d not found\n",val);
                }
                else
                {
                    printf("Element %d Found \n",val);
                }
                break;
            case 4:
                temp = FindMin(root);
                printf("Minimum element is %d\n",temp->data);
                break;
            case 5:
                temp = FindMax(root);
                printf("Maximum element is %d\n",temp->data);
                break;
            case 6:
                printf("\nThanks for using Tree Program...\n");
                exit(1);
                break;
            default:
                printf("\nInvalid Choice. Please Try Again....\n");
                break;
        }
    }
}
```

OUTPUT:


File Edit Selection View Go Run Terminal Help
Project Final
PROBLEMS 1 OUTPUT DEBUG CONSOLE TERMINAL
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS D:\Project Final> & 'c:\Users\LUCIFER\.vscode\extensions\ms-vscode.cpptools-1.13.8-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-v4fach10.4nx' '--stdout=Microsoft-MIEngine-Out-ankfig0m.c1c' '--stderr=Microsoft-MIEngine-Error-p1boawih.13s' '--pid=Microsoft-MIEngine-Pid-hs1sea3m.dmo' '--dbgExe=C:\msys64\mingw64\bin\gdb.exe' '--interpreter=mi'
Tree Menu
1. Insert Node
2. Delete Node
3. Search an Element
4. Find Minimum Element
5. Find Maximum Element
6. Exit
Enter Your Choice (0-9) :
C/C++:...
cppdbg: BT...
cppdbg: Bin...
Ln 1, Col 1 Spaces: 8 UTF-8 CRLF C++ Go Live Win32
Type here to search
23°C
ENG
12:45 PM
27-12-2022

Practical No.: 2

Program Description: Conversion of BST PreOrder/PostOrder/InOrder.

Solution:

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

typedef struct treeNode
{
	int data;
	struct treeNode *left;
	struct treeNode *right;

}treeNode;

treeNode* FindMin(treeNode *node)
{
	if(node==NULL)
	{

		return NULL;
	}
	if(node->left)
		return FindMin(node->left);
	else
		return node;
}
treeNode* FindMax(treeNode *node)
{
	if(node==NULL)
   {

	return NULL;
   }
   if(node->right)
	FindMax(node->right);
   else
	return node;
}

treeNode * Insert(treeNode *node,int data)
{
	if(node==NULL)
	{
		treeNode *temp;
		temp = (treeNode *)malloc(sizeof(treeNode));
```

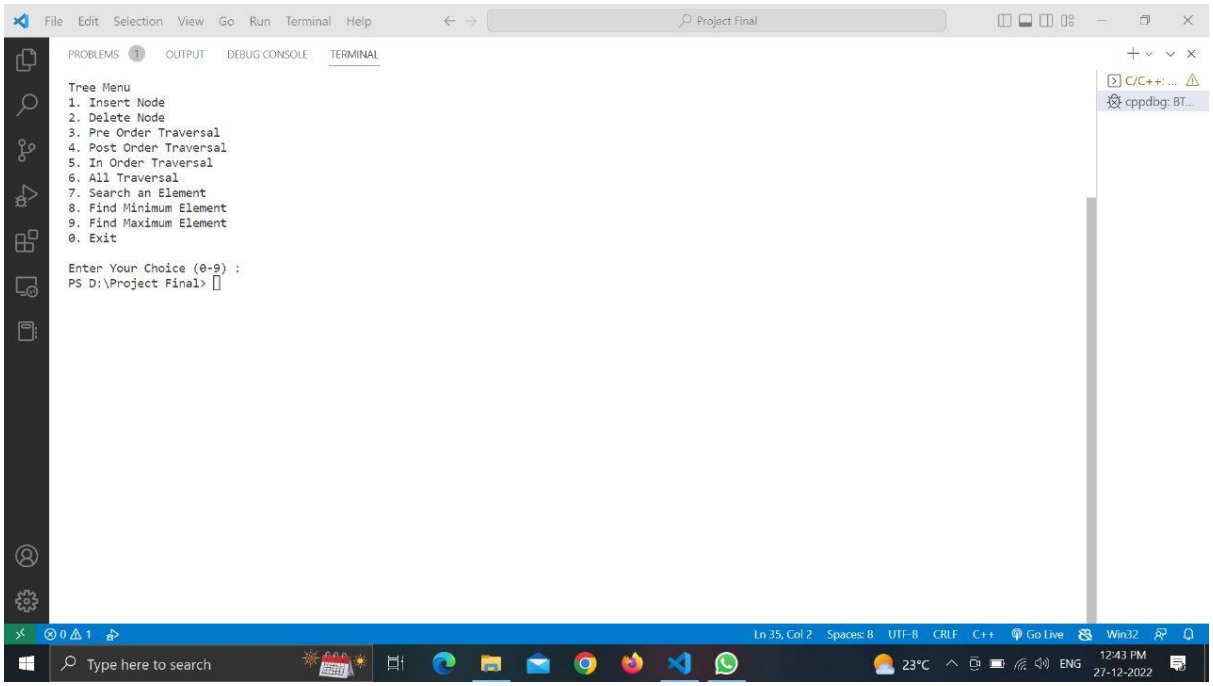
```
            temp -> data = data;
            temp -> left = temp -> right = NULL;     return temp;
        }
        if(data >(node->data))
        {
            node->right = Insert(node->right,data);
        }
        else if(data < (node->data))
        {
            node->left = Insert(node->left,data);
        }
        printf("\nInsertion Successful....\n");
        return node;
}

treeNode * Delete(treeNode *node, int data)
{
        treeNode *temp;
        if(node==NULL)
        {
            printf("Element Not Found");
        }
        else if(data < node->data)
        {
            node->left = Delete(node->left, data);
        }
        else if(data > node->data)
        {
            node->right = Delete(node->right, data);
        }
        else
        {
            if(node->right && node->left)
            {
                temp = FindMin(node->right);
                node -> data = temp->data;
                node -> right = Delete(node->right,temp->data);
            }
            else
            {
                temp = node;
                if(node->left == NULL)
                    node = node->right;
                else if(node->right == NULL)
                    node = node->left;
                free(temp);
            }
        }
```

```
        return node;}

treeNode * Find(treeNode *node, int data)
{
        if(node==NULL)
        {
                return NULL;
        }
        if(data > node->data)
        }
                return Find(node->right,data);
        }
        else if(data < node->data)
        {
                return Find(node->left,data);
        }
        else
        {
                return node;
        }
}

void PrintInorder(treeNode *node)
{
        if(node==NULL)
        {
                return;
        }
        PrintInorder(node->left);
        printf("%d ",node->data);
        PrintInorder(node->right);
}

void PrintPreorder(treeNode *node)
{
        if(node==NULL)
        {
                return;
        }
        printf("%d ",node->data);
        PrintPreorder(node->left);
        PrintPreorder(node->right);
}

void PrintPostorder(treeNode *node)
{
        if(node==NULL)
        {
```

```
            return;
        }
        PrintPostorder(node->left);
        PrintPostorder(node->right);
        printf("%d ",node->data);
}

int main()
{
        treeNode *root = NULL;
    treeNode * temp;
    int choice,val;
    while(1)
    {
            printf("\nTree Menu");
            printf("\n1. Insert Node");
            printf("\n2. Delete Node");
            printf("\n3. Pre Order Traversal");
            printf("\n4. Post Order Traversal");
            printf("\n5. In Order Traversal");
            printf("\n6. All Traversal");
            printf("\n7. Search an Element");
            printf("\n8. Find Minimum Element");
            printf("\n9. Find Maximum Element");
            printf("\n0. Exit");
            printf("\n\nEnter Your Choice (0-9) : ");
            scanf("%d",&choice);
            switch(choice)
            {
                case 1:
                    printf("\nInserting Node in Binary Search Tree\n");
                    printf("Enter value to insert in new node : ");
                    scanf("%d",&val);
                    root=Insert(root,val);
                    break;
                case 2:
                    printf("\nDeleting a Node in Binary Search Tree\n");
                    printf("Enter value of node to Delete : ");
                    scanf("%d",&val);
                    root=Delete(root,val);
                    break;
                case 3:
                    PrintPreorder(root);
                    break;
                case 4:
                    PrintPostorder(root);
                    break;
                case 5:
```

```
                PrintInorder(root);
                break;
            case 6:
                printf("\nPre Order Traversal:");
                PrintPreorder(root);
                printf("\nIn Order Traversal:");
                PrintInorder(root);
                printf("\nPost Order Traversal:");
                PrintPostorder(root);
                break;
            case 7:
                printf("\nSearch a Node");
                printf("\nEnter value to search : ");
                scanf("%d",&val);
                temp = Find(root,val);
                if(temp==NULL)
                {
                    printf("Element %d not found\n",val);
                }
                else
                {
                    printf("Element %d Found \n",val);
                }
                break;
            case 8:
                temp = FindMin(root);
                printf("Minimum element is %d\n",temp->data);
                break;
            case 9:
                temp = FindMax(root);
                printf("Maximum element is %d\n",temp->data);
                break;
            case 0:
                printf("\nThanks for using Tree Program...\n");
                exit(1);
                break;
            default:
                printf("\nInvalid Choice. Please Try Again....\n");
                break;
        }
    }
}
```

Output:


File Edit Selection View Go Run Terminal Help
Project Final
PROBLEMS 1 OUTPUT DEBUG CONSOLE TERMINAL
Tree Menu
1. Insert Node
2. Delete Node
3. Pre Order Traversal
4. Post Order Traversal
5. In Order Traversal
6. All Traversal
7. Search an Element
8. Find Minimum Element
9. Find Maximum Element
0. Exit
Enter Your Choice (0-9) :
PS D:\Project Final>
C/C++:...
cppdbg: BT...
Ln 35, Col 2 Spaces: 8 UTF-8 CRLF C++ Go Live Win32
Type here to search
23°C
ENG
12:43 PM
27-12-2022

Practical No.: 3

Program Description: Implementation of Kruskal Algorithm.

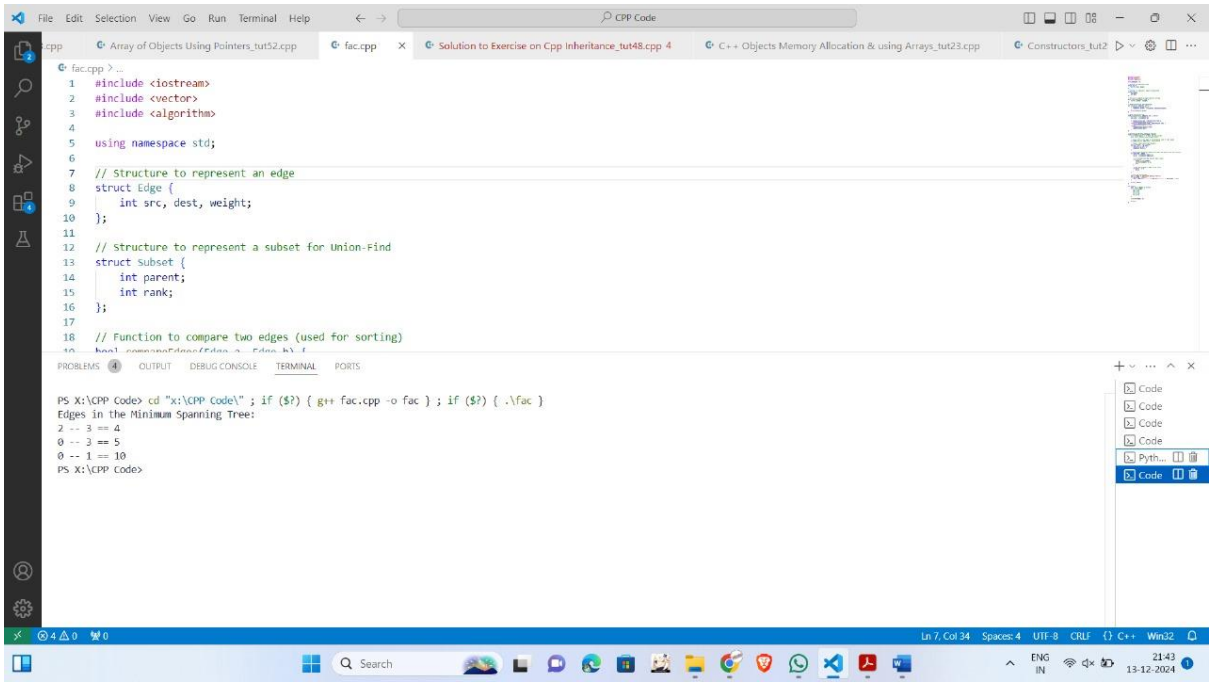
Solution:

```
#include <iostream>
#include <vector>
#include <algorithm>
using namespace std;
struct Edge {
   int src, dest, weight;
};
struct Subset {
   int parent;
   int rank;
};
bool compareEdges(Edge a, Edge b) {
   return a.weight < b.weight;
}

int find(Subset subsets[], int i) {
   if (subsets[i].parent != i) {
      subsets[i].parent = find(subsets, subsets[i].parent);
   }
   return subsets[i].parent;
}
void unionSets(Subset subsets[], int x, int y) {
   int xroot = find(subsets, x);
   int yroot = find(subsets, y);
   if (subsets[xroot].rank < subsets[yroot].rank) {
      subsets[xroot].parent = yroot;
   } else if (subsets[xroot].rank > subsets[yroot].rank) {
      subsets[yroot].parent = xroot;
```

```
    } else {
        subsets[yroot].parent = xroot;
        subsets[xroot].rank++;
    }
}
 void kruskalMST(vector<Edge>& edges, int V) {
    vector<Edge> result; // To store the resultant MST
    int e = 0; // Initial count of edges in MST
    sort(edges.begin(), edges.end(), compareEdges);
    Subset* subsets = new Subset[V];
    for (int v = 0; v < V; v++) {
        subsets[v].parent = v;
        subsets[v].rank = 0;
    }
    for (auto edge : edges) {
        int x = find(subsets, edge.src);
        int y = find(subsets, edge.dest);

        if (x != y) {
            result.push_back(edge);
            unionSets(subsets, x, y);
            e++;
        }
        if (e == V - 1) {
            break;
        }
    }
    cout << "Edges in the Minimum Spanning Tree:\n";
    for (auto edge : result) {
        cout << edge.src << " -- " << edge.dest << " == " << edge.weight << endl;
    }
```

```
    delete[] subsets;
}
int main() {
    int V = 4; // Number of vertices
    vector<Edge> edges = {
        {0, 1, 10},
        {0, 2, 6},
        {0, 3, 5},
        {1, 3, 15},
        {2, 3, 4}
    };
    kruskalMST(edges, V);

    return 0;
}
```

OUTPUT:



Practical No.: 4

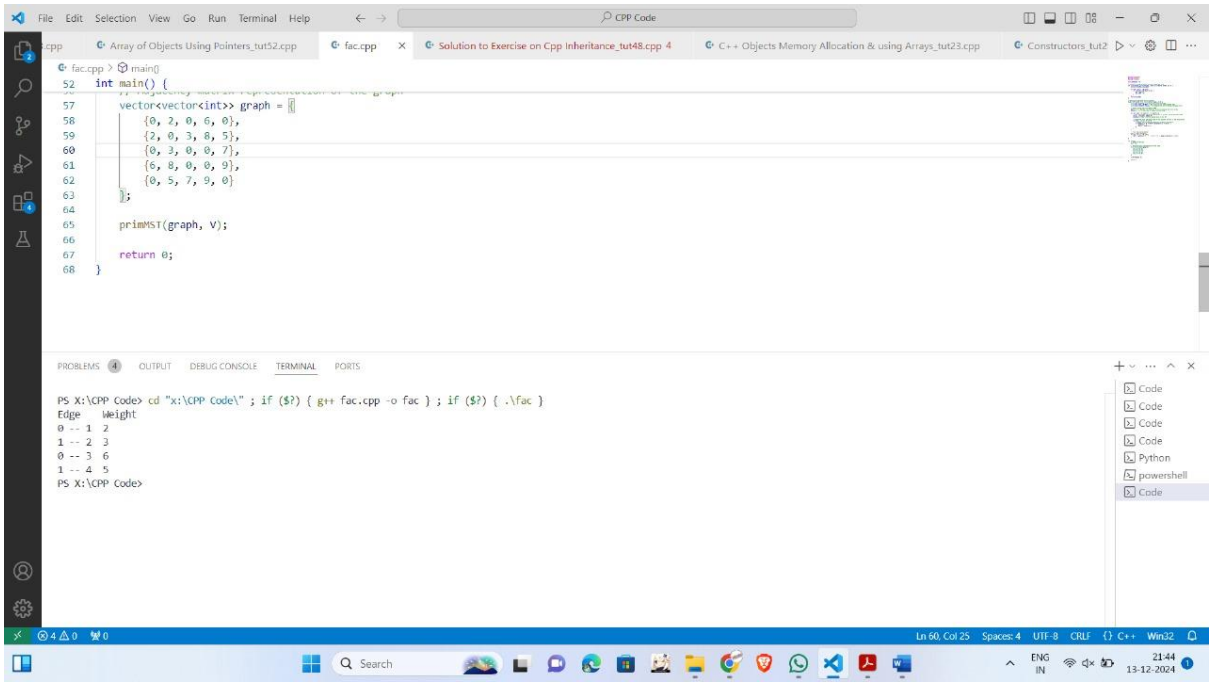
Program Description: Implementation of prim Algorithm.

Solution:

```
#include <iostream>
#include <vector>
#include <climits>
using namespace std;
int minKey(const vector<int>& key, const vector<bool>& mstSet, int V) {
   int min = INT_MAX, min_index;
   for (int v = 0; v < V; v++) {
      if (!mstSet[v] && key[v] < min) {
         min = key[v];
         min_index = v;
      }
   }
   return min_index;
}
void primMST(const vector<vector<int>>& graph, int V) {
   vector<int> parent(V);
   vector<int> key(V, INT_MAX);
   vector<bool> mstSet(V, false);
   key[0] = 0;
   parent[0] = -1; T
   for (int count = 0; count < V - 1; count++) {
      int u = minKey(key, mstSet, V);
      mstSet[u] = true;
      for (int v = 0; v < V; v++) {
         if (graph[u][v] && !mstSet[v] && graph[u][v] < key[v]) {
            parent[v] = u;
            key[v] = graph[u][v];
             }   }
```

```
    cout << "Edge \tWeight\n";
    for (int i = 1; i < V; i++) {
        cout << parent[i] << " -- " << i << "\t" << graph[i][parent[i]] << endl;
    }
}
int main() {
    int V = 5;
    vector<vector<int>> graph = {
        {0, 2, 0, 6, 0},
        {2, 0, 3, 8, 5},
        {0, 3, 0, 0, 7},
        {6, 8, 0, 0, 9},
        {0, 5, 7, 9, 0}
    };
    primMST(graph, V);
    return 0;
}
```

OUTPUT:



Practical No.: 5

Program Description: Implementation of Dijkstra algorithm.

Solution:

```
#include <iostream>
using namespace std;
#include <limits.h>
#define V 9
int minDistance(int dist[], bool sptSet[])
{
   int min = INT_MAX, min_index;
   for (int v = 0; v < V; v++)
      if (sptSet[v] == false && dist[v] <= min)
         min = dist[v], min_index = v;
   return min_index;
}
void printSolution(int dist[])
{
   cout << "Vertex \t Distance from Source" << endl;
   for (int i = 0; i < V; i++)
      cout << i << " \t\t\t\t" << dist[i] << endl;
}
void dijkstra(int graph[V][V], int src)
{
   int dist[V];
   bool sptSet[V];
   for (int i = 0; i < V; i++)
      dist[i] = INT_MAX, sptSet[i] = false;
   dist[src] = 0;
   for (int count = 0; count < V - 1; count++) {
      int u = minDistance(dist, sptSet);
      sptSet[u] = true;
```

```
      for (int v = 0; v < V; v++)
         if (!sptSet[v] && graph[u][v]
            && dist[u] != INT_MAX
            && dist[u] + graph[u][v] < dist[v])
            dist[v] = dist[u] + graph[u][v];
   }
   printSolution(dist);
}
int main()
{
   int graph[V][V] = { { 0, 4, 0, 0, 0, 0, 0, 8, 0 },
                       { 4, 0, 8, 0, 0, 0, 0, 11, 0 },
                       { 0, 8, 0, 7, 0, 4, 0, 0, 2 },
                       { 0, 0, 7, 0, 9, 14, 0, 0, 0 },
                       { 0, 0, 0, 9, 0, 10, 0, 0, 0 },
                       { 0, 0, 4, 14, 10, 0, 2, 0, 0 },
                       { 0, 0, 0, 0, 0, 2, 0, 1, 6 },
                       { 8, 11, 0, 0, 0, 0, 1, 0, 7 },
                       { 0, 0, 2, 0, 0, 0, 6, 7, 0 } };
   dijkstra(graph, 0);
   return 0;
}
```

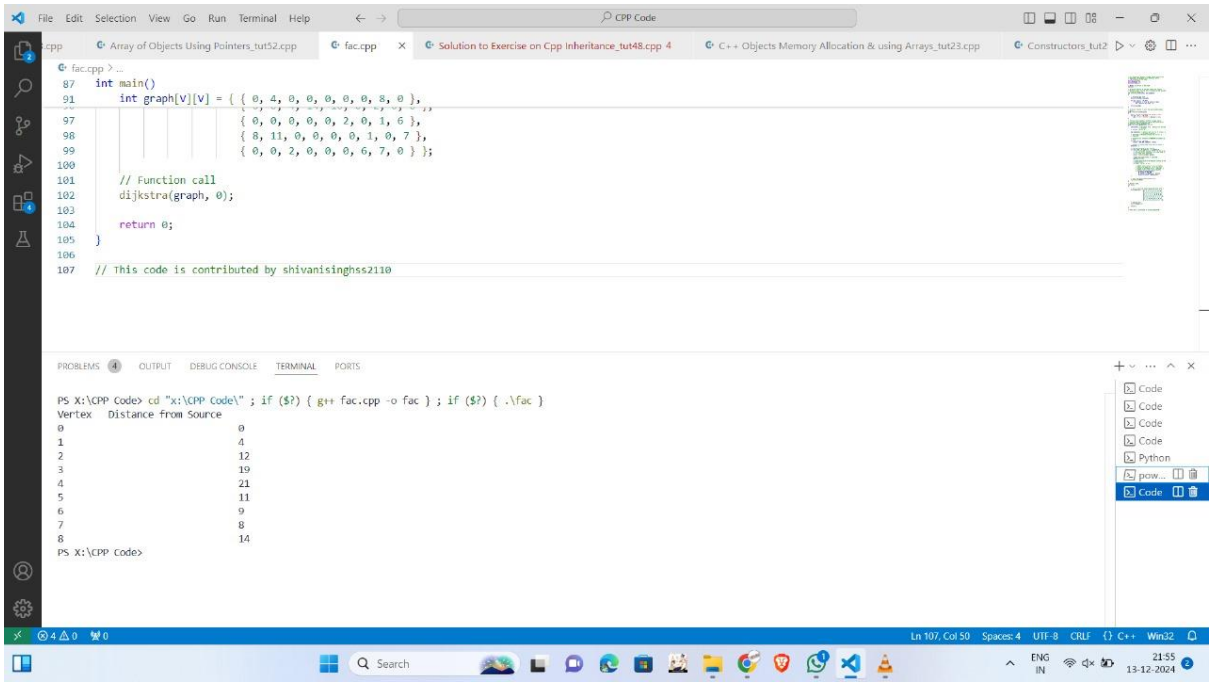
path

```
#include <iostream>
using namespace std;
#include <limits.h>
#define V 9
int minDistance(int dist[], bool sptSet[])
{
   int min = INT_MAX, min_index;
```

```
    for (int v = 0; v < V; v++)
        if (sptSet[v] == false && dist[v] <= min)
            min = dist[v], min_index = v;
    return min_index;
}
void printSolution(int dist[])
{
    cout << "Vertex \t Distance from Source" << endl;
    for (int i = 0; i < V; i++)
        cout << i << " \t\t\t\t" << dist[i] << endl;
}
void dijkstra(int graph[V][V], int src)
{
    int dist[V
    for (int i = 0; i < V; i++)
        dist[i] = INT_MAX, sptSet[i] = false;
    dist[src] = 0;
    for (int count = 0; count < V - 1; count++) {.
        int u = minDistance(dist, sptSet);
        sptSet[u] = true;.
        for (int v = 0; v < V; v++)
            if (!sptSet[v] && graph[u][v]
                && dist[u] != INT_MAX
                && dist[u] + graph[u][v] < dist[v])
                dist[v] = dist[u] + graph[u][v];
    }
    printSolution(dist);
}
int main()
{
    int graph[V][V] = { { 0, 4, 0, 0, 0, 0, 0, 8, 0 },
```

```
                { 4, 0, 8, 0, 0, 0, 0, 11, 0 },
                { 0, 8, 0, 7, 0, 4, 0, 0, 2 },
                { 0, 0, 7, 0, 9, 14, 0, 0, 0 },
                { 0, 0, 0, 9, 0, 10, 0, 0, 0 },
                { 0, 0, 4, 14, 10, 0, 2, 0, 0 },
                { 0, 0, 0, 0, 0, 2, 0, 1, 6 },
                { 8, 11, 0, 0, 0, 0, 1, 0, 7 },
                { 0, 0, 2, 0, 0, 0, 6, 7, 0 } };
    dijkstra(graph, 0);

    return 0;
}
```

OUTPUT:



Section-E (Sorting & Searching)

Practical No.: 1

Program Description: Implementation of sorting.

(A).Bubble

(B).Selection

(C).Insertion

(D).Quick

(E).Merge

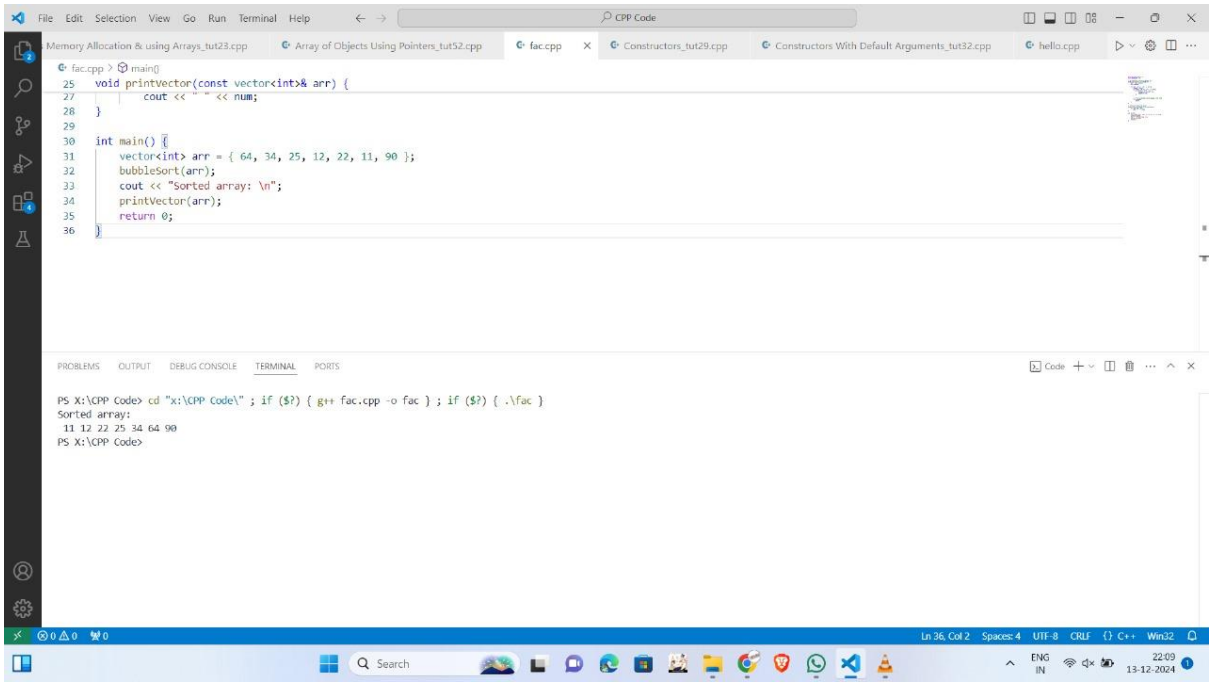
Solution:

(A).Bubble

```
#include <bits/stdc++.h>
using namespace std;
void bubbleSort(vector<int>& arr) {
   int n = arr.size();
   bool swapped;

   for (int i = 0; i < n - 1; i++) {
      swapped = false;
      for (int j = 0; j < n - i - 1; j++) {
         if (arr[j] > arr[j + 1]) {
            swap(arr[j], arr[j + 1]);
            swapped = true;
         }
      }
      if (!swapped)
         break;
   }
}
void printVector(const vector<int>& arr) {
   for (int num : arr)
```

```
        cout << " " << num;
}
int main() {
    vector<int> arr = { 64, 34, 25, 12, 22, 11, 90 };
    bubbleSort(arr);
    cout << "Sorted array: \n";
    printVector(arr);
    return 0;
}
```

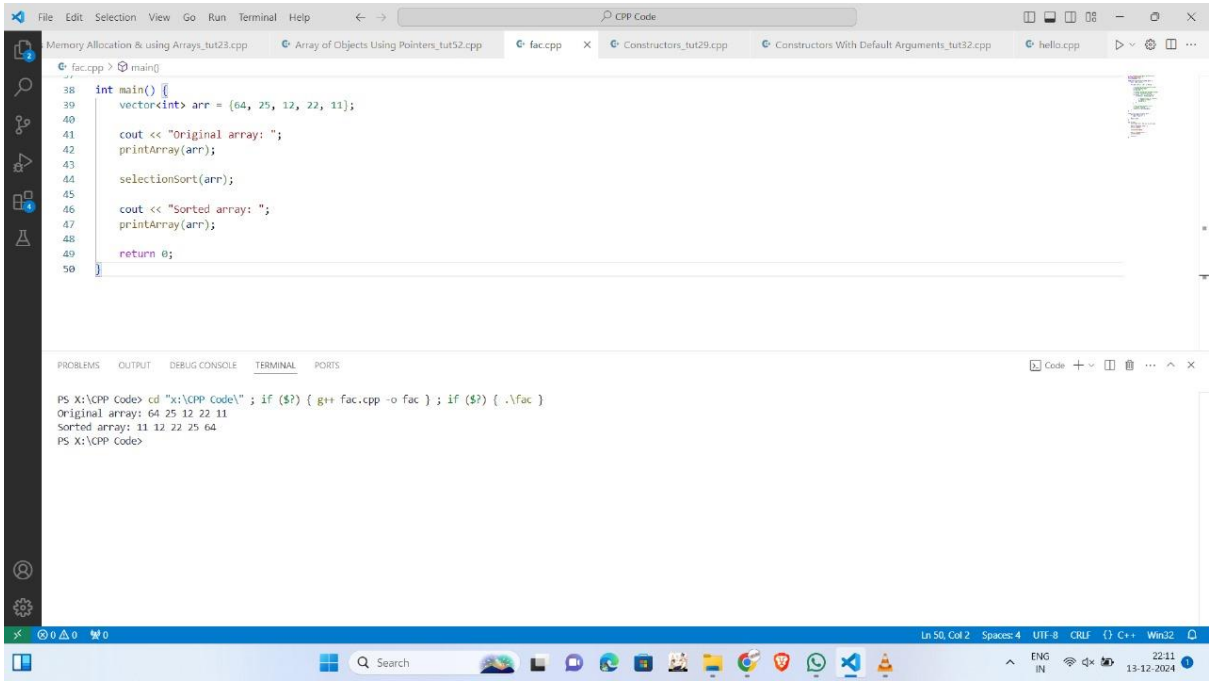
OUTPUT:



(B). Selection

```
#include <bits/stdc++.h>
using namespace std;

void selectionSort(vector<int> &arr) {
   int n = arr.size();
   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]) {

            // Update min_idx if a smaller
            // element is found
            min_idx = j;        }
      }
     swap(arr[i], arr[min_idx]);   }
}
void printArray(vector<int> &arr) {
   for (int &val : arr) {
      cout << val << " ";
   }
   cout << endl;
}
int main() {
   vector<int> arr = {64, 25, 12, 22, 11};
   cout << "Original array: ";
   printArray(arr);
   selectionSort(arr);
   cout << "Sorted array: ";
   printArray(arr);
   return 0; }
```

Output:


File Edit Selection View Go Run Terminal Help
CPP Code
Memory Allocation & using Arrays_tut23.cpp
Array of Objects Using Pointers_tut52.cpp
fac.cpp
Constructors_tut29.cpp
Constructors With Default Arguments_tut32.cpp
hello.cpp
fac.cpp > main()
int main() {
vector<int> arr = {64, 25, 12, 22, 11};
cout << "Original array: ";
printArray(arr);
selectionSort(arr);
cout << "Sorted array: ";
printArray(arr);
return 0;
}
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
PS X:\CPP Code> cd "x:\CPP Code\" ; if ($?) { g++ fac.cpp -o fac } ; if ($?) { .\fac }
Original array: 64 25 12 22 11
Sorted array: 11 12 22 25 64
PS X:\CPP Code>
Ln 50, Col 2 Spaces: 4 UTF-8 CRLF C++ Win32
Search
ENG IN
22:11 13-12-2024

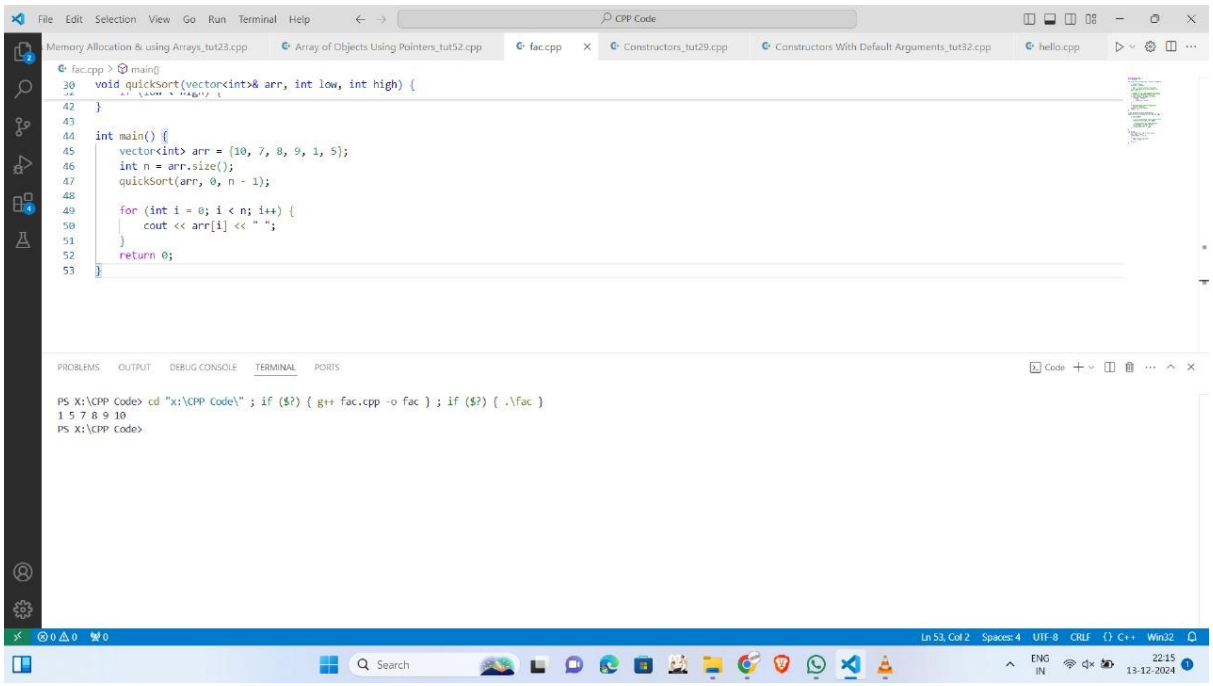
(C). Insertion

```
#include <iostream>
using namespace std;
void insertionSort(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 = j - 1;
      }
      arr[j + 1] = key;
   }
}
void printArray(int arr[], int n)
{
   for (int i = 0; i < n; ++i)
      cout << arr[i] << " ";
   cout << endl;
}
int main()
{
   int arr[] = { 12, 11, 13, 5, 6 };
   int n = sizeof(arr) / sizeof(arr[0]);
   insertionSort(arr, n);
   printArray(arr, n);
   return 0;
}
```

(D).Quick

```
#include <bits/stdc++.h>
using namespace std;
int partition(vector<int>& arr, int low, int high) {
   int pivot = arr[high];

   int i = low - 1;
   for (int j = low; j <= high - 1; j++) {
      if (arr[j] < pivot) {
         i++;
         swap(arr[i], arr[j]);
      }
   }
   swap(arr[i + 1], arr[high]);
   return i + 1;
}
void quickSort(vector<int>& arr, int low, int high) {
   if (low < high) {
      int pi = partition(arr, low, high);
      quickSort(arr, low, pi - 1);
      quickSort(arr, pi + 1, high);  }}
int main() {
   vector<int> arr = {10, 7, 8, 9, 1, 5};
   int n = arr.size();
   quickSort(arr, 0, n - 1);

   for (int i = 0; i < n; i++) {
      cout << arr[i] << " ";    }
 return 0; }
```

OUTPUT:

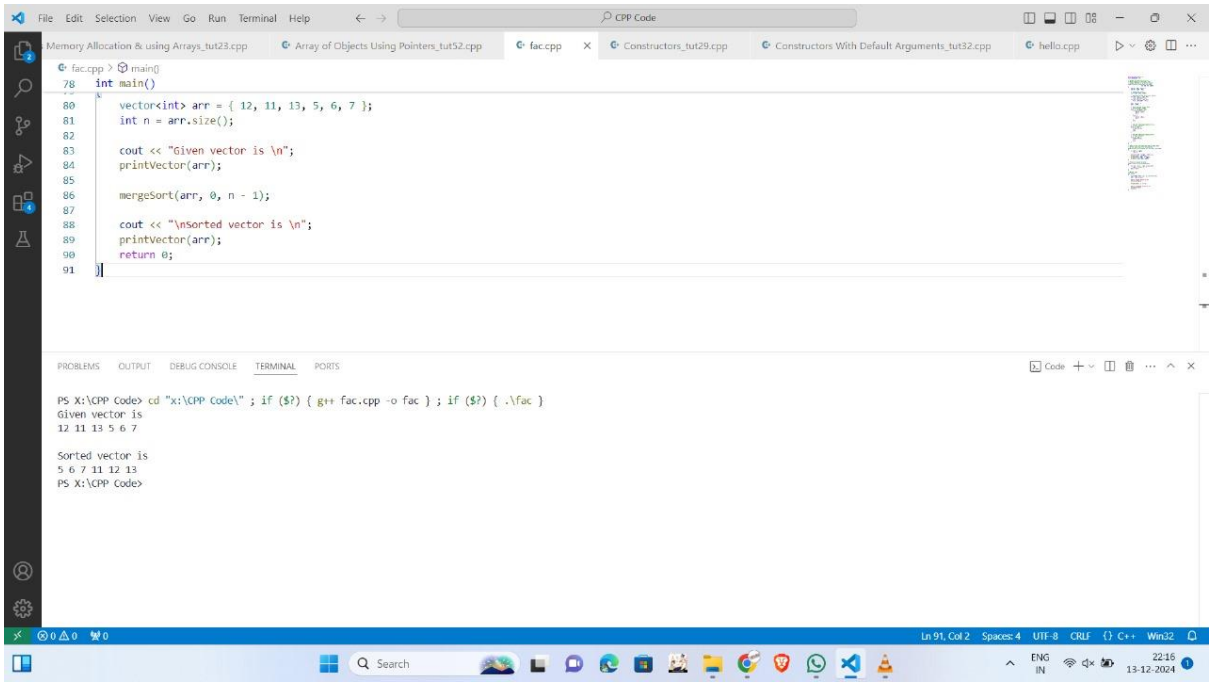

File Edit Selection View Go Run Terminal Help
CPP Code
Memory Allocation & using Arrays_tut23.cpp
Array of Objects Using Pointers_tut52.cpp
fac.cpp
Constructors_tut29.cpp
Constructors With Default Arguments_tut32.cpp
hello.cpp
fac.cpp > main()
30 void quickSort(vector<int>& arr, int low, int high) {
42 }
43
44 int main() {
45 vector<int> arr = {10, 7, 8, 9, 1, 5};
46 int n = arr.size();
47 quickSort(arr, 0, n - 1);
48
49 for (int i = 0; i < n; i++) {
50 cout << arr[i] << " ";
51 }
52 return 0;
53 }
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
PS X:\CPP Code> cd "x:\CPP Code\" ; if ($?) { g++ fac.cpp -o fac } ; if ($?) { .\fac }
1 5 7 8 9 10
PS X:\CPP Code>
Ln 53, Col 2 Spaces: 4 UTF-8 CRLF C++ Win32
Search
ENG IN
22:15 13-12-2024

(E).Merge

```
#include <bits/stdc++.h>
using namespace std;
void merge(vector<int>& arr, int left,
                int mid, int right) {
   int n1 = mid - left + 1;
   int n2 = right - mid;
   vector<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;
   int 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++;
   }
```

```
}
void mergeSort(vector<int>& arr, int left, int right)
{
   if (left >= right)
      return;
   int mid = left + (right - left) / 2;
   mergeSort(arr, left, mid);
   mergeSort(arr, mid + 1, right);
   merge(arr, left, mid, right);
}
void printVector(vector<int>& arr)
{
   for (int i = 0; i < arr.size(); i++)
      cout << arr[i] << " ";
   cout << endl;
}
int main()
{
   vector<int> arr = { 12, 11, 13, 5, 6, 7 };
   int n = arr.size();
   cout << "Given vector is \n";
   printVector(arr);
   mergeSort(arr, 0, n - 1);
   cout << "\nSorted vector is \n";
   printVector(arr);
   return 0;
}
```

OUTPUT:


int main()
{
vector<int> arr = { 12, 11, 13, 5, 6, 7 };
int n = arr.size();
cout << "Given vector is \n";
printVector(arr);
mergeSort(arr, 0, n - 1);
cout << "\nSorted vector is \n";
printVector(arr);
return 0;
}
PS X:\CPP Code> cd "x:\CPP Code\" ; if ($?) { g++ fac.cpp -o fac } ; if ($?) { .\fac }
Given vector is
12 11 13 5 6 7
Sorted vector is
5 6 7 11 12 13
PS X:\CPP Code>

Practical No.: 2

Program Description: Implementation of Binary Search on a list of numbers stored in an Array.

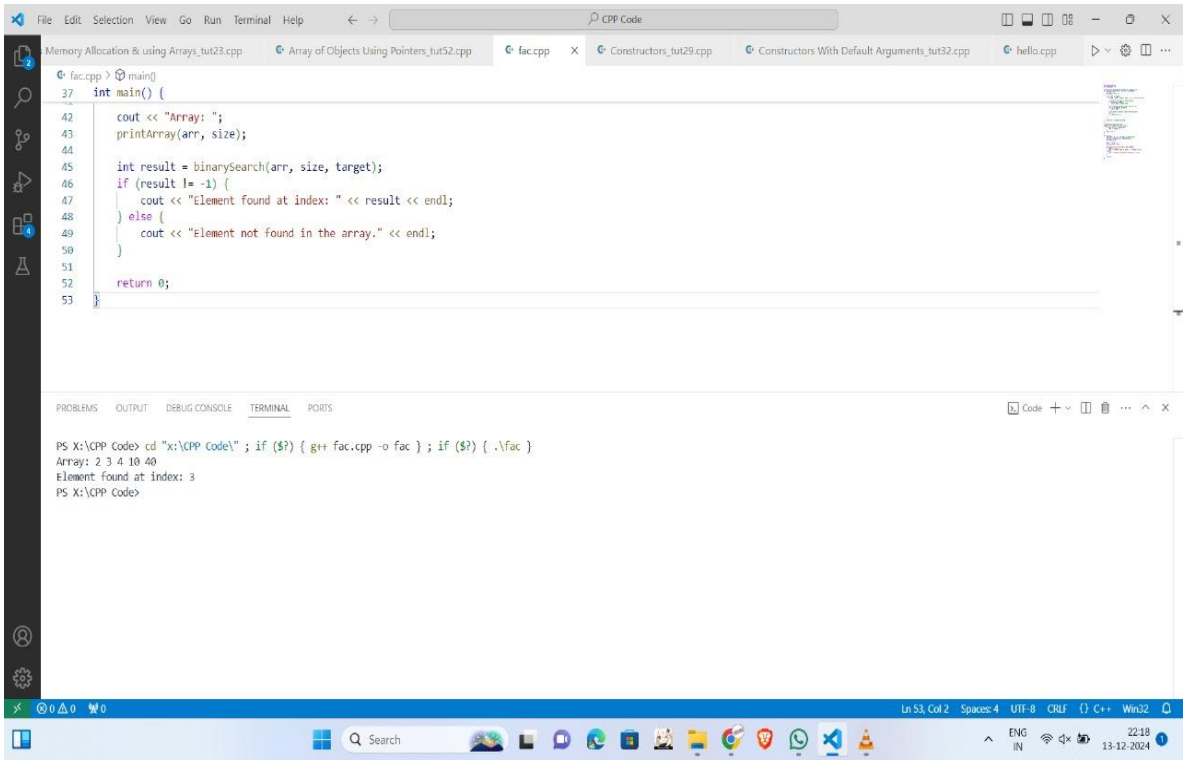
Solution:

```
#include <iostream>
using namespace std;
#include <iostream>
using namespace std;
int binarySearch(int arr[], int size, int target) {
   int left = 0;
   int right = size - 1;
   while (left <= right) {
      int mid = left + (right - left) / 2
      if (arr[mid] == target) {
         return mid;
      }
      else if (arr[mid] < target) {
         left = mid + 1;
      }
      else {
         right = mid - 1;
      }
   }
   return -1;
}
void printArray(int arr[], int size) {
   for (int i = 0; i < size; i++) {
      cout << arr[i] << " ";
   }
   cout << endl;
}
```

```
int main() {
   int arr[] = {2, 3, 4, 10, 40};
   int size = sizeof(arr) / sizeof(arr[0]);
   int target = 10;
   cout << "Array: ";
   printArray(arr, size);
   int result = binarySearch(arr, size, target);
   if (result != -1) {
      cout << "Element found at index: " << result << endl;
   } else {
      cout << "Element not found in the array." << endl;   }
   return 0; }
int binarySearch(int arr[], int size, int target) {
   int left = 0;
   int right = size - 1;
   while (left <= right) {
      int mid = left + (right - left) / 2;
      if (arr[mid] == target) {
         return mid;
      }
      else if (arr[mid] < target) {
         left = mid + 1;       }
           else {
         right = mid – 1 }
  return -1; }
void printArray(int arr[], int size) {
  for (int I = 0; I < size; I++) {
      cout << arr[I] << " "; }
   cout << endl; }
int main() {
   int arr[] = {2, 3, 4, 10, 40;
```

```
    int size = sizeof(arr) / sizeof(arr[0]);
    int target = 10;
    cout << "Array: ";
    printArray(arr, size);
    int result = binarySearch(arr, size, target);
    if (result != -1) {
        cout << "Element found at index: " << result << endl;
    } else {
        cout << "Element not found in the array." << endl;
    }    return 0; }
```

OUTPUT:



Practical No.: 3

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

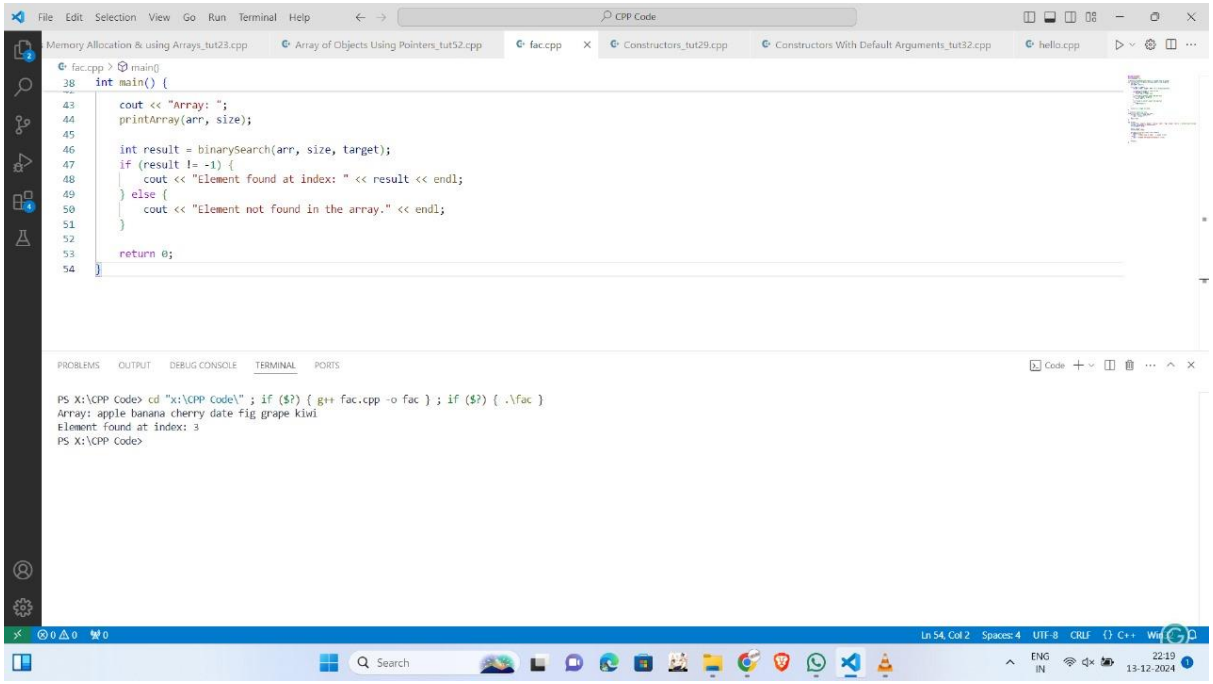
Solution:

```
#include <iostream>
using namespace std;
#include <iostream>
using namespace std;
int binarySearch(int arr[], int size, int target) {
   int left = 0;
   int right = size - 1;
   while (left <= right) {
      int mid = left + (right - left) / 2;
      if (arr[mid] == target) {
         return mid;
      }
      else if (arr[mid] < target) {
         left = mid + 1;
      }
      else {
         right = mid - 1;
      }
   }
   return -1;
}
void printArray(int arr[], int size) {
   for (int i = 0; i < size; i++) {
      cout << arr[i] << " ";
   }
   cout << endl; }
int main() {
```

```
    int arr[] = {2, 3, 4, 10, 40;
    int size = sizeof(arr) / sizeof(arr[0]);
    int target = 10;
    cout << "Array: ";
    printArray(arr, size);
    int result = binarySearch(arr, size, target);
    if (result != -1) {
        cout << "Element found at index: " << result << endl;
    } else {
        cout << "Element not found in the array." << endl;
    }
    return 0;
}
int binarySearch(int arr[], int size, int target) {
    int left = 0;
    int right = size - 1;
    while (left <= right) {
        int mid = left + (right - left) / 2;
        if (arr[mid] == target) {
            return mid;
        }
        else if (arr[mid] < target) {
            left = mid + 1;
        }
        else {
            right = mid - 1;      } }
    return -1; }
void printArray(int arr[], int size) {
    for (int I = 0; I < size; I++) {
        cout << arr[I] << " ";
    }
```

```
    cout << endl;
}
int main() {
    int arr[] = {2, 3, 4, 10, 40};
    int size = sizeof(arr) / sizeof(arr[0]);
    int target = 10;
    cout << "Array: ";
    printArray(arr, size);
    int result = binarySearch(arr, size, target);
    if (result != -1) {
        cout << "Element found at index: " << result << endl;
    } else {
        cout << "Element not found in the array." << endl;
    }
    return 0; }
```

OUTPUT:



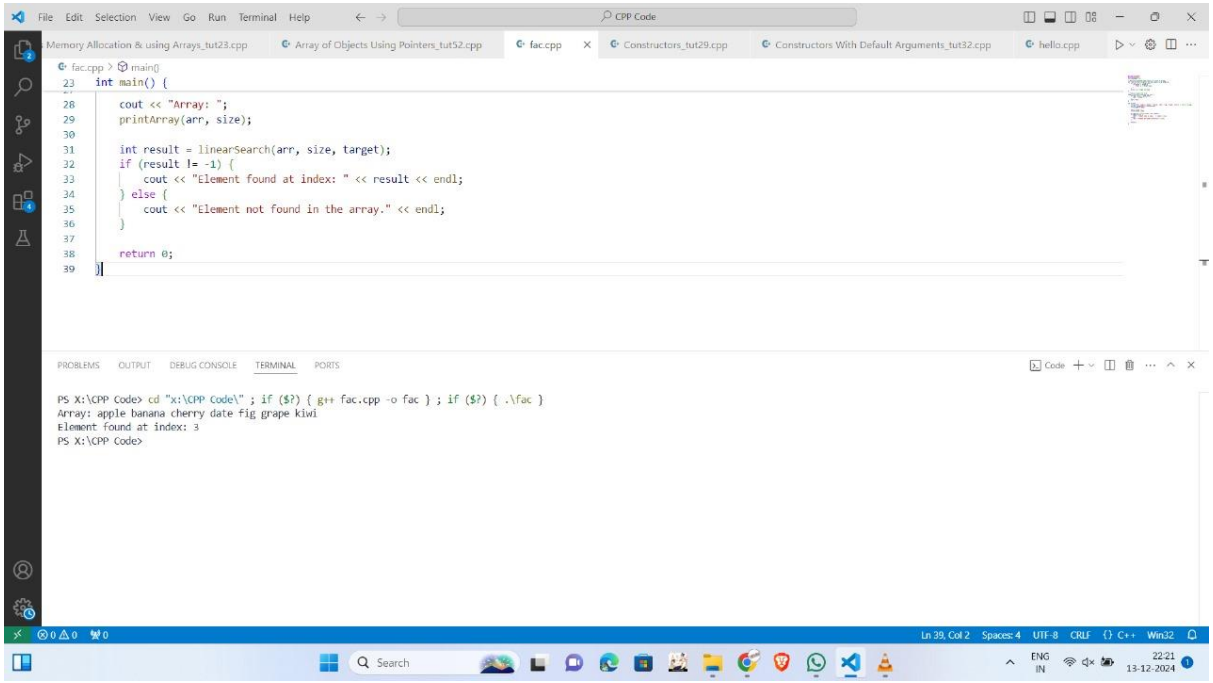
Practical No.: 4

Program Description: Implementation of Linear Search on a list of strings stored in an Array.

Solution:

```
#include <iostream>
#include <string>
using namespace std;
int linearSearch(string arr[], int size, const string& target) {
   for (int I = 0; I < size; I++) {
      if (arr[I] == target) {
         return I;       }
   }
   return -1;
void printArray(string arr[], int size) {
   for (int I = 0; I < size; I++) {
      cout << arr[I] << " ";    }
   cout << endl;
}
int main() {
   string arr[] = {"apple", "banana", "cherry", "date", "fig", "grape", "kiwi"}; // Array of strings
   int size = sizeof(arr) / sizeof(arr[0]);
   string target = "date";
   cout << "Array: ";
   printArray(arr, size);
   int result = linearSearch(arr, size, target);
   if (result != -1) {
      cout << "Element found at index: " << result << endl;
   } else {
      cout << "Element not found in the array." << endl;    }
   return 0;
}
```

OUTPUT:


int main() {
cout << "Array: ";
printArray(arr, size);
int result = linearSearch(arr, size, target);
if (result != -1) {
cout << "Element found at index: " << result << endl;
} else {
cout << "Element not found in the array." << endl;
}
return 0;
}
PS X:\CPP Code> cd "x:\CPP Code\" ; if ($?) { g++ fac.cpp -o fac } ; if ($?) { .\fac }
Array: apple banana cherry date fig grape kiwi
Element found at index: 3
PS X:\CPP Code>