DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
(Accredited by NBA)

DATA STRUCTURES LABORATORY MANUAL
21CSL32

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DATA STRUCTURES LABORATORY   **21CS32**

To be a school of Excellence in Computing for Holistic Education and Research

MISSION

M1: Strive for academic excellence in Computer Science and Engineering through student centric innovative teaching learning process, competent faculty members, efficient assessment and effective use of ICT.
M2:Establish Centre for Excellence in various vertical of Computer Science and Engineering to promote collaborative research and Industry Institute Interaction.
M3:Transform the engineering aspirants to socially responsible, ethical, technically competent and value added professional or entrepreneur.

PROGRAMME OUTCOMES

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1. Ability to adopt quickly for any domain, interact with diverse group of individuals and be an entrepreneur in a societal and global setting.

PSO 2. Ability to visualize the operations of existing and future software Applications.

CourseObjectives

- To develop skills to design and analyze linear and nonlinear datastructures.
- To strengthen the ability to identify and apply the suitable datastructure for the given computational problem.
- To Gain knowledge in practical applications of datastructures in real world.

CourseOutcomes

- Conduct scheduled experiments to design and develop the programs in C to understand the different concepts of datastructures.
- Analyze the output based on the given input data.
- Express the theoretical aspects used in conducting different experiments of Datastructures and Applications.
- Record Experimental process and results
- Conduct any given experiment in Datastructures Laboratory and communicate results effectively.

DATA STRUCTURES LABORATORY   **21CS32**

SYLLABUS

Exp.No.	DETAILS	HOURS
1	Design,Develop andI mplement a menu driven Programing C for the following Array operations a. Creating an Array of N Integer Elements b. Display ofArray Elements with Suitable Headings c. Inserting an Element(ELEM) at a given valid Position(POS) d. Deleting an Element at a given validPosition(POS) e. Exit. Support the program with functions for each of the above operations.	3
2	Design,Develop and Implementa Programing C for the following operations on Strings a. Read a main String(STR),a PatternString(PAT) and a ReplaceString(REP) b. Perform Pattern Matching Operation:Find and Replace all occurrences of PAT in STR with REP if PAT exists in STR.Report suitable messages in case PAT does not exist in STR. Support the program with functions for each of the above operations. Don't use Built-in functions.	3
3	Design,Develop and Implement a menudriven Program in C for the following operations on STACK of Integers(Array Implementation of Stack with maximum size MAX) a. Push an Element onto Stack b. Pop an Element from Stack c. Demonstrate how Stack can be used to check Palindrome d. Demonstrate Overflow and Underflow situations on Stack e. Display the status of Stack f. Exit. Support the program with appropriate functions for each of the Above operations	3
4	Design,Develop and Implement a Program in C for converting an Infix Expression to Postfix Expression.Program should support for both parenthesized and free parenthesized expressions with the operators:+,-, *,/,%(Remainder),^(Power)and alphanumeric operands.	3

5	Design,Develop and Implement a Program in C for the following Stack Applications a. Evaluation of Suffix expression with single digit operands and operators:+,-,*, /,%,^ b. Solving Tower of Hanoi problem with n disks.	3
6	Design,Develop and Implement a menu driven Program in C for the following operations on Circular QUEUE of Characters(Array Implementation of Queue with maximum size MAX) a. Insert an Element onto Circular QUEUE b. Delete an Element from Circular QUEUE c. Demonstrate Overflow and Underflow situations on Circular QUEUE d. Display the status of Circular QUEUE e. Exit Support the program with appropriate functions for each of the above operations.	3
7	Design,Develop and Implement a menu driven Program in C for the following operations on Singly Linked List(SLL) of Student Data with the fields:USN,Name,Branch,Sem, PhNo a. Create a SLL of N Students Data by using front insertion. b. Display the status of SLL and count the number of nodes in it c. Perform Insertion/Deletion at End of SLL d. Perform Insertion/Deletion at Front of SLL(Demonstration of stack) e. Exit	3
8	Design,Develop and Implement a menu driven Program in C for the following operations on Doubly Linked List(DLL) of Employee Data with the fields:SSN,Name,Dept,Designation,Sal,PhNo a. Create a DLL of N Employees Data by using end insertion. b. Display the status of DLL and count the number of nodes in it c. Perform Insertion and Deletion at End of DLL d. Perform Insertion and Deletion at Front of DLL e. Demonstrate how this DLL can be used as Double Ended Queue f.Exit	3
9	Design,Develop and Implement a Program in C for the following operations on Singly Circular Linked List(SCLL) with header nodes a. Represent and Evaluate a Polynomial P(x,y,z)=6x2y2z-4yz5+3x3yz+2xy5z-2xyz3 b. Find the sum of two polynomials POLY1(x,y,z) and POLY2(x,y,z) and store the result in POLYSUM(x,y,z) Support the program with appropriate functions for each of the above Operations.	3

10	Design,Develop and Implement a menu driven Program in C for the following operations on Binary Search Tree(BST) of Integers a.Create a BSTof N Integers :6,9,5,2,8,15,24,14,7,8,5,2 b. Traverse the BST in Inorder,Preorder and PostOrder c.Search the BST for a given element(KEY) and report the appropriate message e. Exit	**3**
11	Design,Develop and Implementa Program in C for the following operations on Graph(G) of Cities a. Createva Graph of N cities using Adjacency Matrix. b. Print all the nodes reachable from a given starting node in a digraph using DFS/BFSmethod	**3**
12	Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in fileF.Assume that file F is maintained in memory by a Hash Table(HT) of m memory locations with L as the set of memory addresses(2-digit) of locations in HT.Let the keys in K and addresses in Lare Integers. Design and develop a Program in C that uses Hash function H:K®LasH(K)=K mod m(remainder method),and implement hashing technique to map a given key K to the address space L.Resolve the collision(if any)using linear probing.	**3**

PROGRAM 1

1.Design,Develop and Implement a menu driven Program in C for the following Array operations
a. Creating an Array of N Integer Elements
b. Display of Array Elements with Suitable Headings
c. Inserting an Element(ELEM) at a given valid Position(POS)
**d. Deleting an Element at a given valid Position(POS)**
e. Exit.
Support the program with functions for each of the above operations

Theory:

Arrays a kind of data structure that can store a fixed-size sequential collection of elements of the sametype. An array is used to store a collection of data, but it is often more useful to think of an array as acollectionofvariables ofthesametype.

Insteadof declaring individual variables, such as number0, number1,..., and number 99, you declare one array variable such as numbers and use numbers[0], numbers[1], and ..., numbers[99] to represent individual variables.A specific element in an array is accessed by an index.

Allarrays consist of contiguous memory locations.The lowest address corresponds to the first element and the highest address to the last element.
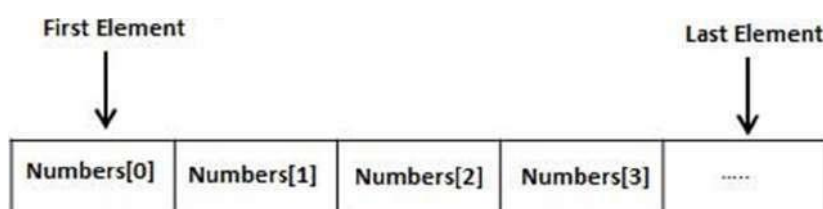
DeclaringArrays

To declare an array in C, a programmer specifies the type of the elements and the number of elementsrequiredbyanarrayasfollows−

> Type array Name[array Size];

This is called a *single-dimensional* array. The **arraySize** must be an integer constant greater than zeroand **type** can be any validC data type. For example, to declare a 10-element array called **balance** of type double,use this statement

> Double balance[10];

Here *balance* is avariable array which is sufficient to hold upto10 double numbers.Initializing Arrays

You can initialize an array in C either one by one or using a single statement as follows−

Double balance[5]={1000.0,2.0,3.4,7.0,50.0};

The number of values between braces{}cannot be larger than the number of elements that we declar efor th earray between square brackets[].

If you omit the size of the array,an array just big enough to hold the initialization is created.Therefore,if you write−

Double balance[]={1000.0,2.0,3.4,7.0,50.0};

You will create exactly the same array as you did in the previous example.Following is an example to assign a single element of the array−

balance[4]=50.0;

The above statement assigns the 5th element in the array with a value of 50.0. All arrays have 0 as theindex of their first element whichis also calledthe baseindex andthelastindex of anarray willbetotal size of the array minus 1. Shown below is the pictorial representation of the array we discussedabove−

	0	1	2	3	4
balance	1000.0	2.0	3.4	7.0	50.0

AccessingArrayElements

An element is accessed by indexing the array name. This is done by placing the index of the elementwithinsquarebracketsafterthenameofthearray.For example−

Double salary =balance[9];

The above statement will take the 10th element from the array and assign the value to salary variable.The following example Shows how to use all the three above mentioned concepts viz. declaration,assignment,andaccessingarrays.

TraversinginLinear Array:

Description: It means processing or visiting each element in thearray exactly onceforoneoperation.Let '**A**' is an array stored in the computer's memory and we want todisplay the contents of '**A**', then ithas to be traversed i.e. by accessing and processingeach element of '**A**' exactly once.Linear array '**A**'withlowerboundary**LB**(0inC++)andupperboundary(**UB**=**N-**

1 in C++) where **N** is the number of values stored in the array. If the array is empty, then **N** will be **equal 0. SIZE** is the total locations/positions available in array. This algorithm traverses '**A**' applying process to each element of '**A**'.

SIZE = 10
N = 5

Lower Bound

A[0]	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]	A[9]
5	6	12	4	15					
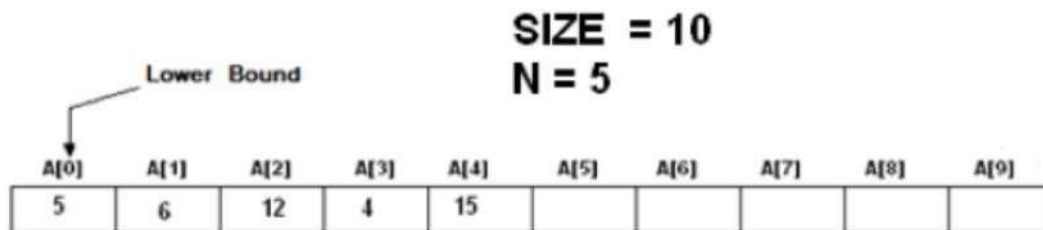
Inserting refers to the addition of a new element in an array, say '**A**'. Inserting an element at the end of the array can be easily done. On the other hand, if an element is to be inserted at the beginning or in the middle of array '**A**', then the elements (from insertions point inclusively) must be moved downward to new locations, to accommodate the new element. Assume, values inside the '**A**' are in sorted order and it is needed to insert the new item at such location in '**A**' so that the sorted order of '**A**' should not be disturbed. See the algorithm:

Deletion refers to the operation of removing one of the elements from the array '**A**'. Deleting an item at the end of the array presents no difficulties. But, deleting an item from beginning or some where in the middle of array would require that each subsequent element be moved one location upward in order to fill up the array.

SOLUTION 1

ALGORITHM

Step 1: Start.
Step 2: Read N value.
Step 3: Read Array of N integer elements Step 4: Print array of N integer elements.
Step 5: Insert an element at given valid position in an array.
Step 6: Delete an element at given valid position from an array.
Step 7: Stop.

PROGRAM CODE:

```c
#include<stdio.h>
#include<stdlib.h>
int a[20];
int n, val, i, pos;

/*Function Prototype*/
void create ();
void display ();
void insert ();
void delete ();

int main ()
{
  int choice;
  while (1)
   {
     printf ("\n\n ------- MENU \n");
     printf ("1.CREATE\n");
     printf ("2.DISPLAY\n");
     printf ("3.INSERT\n");
     printf ("4.DELETE\n");
     printf ("5.EXIT\n");
     printf (" ");

     printf ("\nENTER YOUR CHOICE:\t");
     scanf ("%d", &choice);
     switch (choice)
         {
         case 1:create ();
          break;
         case 2: display ();
          break;
         case 3:insert ();
```

```
          break;
       case 4:delete ();
          break;
       case 5:exit (0);
          break;
       default:printf ("\nInvalid choice:\n");
          break;
       }
   }
  return 0;
}

//creating an array
void create ()
{
 printf ("\nEnter the size of the array elements:\t");
 scanf ("%d", &n);
 printf ("\nEnter the elements for the array:\n");
 for (i = 0; i < n; i++)
   {
     scanf ("%d", &a[i]);
   }
}

//displaying an array elements
void display ()
{
 printf ("\nThe array elements are:\n");
 for (i = 0; i < n; i++)
   {
     printf ("%d\t", a[i]);
   }
}

//inserting an element into an array

void insert ()
{
 printf ("\nEnter the position for the new element:\t");
 scanf ("%d", &pos);
 printf ("\nEnter the element to be inserted :\t");
 scanf ("%d", &val);
 for (i = n - 1; i >= pos; i--)
   {
     a[i + 1] = a[i];
```

```c
  }
 a[pos] = val;
 n = n + 1;
}

//deleting an array element
void delete ()
{
 printf ("\nEnter the position of the element to be deleted:\t");
 scanf ("%d", &pos);
 val = a[pos];
 for (i = pos; i < n - 1; i++)
  {

    a[i] = a[i + 1];
  }
 n = n - 1;
 printf ("\nThe deleted element is =%d", val);
}
```

Sample Output 1

Menu
1.Create
2.Display
3.Insert
4.Delete
5.Exit
───────────────

ENTER YOUR CHOICE: 1
Enter the size of the array elements: 3
Enter the elements for the array: 10 25 30

ENTER YOUR CHOICE: 2
The array elements are:
10 25 30

ENTER YOUR CHOICE: 3
Enter the position for the new element: 1
Enter the element to be inserted : 20

ENTER YOUR CHOICE: 2

The array elements are:
10 20 25 30

ENTER YOUR CHOICE: 4
Enter the position of the element to be deleted: 3
The deleted element is =30

enter your choice: 5 Exit

Sample Output 2

Menu
1.Create
2.Display
3.Insert
4.Delete
5.Exit
—————————————

ENTER YOUR CHOICE: 1
Enter the size of the array elements: 3
Enter the elements for the array: 20 20 20

ENTER YOUR CHOICE: 2
The array elements are:
20 20 20

ENTER YOUR CHOICE: 3
Enter the position for the new element: 1
Enter the element to be inserted : 10

ENTER YOUR CHOICE: 2
The array elements are:
20 10 20 20

ENTER YOUR CHOICE: 4
Enter the position of the element to be deleted: 3
The deleted element is =20

ENTER YOUR CHOICE: 5 Exit

SOLUTION 2

ALGORITHM:
Step1:Start.
Step2:ReadNvalue.
Step3:Read Array of N integer elements
Step4:Print arrayo f N integer elements.
Step 5: Insert an element at given valid position in an array.
Step 6:Delete an element at given valid position from an array.
Step 7: Stop.

PROGRAMCODE:

```
#include<stdio.h>
#include<conio.h>
/* Global variables declaration */
inta[4], n, elem, i, pos;
/*Function Prototype and Definitions*/
voidcreate()    //creating an array
{
        printf("\nEnter the size of the array elements:");
        scanf("%d",&n);
        printf("\nEnter the elements for the array:\n");
        for(i=0;i<n; i++)
        scanf("%d", &a[i]);
}       //endofcreate()

voiddisplay() //displaying an array elements
{
        int i;
        printf("\nThe array elements are:\n");
        for(i=0;i<n; i++)
        {
                printf("%d\t",a[i]);
        }
}       //endofdisplay()


voidinsert()      //insertinga n element in to an array
{
        printf("\nEnter the position for the new element: ");
        scanf("%d",&pos);
        printf("\nEnter the element to be inserted: ");
```

```c
        scanf("%d",&elem);
        for(i=n-1;i>=pos;i--)
        {
        a[i+1]=a[i];
        }
        a[pos] = elem;n=n+1;
}       //end of insert()


voiddel()       //deleting an array element
{
        printf("\nEnter the position of the element to be deleted:");
        scanf("%d",&pos);
        elem = a[pos];
for(i=pos;i<n-1;i++)
{
        a[i]=a[i+1];
}
        n=n-1;
        printf("\nThe deleted elementis=%d",elem);
}//end of delete()


voidmain()
{
        int ch;
        do{
        printf("\n\n--------Menu       \n");
        printf("1.Create\n 2.Display\n 3.Insert\n 4.Delete\n 5.Exit\n");
        printf("");
        printf("\nEnteryourchoice:");
        scanf("%d",&ch);
        switch(ch)
        {

        case1:create();
        break;
        case2:display();
        break;
        case3:insert();
        break;
        case4:del();
        break;
        case5:exit(0);
        break;
```

```
default:printf("\nInvalid choice:\n");
break;
}
}
while(ch!=5);
getch();
}//end ofmain
```

SAMPLEOUTPUT:

```
Menu
1.Create
2.Display
3.Insert
4.Delete
5.Exit
Enter your choice:      1
Enter the size of the array elements:5
Enter the elements for the array:
10     20     30     40     50

Menu
1.Create
2.Display
3.Insert
4.Delete
5.Exit
Enter your choice:      2
The array elements are:
10     20     30     40     50

Menu
1.Create
2.Display
3.Insert
4.Delete
5.Exit
Enter your choice:      3
Enter the position for the new element:      2
Entertheelement tobeinserted:          90
```

<u>Menu</u>
<u>1.Create</u>
<u>2.Display</u>
<u>3.Insert</u>
<u>4.Delete</u>
<u>5.Exit</u>
<u>Enteryourchoice:</u> 2

Thearrayelementsare:

10	20	**90**	30	40	50

<u>Menu</u>
<u>1.Create</u>
<u>2.Display</u>
<u>3.Insert</u>
<u>4.Delete</u>
<u>5.Exit</u>
Enteryourchoice: 4
Entertheposition oftheelement tobedeleted: 5
Thedeleted element is= **50**

<u>Menu</u>
<u>1.Create</u>
<u>2.Display</u>
<u>3.Insert</u>
<u>4.Delete</u>
<u>5.Exit</u>

Enteryourchoice: 2

Thearrayelementsare:

10	20	90	30	40

<u>Menu</u>
<u>1.Create</u>
<u>2.Display</u>
<u>3.Insert</u>
<u>4.Delete</u>
<u>5.Exit</u>
Enteryourchoice: 5

EXIT

SOLUTION 3

PROGRAM CODE

```c
#include<stdio.h>
#include<stdlib.h> int
a[20],b[20],c[40];
int m,n,p,val,i,j,key,pos,temp;
/*Function Prototype*/
void create();
void display();
void insert();
void del();
int main()
{
    int choice;
    do
    {
        printf("\n\n--------Menu --------- \n");
        printf("1.Create\n"); printf("2.Display\n");
        printf("3.Insert\n"); printf("4.Delete\n");
        printf("5.Exit\n");
        printf("---------------------- ");
        printf("\nEnter your choice:\t");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1:create();
            break;
          case 2:display();
        break;
        case 3:insert();
        break;
    case 4:del();
                break;
        case 5:exit(0);
                break;
      default: printf("\n Invalid choice:\n");
            break;
```

```
        }
    }while(choice!=5); return 0;
}

void create() //creating an array
{
    printf("\nEnter the size of the array elements:\t");
    scanf("%d",&n);
    printf("\nEnter the elements for the array:\n");
    for(i=0;i<n;i++)
    {
        scanf("%d",&a[i]);
    }
}//end of create()

void display() //displaying an array elements
{
    int i;
    printf("\nThe array elements are:\n");
     for(i=0;i<n;i++)
    {
        printf("%d\t",a[i]);
    }
 }//end of display()

void insert()  //inserting an  element in to an array
{
  printf("\nEnter the position for the new element:\t");
  scanf("%d",&pos);
  printf("\nEnter the element to be inserted:\t");
  scanf("%d",&val);
  for(i=n-1;i>=pos;i--)
  {
        a[i+1]=a[i];
}
    a[pos]=val;
    n=n+1;
}//end of insert()
```

```c
void del()     //deleting an array element
{
    printf("\nEnter the position of the element to be deleted:\t");
    scanf("%d",&pos);
    val=a[pos];
    for(i=pos;i<n-1;i++)
    {
        a[i]=a[i+1];
    }
    n=n-1;
    printf("\nThe deleted element is =%d",val);
    }//end of delete()
```

SAMPLE OUTPUT

```
............Menu................
1.Create
2.Display
3.Insert
4.Delete
5.Exit
- - - - - - - - - - - - - - -
Enter your choice:      1


Enter the size of the array elements:  5


Enter the elements for the array: 10 20 30 40 50


.........    Menu .......
1.Create
2.Display
3.Insert
4.Delete
5.Exit
- - - - - - - - - - - - - - -
Enter your choice:          2


The array elements are:
10        20   30    40      50
```

```
.......... Menu ........
1.Create
2.Display
3.Insert
4.Delete
5.Exit
- - - - - - - - - - - - - -
Enter your choice:          3

Enter the position for the new element: 2

Enter the element to be inserted :          25

.......... Menu ........
1.Create
2.Display
3.Insert
4.Delete
5.Exit
- - - - - - - - - - - - - -
Enter your choice:          2

The array elements are:
10          20  25    30    40    50

.......... Menu ........
1.Create
2.Display
3.Insert
4.Delete
5.Exit
- - - - - - - - - - - - - -
Enter your choice:          4

Enter the position of the element to be deleted:          3

The deleted element is : 30
```

.... Menu ....
1.Create
2.Display
3.Insert
4.Delete
5.Exit

Enter your choice: 2

The array elements are:
10   20   25   40   50

.... Menu ....
1.Create
2.Display
3.Insert
4.Delete
5.Exit

Enter your choice: 5

PROGRAM -2

2.Design,Develop and Implement a Program in C for the following operations on Strings
        a. Read a main String(STR), a Pattern String(PAT) and a ReplaceString(REP)
        b. Perform Pattern Matching Operation:Find and Replace all occurrences of PAT in STR with REP if PATexists in STR. Report suitable messages in case PAT doesnot exist in STR.
Support the program with functions for each of the above operations.Don't use Built-in functions.*/

SOLUTION 1

ABOUT THE EXPERIMENT:

Strings are actually one-dimensional array of characters terminated by a null character '\0'. Thus a null-terminated string contains the characters that comprise the string followed by a null. The following declaration and initialization create a string consisting of the word "Hello".

To hold the null character at the end of the array, the size of the character array containing the string is one more than the number of characters in the word "Hello."

char greeting[6] = {'H', 'e', 'l', 'l', 'o', '\0'};

If you follow the rule of array initialization then you can write the above statement as follows:

char greeting[] = "Hello";

C language supports a wide range of built-in functions that manipulate null-terminated strings as follows:

strcpy(s1,s2); Copies string s2 into strings1.

strcat(s1,s2);   Concatenates string s2 onto the end of string s1.

strlen(s1);Returns the length of strings1.

strcmp(s1,s2); Returns 0 if s1 and s2 are the same; less than 0 if s1s2.

strchr(s1,ch); Returns a pointer to the first occurrence of character ch in strings1.

strstr(s1,s2);   Returns a pointer to the first occurrence of string s2 in strings1.

ALGORITHM:
Step 1: Start.
Step 2: Read main string STR, pattern string PAT and replace string REP.
Step 3: Search / find the pattern string PAT in the main string STR.
Step 4: if PAT is found then replace all occurrences of PAT in main string STR with REP string.
Step 5: if PAT is not found give a suitable error message.
Step 6: Stop.

PROGRAM CODE:

```c
#include<stdio.h>
void main ()
{
        char STR[100], PAT[100], REP[100], ans[100];
        int i, j, c, m, k, flag = 0;
        printf ("\nEnter the MAIN string: \n");
        gets (STR);
        printf ("\nEnter a PATTERN string: \n");
        gets (PAT);
        printf ("\nEnter a REPLACE string: \n");
        gets (REP);
        i = m = c = j = 0;
        while (STR[c] != '\0')
           {
             // Checking for Match
                 if (STR[m] == PAT[i])
                 {
                     i++;
                     m++;
                 flag = 1;
                 if (PAT[i] == '\0')
                     {
                     //copy replace string in ans string
                             for (k = 0; REP[k] != '\0'; k++, j++)
                         ans[j] = REP[k];
                             i = 0;
                     c = m;
                 }
             }

             else                     //mismatch
                 {
                 ans[j] = STR[c];
                     j++;
                     c++;
                 m = c;
                     i = 0;
         }
           }
         if (flag == 0)
        {
```

```
            printf ("Pattern doesn't found!!!");
        }
          else
          {
            ans[j] = '\0';
            printf ("\nThe RESULTANT string is:%s\n", ans);
          }
      }
```

Sample Output 1

Enter the MAIN string:
good morning
Enter a PATTERN string:
morning
Enter a REPLACE string:
evening
The RESULTANT string is:
good evening

Sample Output 2

Enter the MAIN string:
 hi vcet

Enter a PATTERN string:
bye

Enter a REPLACE string:
hello Pattern doesn't found!!

SOLUTION 2

Theory:

Strings are actually one-dimensional array of characters terminated by a**null** character'\0'.Thus a
null-terminated string containsthecharactersthat comprisethestringfollowedbya**null**.
The following declaration and initialization create a string consisting of the word "Hello". To hold
thenull character at the end of the array, the size of the character array containing the string is one
morethanthenumberofcharactersintheword"Hello."

Char greeting[6]={'H','e','l','l','o','\0'};

Ifyoufollowtheruleofarrayinitializationthenyoucanwritethe above statementasfollows−

Char greeting[]="Hello";

Followingisthememorypresentationof theabovedefinedstringinC/C++−

Index	0	1	2	3	4	5
Variable	H	e	l	l	o	\0
Address	0x23451	0x23452	0x23453	0x23454	0x23455	0x23456

Actually,youdonotplacethe *null* characterattheendofastringconstant.TheCcompilerautomatically places the '\0' at the end of the string when it initializes the array. Let us try to print theabovementionedstring.

PROGRAMCODE:

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

//Declarations
char str[100], pat[50], rep[50], ans[100];
inti, j, c, m, k,flag=0;
void string match()
{
i = m = c = j = 0;
while(str[c]!='\0')
{
        if(str[m]==pat[i])      //      matching
        {
        i++;
        m++;
        if(pat[i]=='\0') //      found occurrences.
        {
        flag=1;

        //      copy replace string in an string.
        for(k=0;rep[k] !='\0';k++,j++)
        ans[j]=rep[k];
                i = 0;
                c=m;
}
}       //ifends.
        else    //...mismatch
                {
                ans[j] = str[c];
                j++;
                c++;
                m=c;
                i = 0;
                }//elseends
        }//endofwhile
ans[j]='\0';
}//end string match()


Void main()
{
        clrscr();
        printf("\nEnter a main string \n");
```

```
        gets(str);
        printf("\nEnter a pattern string \n");
        flushall();
        gets(pat);
        printf("\nEnter a replace string \n");
        flushall();
        gets(rep);
        stringmatch();if(flag==1)
        else
        printf("\nTher esultant stringis\n%s", ans);
        printf("\nPatternstring NOT found\n");
        getch();
}       //end ofmain
```

SAMPLEOUTPUT:

RUN1:
Enter a main string:Test
Enter a pattern string:Te
Enter a replace string :Re

The resultant string is Rest

RUN2:
Enter amain string:This is Data Structure lab
Enter a pattern string:DataStructure
Enter a replace string:Datastructure with C

The resultant string is Thisi s Data structure with C lab

RUN3:
Enter amain string:This is Data Structure lab
Enter a pattern string:Date
Entera replace string:DATA

Pattern string NOT found

SOLUTION 3

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

int main()
{

    char str[100],pat[100],rep[100], ans[100];
    int i,j,k,c,m,flag=0;
    printf("Enter the main string: ");
    gets(str);
    printf("Enter the pattern string: ");
    gets(pat);
    printf("Enter the replace string: ");
    gets(rep);
    i=j=m=c=0;
    while(str[c]!='\0')
    {
        if(str[m]==pat[i])
        {
            i++;
            m++;
            if(pat[i]=='\0')
            {
             for(k=0;rep[k]!='\0';k++,j++)
                ans[j] = rep[k];
            i=0;
            c=m;
            flag=1;
            }
        }
        else{
            ans[j] = str[c];
            j++;
            c++;
            m=c;
            i=0;
        }
    }
    if(flag==0)
    {
        printf("\n\n\tpattern %s not found",pat);
```

```
   }
   else{
      ans[j] ='\0';
      printf("\n\t Resultant string is  %s",ans[j]);
   }
   return 0;
}
```

SAMPLE OUTPUT

Case i)

Enter the MAIN string:

Good Morning

Enter a PATTERN string:

Morning

Enter a REPLACE string:

Evening

The RESULTANT string is: Good Evening

Case ii)

Enter the MAIN string:

Good Morning

Enter a PATTERN string:

Noon

Enter a REPLACE string:

Noon

Pattern doesn't found!!!

PROGRAM-3

3.Design,Develop and Implement a menu driven program in C for the following operations on STACK of integers(Array implementation of stack with maximum size MAX)
Pushan element on to stack
Pop an element from stack.
Demonstrate how stack can beused to check palindrome.
Demonstrate Overflow and Underflow situations on stack.
Display the status of stack.
Exit.
Support the program with appropriate functions for each of the above operations.

ABOUT THE EXPERIMENT:
A stack is an abstract data type (ADT), commonly used in most programming languages.It is named stack

as it behaves like a real-worldstack.

Areal-world stack allows operations at one end only.For example,we can place or remove a card or plate from top of the stack only.Likewise,Stack ADT allows all data operations at on end only. At any given time, we can only access the top element of a stack.

This feature makes it LIFO data structure.LIFO stands for Last-in-first-out.Here,the element which is placed (inserted or added) last is accessed first. In stack terminology, insertion operation is called **PUSH** operation and removal operation is called **POP** operation.

Below given diagram tries to depict as stack and its operation
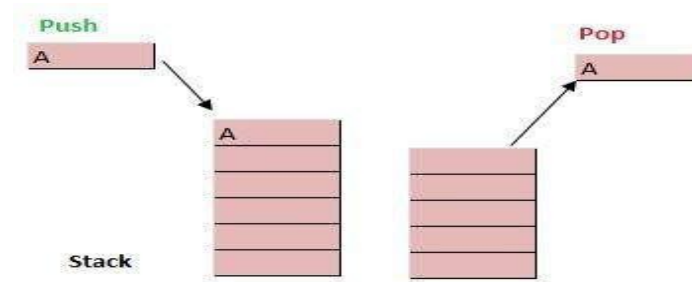
A stack can be implemented by means of Array, Structure, Pointer and Linked-List. Stackcan either be a fixed size one or it may have a sense of dynamic resizing. Here, we are going toimplementstack usingarrays which makes it afixed sizestack implementation.

BasicOperations:

push()-pushing(storing)an element onthestack.

pop() -removing(accessing) an element from the stack.

To use a stack efficiently we need to check status of stack as well. For the same purpose,

thefollowingfunctionalityisadded to stacks;

peek()−get the top data element of the stack,without removing it.

isFull() –check if stack is full.

isEmpty()−check if stack is empty.

SOLUTION 1

ALGORITHM:

Step1:Start.

Step2:Initialize stack size MAX and top of stack-1.

Step3:Push integer element onto stack and display the contents of the stack.if stack is full give a message as'Stack is Overflow'.

Step3:Pop element from stack along with display the stack contents.if stack is empty give a message as'Stackis Underflow'.

Step4:Check whether the stack contents are Palindrome or not.

Step5:Stop.

PROGRAMCODE:

```c
#include<stdio.h>
#include<conio.h>
#defineMAX4
Intstack[MAX],item;
Intch, top =-1, count=0, status =0;
/*PUSHFUNCTION*/
void push(int stack[],intitem)
{
        if(top ==(MAX-1))
        printf("\n\nStack Is Overflow");
        else
        {
        stack[++top] = item;
        status++;
}
}


/*POPFUNCTION*/
intpop(int stack[])
{
        intret;
        if(top==-1)
        printf("\n\nStack is Underflow");
        else
        {
                        ret = stack[top--];
                        status--;
        }               printf("\nPopped elemen tis%d",ret);

        returnret;
}

/*FUNCTION TO CHECK STACK IS PALINDROME OR NOT*/
Void palindrome(intstack[])
{
        int i, temp;
        temp=status;
        for(i=0;i<temp;i++)
        {
                if(stack[i]==pop(stack))
                count++;
                }
        if(temp==count)
```

```
        printf("\nStack contents are Palindrome");
else
            printf("\nStack contents are not palindrome");
}




/*FUNCTION TO DISPLAY STACK*/
Void display(int stack[])
{
        int i;
        printf("\nThe stack contents are:");
        if(top==-1)
        printf("\nStack is Empty");
else

        {       for(i=top;i>=0;i--)
                printf("\n ----- \n| %d|", stack[i]);
                printf("\n");
        }
}




/*MAINPROGRAM*/
voidmain()
{
        clrscr();
        do{
        printf("\n\n ---MAIN MENU \n");
        printf("\n1. PUSH (Insert) in the Stack");
        printf("\n2. POP (Delete) from the Stack");
        printf("\n3.PALINDROME checkusing Stack");
        printf("\n4. Exit (End the Execution)");
        printf("\nEnterYour Choice: ");
        scanf("%d",&ch);

        switch(ch)
        {
        case 1: printf("\nEnter a element to be pushed: ");
        scanf("%d",&item);
        push(stack,item);
        display(stack);
        break;
        case2:item=pop(stack);
```

```
display(stack);
break;
```

```
case3:palindrome(stack);
break;
case 4:exit(0);

break;
default:printf("\nEND OF EXECUTION");
}//end switch
}while(ch!=4);
getch();
}
```

SAMPLEOUTPUT:
----MAINMENU----
1.PUSH (Insert) In the Stack
2.POP (Delete) from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
Enter Your Choice: 1
Enter an element to be pushed: 1
The stack contents are:
|1|

----MAINMENU----
1.PUSH(Insert) in th eStack
2.POP (Delete) from theStack
3.PALINDROME check using Stack
4.Exit (End the Execution)
Enter You rChoice: 1
Enter an element to be pushed: 2
The stack contents are:

|2|

|1|

-------AFTER THE 4 TIMES PUSH OPERATION
----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete) from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYourChoice: 1
Enter an element to be pushed: 9
StackisOverflow
The stack contents are:
|1|

|2|

|2|

|1|

----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete) from the Stack
3.PALINDROME check using Stack
4.Exit(End the Execution)
     EnterYour Choice: 2
     Popped element is: 1

     The stack contents are

|2|

|2|

|1|

(--------AFTER THE 4 TIMES POP OPERATION)
----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete) from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYour Choice: 2
Stack is Underflow
The stack contents are:Stack is Empty

(--------CHECKING FOR PALINDROME OR NOT USING STACK   )
----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete) from the Stack
3.PALINDROME checkusing Stack
4.Exit (End the Execution)
Enter YourChoice: 1
Enter an element t obepushed: 1

The stackcontents are:
|1|

----MAINMENU----
1.PUSH(Insert) in the Stack
2.POP (Delete)from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYour Choice: 1
Enter an element to be pushed: 2
The stack contents are:

|2|

|1|
----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete) from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYour Choice: 1
Enter a element to be pushed: 1
The stack contents are:

|1|

|2|

|1|
----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete)from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYour Choice: 3
Stack contents are is Palindrome

(--------CHECKING FOR PALINDROME OR NOT USING STACK   )
----MAINMENU----
1.PUSH(Insert) in the Stack
2.POP (Delete)from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYour Choice: 1

Enter an element to be pushed: 1
The stack contents are:

|1|

(AFTER 3 TIMES PUSH)
----MAIN MENU----
1.PUSH(Insert)in the Stack
2.POP (Delete)from the Stack
3.PALINDROME check usingStack
4.Exit (End the Execution)
EnterYour Choice: 1
Enter an element to b epushed: 3

The stack contents are:

|3|

|2|

|1|

----MAIN MENU----
1.PUSH(Insert) in the Stack
2.POP (Delete)from the Stack
3.PALINDROME check using Stack
4.Exit (End the Execution)
EnterYourChoice: 3
Stack contents are not Palindrome

SOLUTION 2

PROGRAM CODE:

```c
#include<stdlib.h>
#include<stdio.h>
#include<string.h>
#define max_size 5
int stack[max_size], top = -1, flag = 1;
int i, temp, item, rev[max_size], num[max_size];
void push ();
void pop ();
void display ();
void pali ();
int main ()
{
  int choice;
  printf ("\n\n--------STACK OPERATIONS        ");
  printf ("1.Push\n");
  printf ("2.Pop\n");
  printf ("3.Palindrome\n");
  printf ("4.Display\n");
  printf ("5.Exit\n");
  printf (" ");
  while (1)
  {
   printf ("\nEnter your choice:\t");
   scanf ("%d", &choice);
   switch (choice)
         {
     case 1:
             push ();
              break;
     case 2:
              pop ();
        if (flag)
      printf ("\nThe poped element: %d\t", item);
               temp = top;
               break;
     case 3:
              pali ();
        top = temp;
               break;
 case 4:
             display ();
              break;
 case 5:
             exit (0);
              break;
     default:
             printf ("\nInvalid choice:\n");
             break;
```

```c
        }

    }
//return 0;
}
void push ()                        //Inserting element into the stack
{
   if (top == (max_size - 1))
   {
      printf ("\nStack Overflow:");
   }
  else
   {
      printf ("Enter the element to be inserted:\t");
      scanf ("%d", &item);
      top = top + 1;
      stack[top] = item;
   }
   temp = top;
}

void pop ()                        //deleting an element from the stack
{
   if (top == -1)
   {
      printf ("Stack Underflow:");
      flag = 0;
   }
  else
   {
      item = stack[top];
      top = top - 1;
   }
}

void pali ()
{
   i = 0;
   if (top == -1)
   {
      printf ("Push some elements into the stack first\n");
   }
  else
   {
      while (top != -1)
        {
                rev[top] = stack[top];
                 pop ();
        }
      top = temp;
      for (i = 0; i <= temp; i++)
 {
        if (stack[top--] == rev[i])
```

```
                {
            if (i == temp)
                    {
            printf ("Palindrome\n");
                    return;
                }
            }
        }
    printf ("Not Palindrome\n");

    }
}

void display ()
{
    int i;
top = temp;
if (top == -1)
    {
        printf ("\nStack is Empty:");
}
  else
    {
        printf ("\nThe stack elements are:\n");
         for (i = top; i >= 0; i--)
         {
        printf ("%d\n", stack[i]);
}
}
}
```

Sample Output 1

--------STACK OPERATIONS-----------
1.Push
 2.Pop
3.Palindrome
4.Display
5.Exit

    ──────────────

Enter your choice: 1
Enter the element to be inserted: 1

Enter your choice: 1
Enter the element to be inserted: 2

Enter your choice: 1
Enter the element to be inserted: 1

Enter your choice: 1

Enter the element to be inserted: 5

Enter your choice: 2
The poped element: 5

Enter your choice: 4
The stack elements are: 1 2
1
Enter your choice: 3
Numbers= 1
Numbers= 2
Numbers= 1
reverse operation :
reverse array : 1 2 1
check for palindrome : It is palindrome number

Enter your choice: 5
Exit

Sample Output 2

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
_____

Enter your choice: 1
Enter the element to be inserted: 10

Enter your choice: 1
Enter the element to be inserted: 20

Enter your choice: 1
Enter the element to be inserted: 10

Enter your choice: 1
Enter the element to be inserted: 50

Enter your choice: 2 The poped element: 50

Enter your choice: 4
The stack elements are: 10 20
10
Enter your choice: 3
Numbers= 1
Numbers= 2
Numbers= 1
reverse operation : reverse array : 1 2 1
check for palindrome : It is palindrome number

Enter your choice: 5
Exit

SOLUTION 3

```c
#include<stdlib.h>
#include<stdio.h>
#include<string.h> #define
max_size 5
int stack[max_size],top=-1;
 void push();
void pop();
void display();
void pali();
int main()
{
	while(choice)
{

	printf("\n\n--------STACK OPERATIONS ----------\n");
	printf("1.Push\n");
	printf("2.Pop\n");
	printf("3.Palindrome\n");
	printf("4.Display\n");
	printf("5.Exit\n");
	 printf("---------------------- ");
	printf("\nEnter your choice:\t");
	scanf("%d",&choice);
	switch(choice)
	{
	case 1:
	push();
	break;
	case 2:
	pop();
	break;
	case 3:
	pali();
	break;
	case 4:
	display();
	break;
	case 5:
	exit(0);
	break;
	default:
```

```c
            printf("\nInvalid choice:\n");
            break;
        }
    }

    return 0;
}
void push() //Inserting element into the stack
{
        int item;
        if(top==(max_size-1))
        {
                printf("\nStack Overflow:");
        }
        else
        {
                printf("Enter the element to be
                inserted:\t"); scanf("%d",&item);
                top=top+1;
                stack[top]=item;
        }
}

void pop() //deleting an element from the stack
{
        int item;
        if(top==-1)
        {
                printf("Stack Underflow:");
        }
        else
        {
        item=stack[top];
        top=top-1;
        printf("\nThe poped element: %d\t",item);
        }
}
void pali()
{
int digit,j,k,len=top+1,ind=0;
int num[len],rev[len],i=0;
while(top!=-1)
{
```

```c
            digit= stack[top];
            num[i]=digit;
            top--;
            i++;
    }
  for(j=0;j<len;j++)
  {
            printf("Numbers= %d\n",num[j]);
  }
  printf("reverse operation : \n");
  for(k=len-1;k>=0;k--)
  {
            rev[k]=num[ind];
            ind++;
  }
  printf("reverse array : );
  for(k=0;k<len;k++)
  {
  printf("%d\n",rev[k]);
  }
  printf("check for palindrome: \n");
  int length = 0;
  for(i=0;i<len;i++) {
  if(num[i]==rev[i])
  { length = length+1;
  }
  }
  if(length==len)
  {
            printf("It is palindrome number\n");
  }
else
{
printf("It is not a palindrome number\n");
}
top = len-1;
}

void display()
{
int i;
if(top== -1)
```

```
{
printf("\nStack is Empty:");
}
else
 {
printf("\nThe stack elements are:\n" );
for(i=top;i>=0;i--)

{
printf("%d\n",stack[i]);
}
}
}
```

SAMPLE Output:

```
--------STACK OPERATIONS-----------
 1.Push
 2.Pop
 3.Palindrome
 4.Display
 5.Exit
- - - - - - - - - - - - - -
 Enter your choice:1
 Enter the element to be inserted:       1

--------STACK OPERATIONS-----------
 1.Push
 2.Pop
 3.Palindrome

 4.Display
 5.Exit
- - - - - - - - - - - - - -
 Enter your choice:      1
 Enter the element to be inserted:      2

--------STACK OPERATIONS-----------
 1.Push
 2.Pop
 3.Palindrome
```

4.Display

5.Exit

- - - - - - - - - - - - - -

Enter your choice: 1

Enter the element to be inserted: 1

-------STACK OPERATIONS-----------

1.Push

2.Pop

3.Palindrome

4.Display

5.Exit

- - - - - - - - - - - - - -

Enter your choice: 4

The stack elements are: 1 2 1

-------STACK OPERATIONS-----------

1.Push

2.Pop

3.Palindrome

4.Display

5.Exit

- - - - - - - - - - - - - -

Enter your choice: 4

The stack elements are:

1

2

1

-------STACK OPERATIONS-----------

1.Push

2.Pop

3.Palindrome

4.Display

5.Exit

- - - - - - - - - - - - - -

Enter your choice: 3

Numbers= 1

Numbers= 2
Numbers= 1
reverse operation :
reverse array :
1
2
1
check for palindrome :
It is palindrome number

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - -
Enter your choice: 2

The poped element: 1

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - -
Enter your choice: 4

The stack elements are: 2 1

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - -
Enter your choice: 1

Enter the element to be inserted: 3

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - -
Enter your choice: 4

The stack elements are: 3 2 1

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - -
Enter your choice: 3
Numbers= 3
Numbers= 2
Numbers= 1
reverse operation : reverse
array :
1
2
3
check for palindrome :
It is not a palindrome number

--------STACK OPERATIONS-----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - -
Enter your choice: 5

PROGRAM- 4

4.Design, Develop andImplement a Program in C for converting an Infix Expression to PostfixExpression. Program should support for both parenthesized and free parenthesized expressions with the operators:+, -,*, /,%(Remainder),^(Power)and alpha numeric operands.

ABOUTTHEEXPERIMENT:
Infix: Operators are written in-between their operands. Ex: X + Y
Prefix: Operators are written before their operands. Ex: +X Y
postfix: Operatorsarewrittenafter their operands.Ex:XY+
ExamplesofInfix,Prefix,andPostfix

InfixExpression	PrefixExpression	PostfixExpression
A+B	+AB	AB +
A+B*C	+A*B C	ABC*+

Infix to prefix conversion Expression = **(A+B^C)*D+E^5**
Step1. Reverse the infixexpression=**5^E+D*)C^B+A(**
Step2. MakeEvery'('as')'andevery')'as'('**5^E+D*(C^B+A)**
Step3. Convert expressiontopostfixform.
Step4. Reversethe expression.
+*+A^BCD^E
Step5. Result
+*+A^BCD^E5

A+(B*C-(D/E-F)*G)*H			
Expression	**Stack**	**Output**	**Comment**
5^E+D*(C^B+A)	Empty	-	Initial
^E+D*(C^B+A)	Empty	5	Print
E+D*(C^B+A)	^	5	Push
+D*(C^B+A)	^	5E	Push
D*(C^B+A)	+	5E^	PopAndPush
*(C^B+A)	+	5E^D	Print
(C^B+A)	+*	5E^D	Push
C^B+A)	+*(	5E^D	Push
^B+A)	+*(	5E^DC	Print
B+A)	+*(^	5E^DC	Push
+A)	+*(^	5E^DCB	Print
A)	+*(+	5E^DCB^	PopAndPush
)	+*(+	5E^DCB^A	Print
End	+*	5E^DCB^A+	Pop Until'('

| End | Empty | 5E^DCB^A+*+ | PopEveryelement |

SOLUTION 1

ALGORITHM:

Step 1:Start.
Step2:Read an infix expression withparenthesis and without parenthesis.
Step3:convert the infix expression to postfix expression.
Step 4:Stop

PROGRAMCODE:

```c
#include<stdio.h>
#include<string.h>
#include<conio.h>
IntF(charsymbol)
{
switch(symbol)
{
        case '+'
        case'-':
                return 2;
        case'*':
        case'/':
                return 4;
        case '^':
        case'$':
        return 5;
        case'(':


                return 0;
        case'#':
        return -1;
        default:return8;
}
}


Int G(char symbol)
{
switch(symbol)
{
        case '+'
        case'-':
        return 1;
        case'*':
```

case'/':

```c
            return 3;
            case '^':
            case'$':return 6;
            case'(':
            return9;
            case')':
            return0;
            default:return7;
    }
}
Void infix_postfix(char infix[],char postfix[])
{
Int top, j, i;
chars[30],symbol;
top=-1;
s[++top]='#';
j = 0;
for(i=0;i <strlen(infix);i++)
        {
        symbol=infix[i];while(F(s[top])>G(symbol))
        {
                postfix[j] = s[top--];
                j++;
        }
if(F(s[top]) != G(symbol))
        s[++top]=symbol;
else
        top--;
        }
while(s[top]!='#')
        {
                postfix[j++]=s[top--];
        }
postfix[j]='\0';
}

void main()
{
char infix[20], postfix[20];
printf("\nEnter a valid infix expression\n");
flushall();
gets(infix);
infix_postfix(infix,postfix);
printf("\nThe infix expression is:\n");
printf("%s",infix);
printf("\nThe postfix expression is:\n");
printf("%s",postfix);
getch();
```

}

SAMPLEOUTPUT:

Enter a valid infix expression
(a+(b-c)*d)
Theinfixexpressionis:
(a+(b-c)*d)
The postfix expression is:
abc-d*+

SOLUTION 2

```c
#define SIZE 50 /* Size of Stack */
#include <ctype.h>
#include <stdio.h>
char s[SIZE];
int top = -1; /* Global declarations */
push(char elem) /* Function for PUSH operation */
{
s[++top] = elem;
}
char pop() /* Function for POP operation */
{
return (s[top--]);
}
int pr(char elem) /* Function for precedence */
{
    switch (elem)
    {
       case '#': return 0;
       case '(': return 1;
       case '+':
       case '-': return 2;
       case '*':
       case '/':
       case '%': return 3;
       case '^': return 4;
    }
}
void main() /* Main Program */
{
    char infx[50], pofx[50], ch, elem;
    int i = 0, k = 0;
    printf("\n\nRead the Infix Expression ? ");
    scanf("%s", infx);
    push('#');
    while ((ch = infx[i++]) != '\0')
    {
       if (ch == '(')
          push(ch);
       else if (isalnum(ch))
          pofx[k++] = ch;
       else if (ch == ')')
       {
          while (s[top] != '(')
             pofx[k++] = pop();
          elem = pop(); /* Remove ( */
       }
```

```
      else /* Operator */
      {
        while (pr(s[top]) >= pr(ch))
          pofx[k++] = pop();
        push(ch);
      }
  }
  while (s[top] != '#') /* Pop from stack till empty */
    pofx[k++] = pop();
  pofx[k] = '\0'; /* Make pofx as valid string */
  printf("\n\nGiven Infix Expn: %s Postfix Expn: %s\n", infx, pofx);
}
```

Sample Output 1

Read the Infix Expression
(a+b)*c/d^5%1
Given Infix Expn:
(a+b)*c/d^5%1
Postfix Expn:
ab+c*d5^/1%

Sample Output 2

Read the Infix Expression
(a+(b-c)*d)
Given Infix Expn:
(a+(b-c)*d)
Postfix Expn:
 abc-d*+

SOLUTION 3

Algorithm   F(symbol)
switch
case+/-return2
case%/*//return4
case^/$return5
case(return0
case#return-1
default:return8

Algorithm   G(symbol)
switch
case+/-return1
case%/*//return3
case^/$return6
case)return0
case(return9
defaultreturn7

Algorithm main
1.Start
2.Readinfixexpression
3.Checkforvalidexpressionif(infix[i]=='(')
   c++
   if(infix[i]==')')
    c--
4.if(c=0)
Thencallinfix_postfix(infix,postfix)
5.printthepostfixexpression
else
   printinvalidexpression
6.stop

Algorithm   infix_postfix(in,po)
1.Pushtostack
2.Repeati=0tostringlengthof infix expression
symbol=in[i]
repeatF(s[top])>G(symbol)
po[j++]=s[top--]
if(F(s[top])>G(symbol)
thenpushsymboltostack
else
pop
3.repeatuntilitis'#'
po[j++]=s[top--]
4.po[j]='\0'

PROGRAMCODE

```
#include<stdio.h>
Void infix_to_postfix();
Void push(char);
Char pop();
Int priority(char);
Char infix[30],postfix[30],stack[30];
int top=-1;

void main()
{
        printf("Enter the valid Infix expression\n");
        scanf("%s",infix);
        infix_to_postfix();
        printf("\nInfix expression:%s",infix);
        printf("\nPostfix expression:%s\n",postfix);
}

//pushsymboltostack
Void push(char item)
{
        stack[++top]=item;
}//end of function push

//popsymbolfromstack
char pop()
{
Return stack[top--];
}//end of function pop

//check the priority of operator
Int priority(char symb)
{
        Int p;
switch(symb)
{
        case'+':
        case'-':p=1;
                    break;
        case'*':
        case'/':
        case'%':p=2;
                      break;
        case'^':
        case'$':p=3;
                    break;
```

```
        case'(':
        case')':p=0;
                break;
        case'#':p=-1;
        break;
        }//end of  switch return p;
}//end  of function priority

//converting an Infix Expression to Postfix Expression
void infix_to_postfix()
{
        inti=0,j=0;
        char symb,temp;
        push('#');
        for(i=0;infix[i]!='\0';i++)
        {
                symb=infix[i];switch(symb)
        {

        case'(':push(symb);//push to top of stack
                break;
        case')':temp=pop();//pop symbol from top of stack
                while(temp!='(')//pop all symbols from  topof stack
                {

                postfix[j++]=temp;
                temp=pop();

                }//end ofwhile
                break;
        case'+':
        case'-':
        case'*':
        case'/':

        case'%':
        case'^':
        case'$':
        while(priority(stack[top])>=priority(symb))//checkforpriority of operator//
        {
                temp=pop();
                postfix[j++]=temp;
        }
        push(symb);
        break;
        default:
                postfix[j++]=symb;
        }//endofswitch
```

```
        }//end of for
while(top>0)
{
        temp=pop();
        postfix[j++]=temp;
}//end of  while
        postfix[j]='\0';//end string postfix
}//end of function infix_to_postfix
```

SAMPLE OUTPUT:

```
Enter the vaild infix expression
a-b+c
infix expression: a-b+c
postfix expression: ab-c+


Enter the vaild infix expression
a+(b+c*d)+c
infix expression: a+(b+c*d)+c
postfix expression: abcd*++c+
```

PROGRAM -5

5.Design,develop and Implement a Program in C forthe following Stack Applications
   a) **Evaluation of Suffix expression with single digit operands and operators:+, -, *, /, %, ^**
   b) **Solving Tower of Hanoi problem with n disks**.

ABOUT THE EXPERIMENT:
   a. Evaluation of Suffix expression with single digit operands and operators: +,-, *, /, %, ^
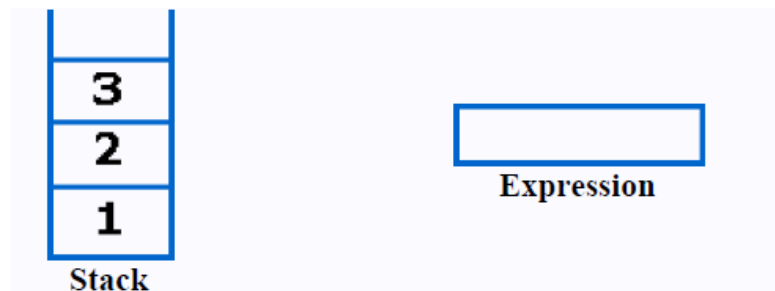   **Postfix/SuffixExpression:**Operators are written after their operands.Ex:XY+
   In normal algebra we use the infix notation like **a+b*c**.
   The corresponding postfix notationis **abc*+**
   Example: Postfix String: 123*+4-
   Initially the Stackisempty.Now,the first three characters scanned are1,2and 3,which are operands.Thus they will be pushed into the stack inthat order.

Stack | Expression

Next character scanned is"*", which is anoperator. Thus, we pop the top two elements fromthe stack and perform the"*"operation with the two operands.The second operand will be the first element that is popped.

Stack | 2*3=6 Expression
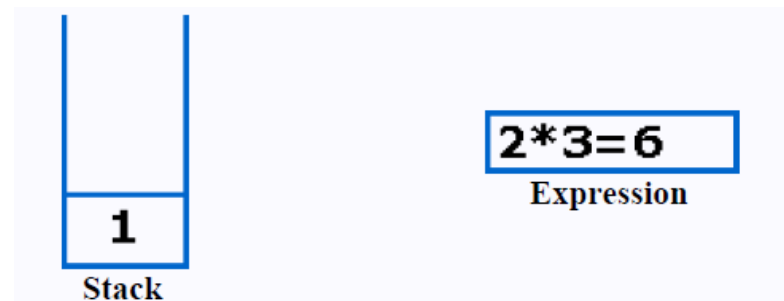
The value of the expression(2*3)that has beenevaluated(6) is pushed into the stack.
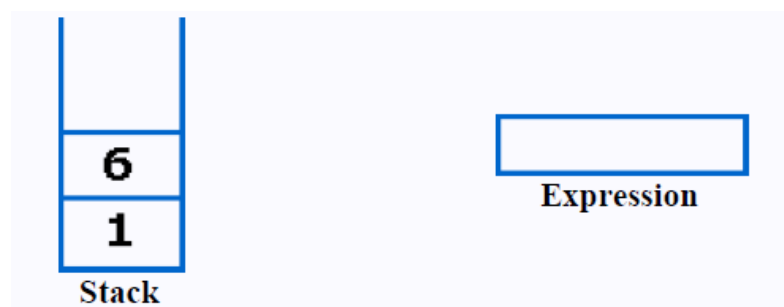
Stack | Expression

Next character scanned is "+",which is an operator.Thus,we pop the top two elements from the stack and perform the"+" operation with the two operands.The second operand will be then first element that is popped.

1+6=7

Expression

Stack

The value of the expression (1+6) that has been evaluated (7) is pushed into the stack.

7

Stack

Expression

Next character scanned is"4",which is added to the stack.
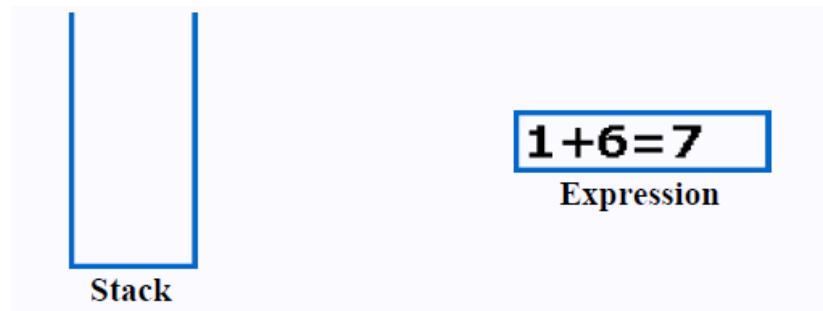

4

7

Stack

Expression

Next character scanned s"-", which is an operator.Thus, we pop the top two elements from the stack and perform the"-"operation with the two operands.The second operand will be the first element that is popped.
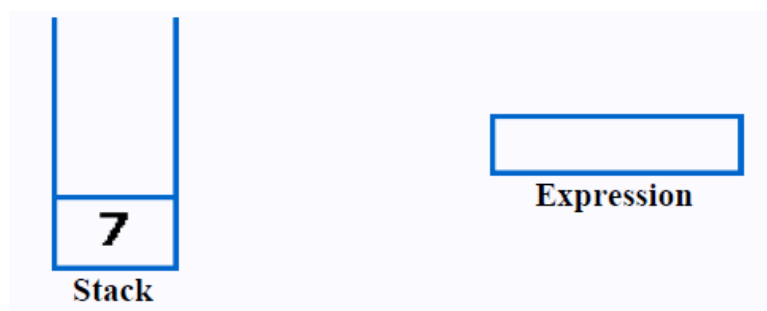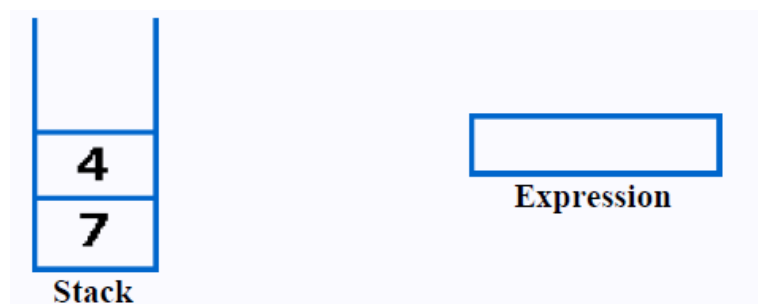

7-4=3
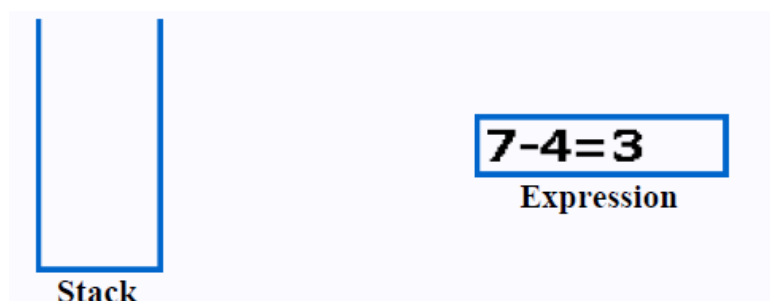
Expression

Stack

The value of the expression(7-4) that has been evaluated(3) is pushed into the stack.
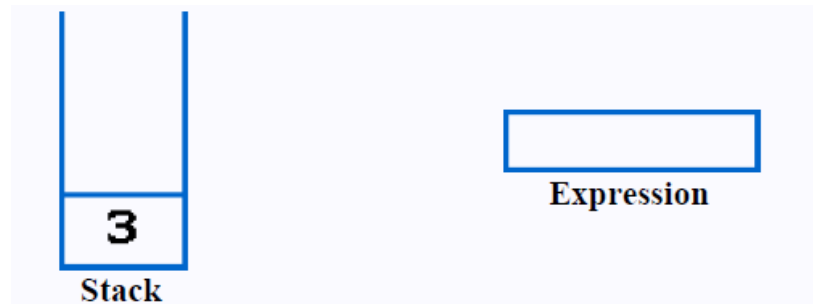
Now,since all the characters are scanned, the remaining element in the stack (there will be only one element in the stack)will be returned.

End	
PostfixString: 123*+4	

ALGORITHM:
Step 1:Start.
Step 2:Read the postfix/suffixexpression.
Step 3:Evaluate the postfix expression based on the precedence of theoperator.
Step 4:Stop.

SOLUTION 1

```c
#include<stdio.h>
#include<stdlib.h>
#include<math.h>
int i,top=-1;
int op1, op2, res,s[20];
char postfix[90],symb;

void push(int item)
{
        top = top+1;
        s[top]= item;
}

int pop()
{
        int item;
        item=s[top];
        top = top-1;
        return item;
}
void main()
{
```

```c
        printf("\nEnter a valid postfix expression:\n");
        scanf("%s",postfix);
        for(i=0;postfix[i]!='\0';i++)
        {
        symb= postfix[i];
        if(isdigit(symb))
        {
                push(symb-'0');
        }
        else
        {
                op2 = pop();
                op1 = pop();
                switch(symb)
                {
case'+':

        push(op1+op2);
         break;
  case'-':
        push(op1-op2);
        break;
  case'*':
        push(op1*op2);
        break;
  case'/':
        push(op1/op2);
       break;
  case'%':
        push(op1%op2);
       break;
  case'$':
  case'^':push(pow(op1,op2));
        break;
 default:push(0);
}
}
}
res= pop();
printf("\nResult= %d",res);
}
```

Output:
Enter a valid postfix expression:
623+-382/+*2$3+
Result=52

Enter a valid postfix expression:
42$3*3-84/11+/+

Result=46

SOLUTION 2

```c
#include<stdio.h>
#define MAX 20
typedef struct stack
{
int data[MAX];
int top;
}stack;
 void init(stack *);
int empty(stack *);
int full(stack *);
int pop(stack *);
void push(stack *,int);
int evaluate(char x,int op1,int op2);
 int main()
{
        stack s;
        char x;
        int op1,op2,val;
        init(&s);
        printf("Enter the expression: Single digit operand and operators only:");
        while((x=getchar())!='\n')
        {
        if(isdigit(x))
                push(&s,x-48); //x-48 for removing the effect of ASCII
        else
        {
                op2=pop(&s);
                op1=pop(&s);
                val=evaluate(x,op1,op2);
                push(&s,val);
                }
        }

        val=pop(&s);
        printf("\nValue of expression=%d",val);

        return 0;
        }

int evaluate(char x,int op1,int op2)
{
if(x=='+')
return(op1+op2);
if(x=='-')
```

return(op1-op2);

```
if(x=='*')
return(op1*op2);
if(x=='/')
return(op1/op2);
if(x=='%')
return(op1%op2);
}

void init(stack *s)
{
s->top=-1;
}

int empty(stack *s)
{
        if(s->top==-1)
        return(1);
        return(0);
}

int full(stack *s)
{
        if(s->top==MAX-1)
        return(1);
        else
        return(0);
}

void push(stack *s,int x)
{
        s->top=s->top+1;
        s->data[s->top]=x;
}

int pop(stack *s)
{
        int x;
        x=s->data[s->top];
        s->top=s->top-1;
        return(x);
}
```

Output

Enter the expression(eg: 59+3*)
Single digit operand and operators only:74+5-
Value of expression=6

SOLUTION 3

```c
#include <stdio.h>
#include <stdlib.h>
#include<math.h>
#include<string.h>
double compute(char symbol, double op1, double op2)
{
   switch(symbol)
   {
      case '+': return op1+op2;
      case '-': return op1-op2;
      case '*': return op1*op2;
      case '/': return op1/op2;
      case '%':
      case '^': return pow(op1,op2);
   }
}
void main()
{
   double s[20];
   double res;
   double op1;
   double op2;
   int top,i;
   char postfix[20];
   char symbol;

   printf("enter the postfix expression:\n");
   scanf("%s",postfix);
   top=-1;
   for(i=0;i<strlen(postfix);i++)
   {
      symbol=postfix[i];
      if(isdigit(symbol))
```

```
    s[++top]=symbol-'0';
    else
    {
       op2=s[top--];
       op1=s[top--];
       res=compute(symbol,op1,op2);
       s[++top]=res;
    }
  }
  res=s[top--];
  printf("3the result is: %f",res);
}
```

Output:

Insert a postfix notation :: 45^98*+
Result :: 1096
Process returned 16 (0x10) execution time : 8.469 s
Press any key to continue.

b.Solving Tower of Hanoi problem with n disks.

The towers of Hanoi is a mathematical game or puzzle. It consists of three rods and number of disks of different size which can slide onto any rod. The puzzle starts with the disks in stacked in ascending order of size one rod, the smallest at the top thus making a conical shape. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules

- Only one disk can be moved at a time
- Each move consists of taking the upper disk from one of the stack and placing it on top of another stack.
- No disk may be placed on top of a smaller disk.

With three disks, the puzzle can be solved in seven moves. The minimum number of moves required to solve a Tower of Hanoi puzzle is 2^n-1, where *n* is the number of disks.
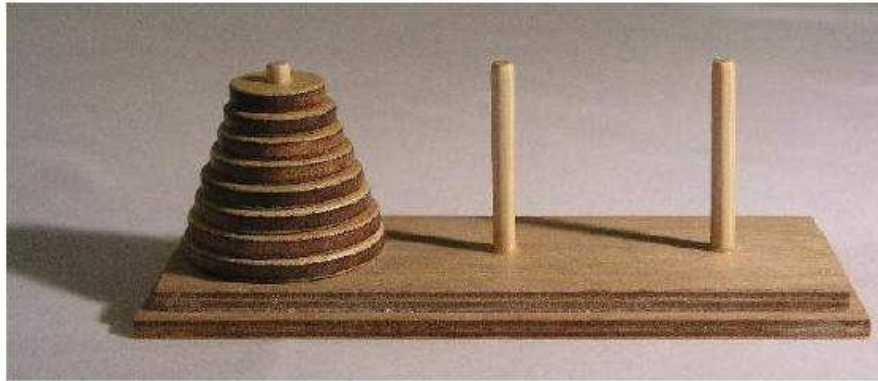
ALGORITHM:
Step 1:Start.
Step 2:Read N number of discs.
Step3: Move all the discs from source to destinationbyusingtemprod.
Step 4: Stop.

SOLUTION 1

```c
#include <stdio.h>
void towers(int, char, char, char);
int main()
{
int num;
printf("Enter the number of disks : ");
scanf("%d", &num);
printf("The sequence of moves involved in the Tower of Hanoi are :\n");
towers(num, 'A', 'C', 'B');
return 0;
}
void towers(int num, char frompeg, char topeg, char auxpeg)
{
if (num == 1)
{
printf("\n Move disk 1 from peg %c to peg %c", frompeg, topeg);
return;
}
towers(num - 1, frompeg, auxpeg, topeg);
printf("\n Move disk %d from peg %c to peg %c", num, frompeg, topeg);
towers(num - 1, auxpeg, topeg, frompeg);
```

}

Output:

Enter the number of disks: 4
The sequence of moves involved in the Tower of Hanoi are:

Move disk 1 from peg A to peg B
Move disk 2 from peg A to peg C
Move disk 1 from peg B to peg C
Move disk 3 from peg A to peg B
Move disk 1 from peg C to peg A
Move disk 2 from peg C to peg B
Move disk 1 from peg A to peg B
Move disk 4 from peg A to peg C

SOLUTION 2

```c
#include<stdio.h>
void towers_hanoi(int n)
{
        int x;
        for(x=1;x<(1<<n);x++)
         printf("Move from Pole %d to Pole %d\n",(x&(x-1))%3,(((x |(x-1)) + 1)%3));
}

int main()
{
        int m;
        printf("\n Enter the Number of Disks : ");
        scanf("%d",&m);
        towers_hanoi(m);
        return 0;
}
```

SOLUTION 3

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

// A structure to represent a stack
```

```c
struct Stack
{
unsigned capacity;
int top;
int *array;
};

// function to create a stack of given capacity.
struct Stack* createStack(unsigned capacity)
{
    struct Stack* stack = (struct Stack*) malloc(sizeof(struct Stack));
    stack -> capacity = capacity;
    stack -> top = -1;
    stack -> array =(int*) malloc(stack -> capacity * sizeof(int));
    return stack;
}

// Stack is full when top is equal to the last index
int isFull(struct Stack* stack)
{
        return (stack->top == stack->capacity - 1);
}

// Stack is empty when top is equal to -1
int isEmpty(struct Stack* stack)
{
        return (stack->top == -1);
}

// Function to add an item to stack. It increases
// top by 1
void push(struct Stack *stack, int item)
{
          if (isFull(stack))
              return;
          stack -> array[++stack -> top] = item;
}

// Function to remove an item from stack. It
// decreases top by 1
int pop(struct Stack* stack)
{
   if (isEmpty(stack))
      return INT_MIN;
   return stack -> array[stack -> top--];
}

//Function to show the movement of disks
```

```c
void moveDisk(char fromPeg, char toPeg, int disk)
{
   printf("Move the disk %d from \'%c\' to \'%c\'\n" disk, fromPeg, toPeg);
}

// Function to implement legal movement between
// two poles
void moveDisksBetweenTwoPoles(struct Stack *src,struct Stack *dest, char s, char d)
{
   int pole1TopDisk = pop(src);
   int pole2TopDisk = pop(dest);

   // When pole 1 is empty
   if (pole1TopDisk == INT_MIN)
   {
      push(src, pole2TopDisk);
      moveDisk(d, s, pole2TopDisk);
   }

   // When pole2 pole is empty
   else if (pole2TopDisk == INT_MIN)
   {
      push(dest, pole1TopDisk);
      moveDisk(s, d, pole1TopDisk);
   }

   // When top disk of pole1 > top disk of pole2
   else if (pole1TopDisk > pole2TopDisk)
   {
      push(src, pole1TopDisk);
      push(src, pole2TopDisk);
      moveDisk(d, s, pole2TopDisk);
   }
   // When top disk of pole1 < top disk of pole2
   else
   {
      push(dest, pole2TopDisk);
      push(dest, pole1TopDisk);
      moveDisk(s, d, pole1TopDisk);
   }
}

//Function to implement TOH puzzle
void tohIterative(int num_of_disks, struct Stack*src, struct Stack *aux,struct Stack *dest)
{
   int i, total_num_of_moves;
   char s = 'S', d = 'D', a = 'A';
```

```
//If number of disks is even, then interchange
//destination pole and auxiliary pole
if (num_of_disks % 2 == 0)
{
    char temp = d;
    d = a;
    a = temp;
}
total_num_of_moves = pow(2, num_of_disks) - 1;

//Larger disks will be pushed first
for (i = num_of_disks; i >= 1; i--)
    push(src, i);

for (i = 1; i <= total_num_of_moves; i++)
{
    if (i % 3 == 1)
    moveDisksBetweenTwoPoles(src, dest, s, d);

    else if (i % 3 == 2)
    moveDisksBetweenTwoPoles(src, aux, s, a);

    else if (i % 3 == 0)
    moveDisksBetweenTwoPoles(aux, dest, a, d);
}
}

// Driver Program
int main()
{
    // Input: number of disks
    unsigned num_of_disks = 3;

    struct Stack *src, *dest, *aux;

    // Create three stacks of size 'num_of_disks'
    // to hold the disks
    src  = createStack(num_of_disks);
    aux  = createStack(num_of_disks);
    dest = createStack(num_of_disks);

    tohIterative(num_of_disks, src, aux, dest);
    return 0;
}
```

SAMPLE OUTPUT:

Enter the number of discs:3
Movedisc1fromAtoC
Movedisc2fromAtoB
Movedisc1fromCtoB
Move disc3fromAtoC
Movedisc1fromBtoA
Movedisc2fromBtoC
Move disc1 from Ato C

TotalNumber ofmoves are:7

PROGRAM-6

6.Design,Develop and Implement a menu driven Program in C for the following operations on Circular QUEUE of Characters (Array Implementation of Queue with maximum sizeMAX)
  a. **Insert anElement onto CircularQUEUE**
  b. **Delete an Element from CircularQUEUE**
  c. **Demonstrate *Overflow* and *Underflow*situations on Circular QUEUE**
  d. **Display the status of Circular QUEUE**
  e. **Exit**
Support the program with appropriate functions for each of the above operations

ALGORITHM:
Step 1:Start.
Step 2:Initialize queue sizeto MAX.
Step 3:Insert theelements into circularqueue.If queue is full give a messageas 'queue is overflow"
Step 4:Delete an element from the circular queue. If queue is empty give a message as 'queue is underflow'.
Step 5:Display the contents of the queue.
Step 6:Stop.

ABOUT THE EXPERIMENT:
Circular queue is a linear data structure.It follows FIFO principle.In **circular queue** the last node is connected back to the first node to make a **circle**. **Circular** linked list follows the First In First Out principle. Elements are added at the rear end and the elements ar edeleted at front end of the **queue**.The queue is considered as a circular queue when the positions0 and g
MAX-1are adjacent.Any position before front is also after rear.
A circular queue looks like
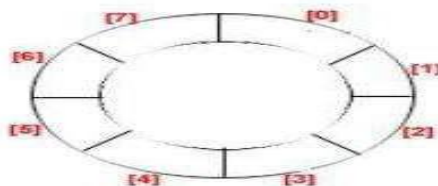
Consider   the   example   with   Circular   Queue   implementation:
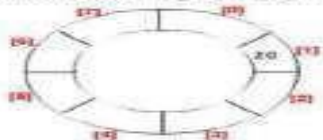
SOLUTION 1

```c
#include<stdio.h>
#include<stdlib.h>
#define max 10
int q[10],front=0,rear=-1; void
main()
{
int ch;
void insert();
void delet();
void display();
printf("\nCircular Queue operations\n");
printf("1.insert\n2.delete\n3.display\n4.exit\n"); while(1)
{
printf("Enter your choice:");
scanf("%d",&ch);
switch(ch)
{
case 1: insert(); break;
case 2: delet(); break;
case 3: display(); break;
case 4: exit(1);
default: printf("Invalid option\n");
}
}
}
void insert()
{
int x;
if((front==0&&rear==max-1)||(front>0&&rear==front-1))
printf("Queue is overflow\n");
else
{
printf("Enter element to be insert:"); scanf("%d",&x);
if(rear==max-1&&front>0)
{
rear=0;
q[rear]=x;
}
else
{
```

```c
if((front==0&&rear==-1)||(rear!=front-1))
q[++rear]=x;
}
}
}
void delet()
{
int a; if((front==0)&&(rear==-1))
{
printf("Queue is underflow\n"); exit(1);
}
if(front==rear)
{
a=q[front]; rear=-
1; front=0;
}
else if(front==max-1)
{
a=q[front];
front=0;
}
else a=q[front++];
printf("Deleted element is:%d\n",a);
}
void display()
{
int i,j; if(front==0&&rear==-1)
{
printf("Queue is underflow\n"); exit(1);
}
if(front>rear)
{
for(i=0;i<=rear;i++)
printf("\t%d",q[i]);
for(j=front;j<=max-1;j++)
printf("\t%d",q[j]);
printf("\nrear is at %d\n",rear);
printf("\nfront is at %d\n",front);
}
else
{
for(i=front;i<=rear;i++)
```

```
{
printf("\t%d",q[i]);
}
printf("\nrear is at %d\n",rear);
printf("\nfront is at %d\n",front);
}
printf("\n");
}
```

Output:

Circular Queue operations 1.insert
2.delete
3.display
4.exit
Enter your choice:1
Enter element to be insert:1 Enter
your choice:1
Enter element to be insert:2 Enter
your choice:1
Enter element to be insert:3 Enter
your choice:1
Enter element to be insert:4 Enter
your choice:3
        1 2 3 4 rear is at 4

front is at 1

 Enter your choice:2 Deleted
    element is:1 Enter your
      choice:3 2   3   4
rear is at 4

front is at 2

Enter your choice:2 Deleted
element is:2 Enter your
choice:3
        3 4 rear is at 4

front is at 3

Enter your choice:2
Deleted element is:3
Enter your choice:3 4
rear is at 4

front is at 4

Enter your choice:2
Deleted element is:4
Enter your choice:3
Queue is underflow

Process returned 1 (0x1) execution time : 28.719 s
Press any key to continue.

SOLUTION 2

```c
#include<stdio.h>
#include<conio.h>
#define MAX 4
int ch, front=0,rear=1,count=0;
char q[MAX],item;
void insert()
{
        if(count==MAX)
        printf("\n Queue is Full");
        else
        {
        rear=(rear+1)%MAX;
        q[rear]=item;
}
count++;
}
void del()
{
        if(count==0)
                printf("\n Queue is Empty");
        else
                if(front>rear&&rear=MAX-1)
                {
                        front=0;
                        rear=-1;
                        count=0;
                }
                else
                {
```

```
                          item=q[front];
                          printf("\n Deleted item is:%c",item);
                          front=(front+1)%MAX;
                          count--;
                  }
          }
}
void display()
{
int i, f=front, r=rear;
if(count==0)
printf("\n Queue is Empty");
else
{
printf("\n Contents of Queue is:\n");
for(i=f;i<=r;i++)
{
        printf("%c\t",q[i]);
        f=(f+1)%MAX;
}
}
}
void main()
{
do
{
printf("\n 1:Insert\n 2:Delete\n 3:Display\n 4:Exit\n");
printf("\n Enter the choice:");
scanf("%d",&ch);
switch(ch)
{
case 1: printf("\n Enter the character to be inserted:");
         scanf("%c",&item);
        insert();
        break;
case 2: del();
        break;
case 3: display();
        break;
case 4: exit(0);
        break;
}}while(ch!=4);
```

OUTPUT:

1.Insert 2. Delete 3. Display 4. Exit
Enter the choice: 1
Enter the character/ item to be inserted: A
1.Insert 2. Delete 3. Display4.Exit
Enter the choice: 1
Enter the character/ item to be inserted: B
1.Insert2. Delete 3. Display4. Exit
Enter the choice: 1
Enter the character/ item to be inserted: C
1.Insert 2. Delete 3. Display 4. Exit
Enter the choice: 1
Enter the character/ item to be inserted: D
1.Inser t2. Delete 3. Display4. Exit
Enter the choice: 3
Contents of Queue is:
ABCD

1.Insert 2. Delete 3. Display4. Exit
Enter the choice: 1
Enter the character/ item to be inserted: F

Queue is Full
1.Insert 2. Delete 3. Display 4. Exit
Enter the choice: 2
Deleted item is: **A**

PROGRAM-7

7. Design, Develop and Implement a menu driven Program in C for the following operations on Singly Linked List (SLL) of Student Data with the fields: *USN, Name, Branch, Sem, PhNo*

        a. Create a SLL of N Students Data by using *front insertion.*
        b. Display the status of SLL and count the number of nodes in it
        c. Perform Insertion and Deletion at End of SLL
        d. Perform Insertion and Deletion at Front of SLL
        e. Demonstrate how this SLL can be used as STACK and QUEUE
        f. Exit

ABOUT THE EXPERIMENT:

Linked List is a linear data structure and it is very common data structure which consists of group of nodes in a sequence which is divided in two parts. Each node consists of its own data and the address of the next node and forms a chain. Linked Lists are used to create trees and graphs.

- They area dynamic in nature which allocates the memory when required.
- Insertion and deletion operations can be easily implemented.
- Stacks and queues can be easily executed.
- Linked List reduces the access time.
- Linked lists are used to implement stacks, queues, graphs, etc.
- Linked lists let you insert elements at the beginning and end of the list.
- In Linked Lists we don't need to know the size in advance.

Types of Linked List:

Singly Linked List: Singly linked lists contain nodes which have a data part as well as an address part i.e. next, which points to the next node in sequence of nodes. The operations we can perform o nsingly linked lists are insertion, deletion and traversal.
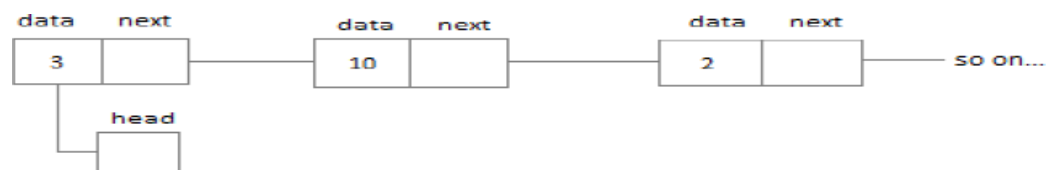
Doubly Linked List: In a doubly linked list, each node contains two links the first link points to the previous node and the next link points to the next nodein the sequence.
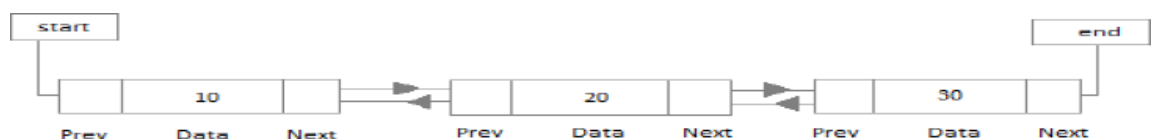
- **Circular Linked List:**In the circular linked list the last node of the list contains the address of the first node and forms a circular chain.
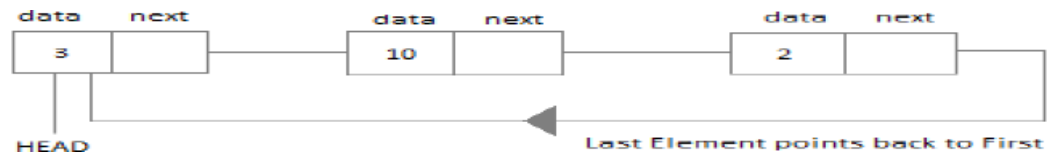
ALGORITHM:

Step 1:Start.
Step2:Read the value of N
Step 3: Display
Step4: Count
Step 5: Perform insertion at front of list.
Step6: Perform deletion at front of the list.
Step 7: Perform insertion at end of the list.
Step 8: Perform deletion at the end of the list.
Step 9: show singly linked list usage as stack
Step10:show singly linked list usage as queue.
Step 11: Stop

SOLUTION 1

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h> int
count=0;
struct node
{
int sem,phno;
char name[20],branch[10],usn[20]; struct
node *next;
}*first=NULL,*last=NULL,*temp=NULL, *temp1;
void create()
{
int sem,phno;
char  name[20],branch[10],usn[20];
temp=(struct node*)malloc(sizeof(struct node));
printf("\n Enter usn,name, branch, sem, phno of student : ");
scanf("%s %s %s %d %d", usn, name,branch, &sem,&phno);
strcpy(temp->usn,usn);
strcpy(temp->name,name);
strcpy(temp->branch,branch); temp-
>sem = sem;
```

```c
temp->phno = phno;
temp->next=NULL;
count++;
}
void insert_atfirst()
{
if (first == NULL)
{
create(); first =
temp; last = first;
}
else
{
create();
temp->next = first; first =
temp;
}
}
void insert_atlast()
{
if(first==NULL)
{
create(); first =
temp; last = first;
}
else
{
create();
last->next = temp;
last = temp;
}
}
void display()
{
temp1=first; if(temp1 ==
NULL)
{
printf("List empty to display \n");
return;
}
printf("\n Linked list elements from Beginning : \n"); while
(temp1!= NULL)
printf("%s %s %s %d %d\n", temp1->usn, temp1->name,temp1->branch,temp1->sem,temp1->phno );
temp1 = temp1->next;
```

```c
}
printf(" No of students = %d ", count);
}
int deleteend()
{
struct node *temp; temp=first;
if(temp->next==NULL)
{
free(temp);
first=NULL;
}
else
{
while(temp->next!=last)
temp=temp->next;
printf("%s %s %s %d %d\n", last->usn, last->name,last->branch, last->sem, last->phno );
free(last);
temp->next=NULL;
last=temp;
}
count--; return
0;
}
int deletefront()
{
struct node *temp; temp=first;
if(temp->next==NULL)
{
free(temp);
first=NULL; return
0;
}
else
{
first=temp->next;
printf("%s %s %s %d %d", temp->usn, temp->name,temp->branch,temp->sem, temp->phno );
free(temp);
}
count--;
return 0;
}
void main()
{
```

```c
int ch,n,i;
first=NULL;
temp = temp1 = NULL;
printf("_____MENU_____\n");
printf("\n 1 - create a SINGLE LINKED LIST of n Students");
printf("\n 2 - Display from Beginning");
printf("\n 3 - Insert at end"); printf("\n 4 -
delete at end"); printf("\n 5 - Insert at
Beginning"); printf("\n 6 - delete at
Beginning"); printf("\n 7 - exit\n");
printf("_____\n"); while
(1)
{
printf("\n Enter choice : ");
scanf("%d", &ch);
switch (ch)
{
case 1: printf("\n Enter no of students : "); scanf("%d",
&n);
for(i=0;i<n;i++)
insert_atfirst(); break;
case 2: display(); break;
case 3: insert_atlast();
break;
case 4: deleteend(); break;
case 5: insert_atfirst();
break;
case 6:deletefront();
break;
case 7: exit(0);
default: printf("wrong choice\n");
}
}
}
```

Output:

_____MENU_____

 1 - create a SINGLE LINKED LIST of n emp 2 -
Display from Beginning
 3 - Insert at end
 4 - delete at end

---

5 - Insert at Beginning
6 - delete at Beginning
7 - exit
- -

Enter choice : 1

Enter no of students : 1

Enter usn,name, branch, sem, phno of student :
1VE15IS001 GURU CSE 6 28566200

Enter choice : 2

Linked list elements from Beginning :
1VE15IS001 GURU CSE 6 28566200 No of students = 1

Enter choice : 3

Enter usn,name, branch, sem, phno of student : 1VE15IS002 PRASAD CSE 6 28555200
Enter choice : 2

Linked list elements from Beginning :
1VE15IS001 GURU CSE 6 28566200
1VE15IS002 PRASAD CSE 6 28555200 No
of students = 2
Enter choice : 4
1VE15IS002 PRASAD CSE 6 28555200

Enter choice : 2

Linked list elements from Beginning :
1VE15IS001 GURU CSE 6 28566200 No of students = 1
Enter choice : 5

Enter usn,name, branch, sem, phno of student :
1VE15IS003 GURUPRASAD CSE 6 2855 0000

Enter choice : 2

Linked list elements from Beginning : 1VE15IS003
GURUPRASAD CSE 6 28550000 1VE15IS001 GURU
CSE 6 28566200
No of students = 2

Enter choice : 6
1VE15IS003 GURUPRASAD CSE 6 28550000

Enter choice : 2

Linked list elements from Beginning : 1VE15IS001
GURU CSE 6 28566200
No of students = 1
Enter choice : 7

Process returned 0 (0x0) execution time : 117.734 s
Press any key to continue.

SOLUTION 2

```
#include<stdio.h>
#include<conio.h>
int MAX=4,count;
struct student
{
char usn[10];
char name[30];
charbranch[5];
int sem;
char phno[10];
struct student *next;    //Self referentialpointer.
};

typedef struct student NODE;

int count nodes(NODE*head)
{
        NODE*p;
        count=0;
        p=head;
        while(p!=NULL)
        {
        p=p->next;
        count++;
        }
        return count;
}
NODE * getnode(NODE*head)
{
        NODE *newnode;
        Newnode=(NODE*)malloc(sizeof(NODE));
```

```c
        //Create firstNODEprintf("\nEnterUSN, Name, Branch,Sem,Ph.No\n");
        flushall();
        gets(newnode->usn);
        flushall();
        gets(newnode->name);
        flushall();
        gets(newnode->branch);
        scanf("%d",&(newnode->sem));
        flushall();
        gets(newnode->phno);
        newnode->next=NULL;        //Set next to NULL...head=newnode;
        returnhead;
}
NODE* display(NODE*head)
{
        NODE*p;
        if(head == NULL)
        printf("\nNostudentdata\n");
else
        {

        p=head;
        printf("\n----STUDENTDATA---\n");
        printf("\nUSN\tNAME\t\tBRANCH\tSEM\tPh.NO.");
        while(p!=NULL)
        {
                printf("\n%s\t%s\t\t%s\t%d\t%s", p->usn, p->name, p->branch, p->sem,p>phno);
                p =p->next;     //Go to next node...
        }
printf("\nThe no. ofnodes in listis: %d",countnodes(head));
return head;
}

NODE* create(NODE*head)
{
        NODE* newnode;
        if(head==NULL)
        {

        }
        else
        {
        }
        Newnode=getnode(head);head=newnode;
        Newnode=getnode(head);newnode->next=head;head=newnode;
        return head;
}

NODE* insert_front(NODE*head)
{
```

```c
        if(countnodes(head)==MAX)
                printf("\nList isFull / Overflow!!");
        else
                head=create(head);//create()insertnodesatfront.
        returnhead;
        }
NODE* insert_rear(NODE*head)
{
        NODE*p,*newnode;
        p=head;
        if(countnodes(head)==MAX)
        printf("\nList isFull(QUEUE)!!");
else
{
        if(head == NULL)
{
}
else
{
        Newnode=getnode(head);
        head=newnode;          //set first nodeto be head
        newnode=getnode(head);
        while(p->next!=NULL)
        {
                p=p->next;
        }
        p->next=newnode;
}
}
returnhead;
}

NODE* insert(NODE *head)
{
        int ch;
        do
        {
        printf("\n1.InsertatFront(First)\t2.Insert atEnd(Rear/Last)\t3.Exit");
        printf("\nEnteryour choice:");
        scanf("%d",&ch);switch(ch)
        {
                case 1: head=insert_front(head);
                break;
                case 2: head=insert_rear(head);
                break;
                case 3:
                break;
        }
        head=display(head);
        }while(ch!=3);returnhead;
```

```c
}

NODE* delete_front(NODE *head)
{
        NODE*p;
        if(head==NULL)
                printf("\nList is Empty/Underflow(STACK/QUEUE)");
        else
        {
        }
        p=head;
        head=head->next;        //Set 2nd NODE asheadfree(p);
        printf("\nFront(first)nodeis deleted");
        return head;
}
NODE* delete_rear(NODE *head)
{
        NODE*p, *q;
        p=head;
        while(p->next!=NULL)
        {
        p=p->next; //Go upto -1NODEwhichyouwanttodelete
}
        q=p->next;
        free(q);//Delete last NODE...p->next=NULL;
        printf("\nLast(end) entryis deleted");
        return head;
}

NODE* del(NODE *head)
{
        int ch;
        do{
        printf("\n1.Delete from Front(First)\t2. Deletefrom End(Rear/Last))\t3.Exit");
        printf("\nEnteryour choice:");
        scanf("%d",&ch);
        switch(ch)
        {

                case 1:head=delete_front(head);break;
                case 2:head=delete_rear(head);break;
                case 3:break;
        }
        head=display(head);
        }while(ch!=3);returnhead;
        }
NODE* stack(NODE*head)
{
        int ch;
        do
```

```c
        {
                printf("\nSSLused as Stack...");
                printf("\n1.Insertat Front(PUSH)\t 2.Delete fromFront(POP))\t3.Exit");
                printf("\nEnteryour choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                case 1: head=insert_front(head);
                break;
                case 2: head=delete_front(head);
        break;

        case 3: break;
                }
                head=display(head);
        }while(ch!=3);returnhead;}
NODE* queue(NODE *head)
{
        int ch;do
        printf("\nSSLused asQueue...");
        printf("\n1.InsertatRear(INSERT)\t 2.Deletefrom Front(DELETE))\t3.Exit");
        printf("\nEnteryour choice:");
        scanf("%d",&ch);
        switch(ch)
        {
                case 1: head=insert_rear(head);
                break;
                case 2: head=delete_front(head);
                break;
                case 3: break;
                }
                head=display(head);
        }while(ch!=3);returnhead;
}

void main()
{
        int ch, i, n;NODE*head;
        head=NULL;
        clrscr();
        printf("\n*----------StudedntDatabase --------- *");
        do
        {
                printf("\n1.Create\t2.Display\t3.Insert\t4.Delete\t5.Stack\t 6.Queue\t 7.Exit");
                printf("\nEnteryour choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1: printf("\nHow manystudent datayouwantto create:");
                        scanf("%d",&n);
                        for(i=0;i<n;i++)
```

```
                        head=create(head);//Call toCreate NODE...
                        break;
                        case 2: head=display(head);   //Call to Display...break;
                        case 3: head=insert(head);      //Call toInsert...break;
                        case 4: head=del(head);          //Call to deletebreak;
                        case 5: head=stack(head);break;
                        case 6: head=queue(head);break;
                        case 7: exit(); //Exit...
                }
        }while(ch!=7);
}
```

OUTPUT:
1. Create 2. Display3.Insert 4. Delete 5. Stack 6.Queue7. Exit
Enteryourchoice: 1
How manystudent data you want to create:2
EnterUSN,Name,Branch,Sem, Ph.No
1kt12cs001   kumar cs   3   9900099000
EnterUSN,Name,Branch,Sem, Ph.No
1kt12is002   ravi   is   3   9900099111
1. Create 2. Display3.Insert 4. Delete 5. Stack 6.Queue7. Exit
Enteryourchoice: 2
----STUDENTDATA----
USN   NAMEBRANCH   SEM   Ph.NO.
1kt12is002   ravi   is   3   9900099111
1kt12cs001   kumar cs   3   9900099000
The no. of nodes in list is: 2
1. Create 2. Display 3.Insert 4. Delete 5. Stack 6.Queue 7. Exit
Enteryourchoice: 3
1.Insert at Front(First) 2.Insert at End(Rear/Last) 3.Exit

Enteryourchoice: 1
EnterUSN,Name,Branch,Sem, Ph.No
1kt12cs003   suresh cs   3   99000992222
----STUDENTDATA----
USN1kt12cs003   NAME
suresh BRANCH
cs   SEM
3   Ph.NO.
99000992222
1kt12is002   ravi   is   3   9900099111
1kt12cs001   kumar cs   3   9900099000
Theno. of nodes in list is: 3
1.InsertatFront(First)2.InsertatEnd(Rear/Last)3.ExitEnteryourchoice: 2
EnterUSN,Name,Branch,Sem, Ph.No
1kt12is004   naresh is   3   99000993333

----STUDENTDATA----

USN
1kt12cs003   NAME
suresh BRANCH
cs   SEM
3   Ph.NO.
99000992222
1kt12is002   ravi   is   3   9900099111
1kt12cs001   kumar cs   3   9900099000
1kt12is004   naresh is   3   99000993333
Theno. of nodes in list is: 4
1.Insert atFront(First)2.InsertatEnd(Rear/Last)3.Exit
Enteryourchoice: 3
1.   Create 2. Display3.Insert 4. Delete 5. Stack 6.Queue7. Exit
2.   Enteryourchoice: 4
1.   Delete from Front (First) 2. Delete from End (Rear/Last) 3.Exit
2.   Enteryourchoice: 1
Front(first) nodeis deleted
----STUDENTDATA----

USN
1kt12is002   NAME
ravi   BRANCH
is   SEM
3   Ph.NO.
9900099111
1kt12cs001   kumar cs   3   9900099000
1kt12is004   naresh is   3   99000993333

Theno. of nodes in list is: 3
1.   Delete from Front (First) 2. Delete from End (Rear/Last) 3.Exit
2.   Enteryourchoice: 2
Last (end) nodeis deleted
----STUDENTDATA----
USN   NAMEBRANCH   SEM   Ph.NO.
1kt12is002   ravi   is   3   9900099111
1kt12cs001   kumar cs   3   9900099000Theno. of nodes in list is: 2
1.   Delete from Front (First) 2. Delete from End (Rear/Last) 3.Exit
2.   Enteryourchoice: 3
1.   Create 2. Display3.Insert 4. Delete 5. Stack 6.Queue7. Exit
2.   Enteryourchoice: 5
SSL used as Stack...

1.Insert at Front(PUSH)2.Delete from Front(POP))3.Exit
Enter your choice: 1
Enter USN,Name,Branch,Sem, Ph.No : 1kt12is010 vikkyis 3 9900011111
----STUDENTDATA----

USN   NAMEBRANCH   SEM   Ph.NO.

```
1kt12is010     vikky  is      3      9900011111
1kt12is002     ravi   is      3      9900099111
1kt12cs001     kumar  cs      3      9900099000
1.Create 2. Display 3.Insert 4. Delete 5. Stack 6.Queue7. Exit
Enter your choice: 7
```

PROGRAM-8

8. **Design,develop and Implement a menu driven Program in C for the following operations on Doubly Linked List(DLL) of Employee Data with the fields:**
SSN,Name,Dept,Designation,Sal,PhNo.

   1. Create a DLL of N Employees Data by using *end insertion*.
   2. Display the status of DLL and count the number of nodes in it
   3. Perform Insertion and Deletion at End of DLL
   4. Perform Insertion and Deletion at Front of DLL
   5. Demonstrate how this DLL can be used as Double Ended Queue
   6. Exit

ABOUT THE EXPERIMENT:

Doubly Linked List: In a doublylinked list, each node contains two links the first link points to the previous node and the next link points to the next node in the sequence. In computer science, a **doubly linked list** is a linked data structure that consists of a set of sequentially linked records called nodes. Each node contains two fields, called *links*, that are references to the previous and to the next node in theSequenceofnodes.Thebeginningandending nodes'**previous**and**next**links, respectively.

 A Doublylinked list whose nodes contain three fields:an integer value,the link to the next node, and the link to the previous node.The two node links allow traversal of the list in either direction.While adding or removing a node in a doubly linked list requires changing more links than the same operations on a singly linked list, the operations are simple and potentially more efficient (for nodes other than first nodes)because there is no need to keep track of the previous node during traversal or no need to traverse the list to find the previous node, so that itslink can be modified.

ALGORITHM:
   Step 1:Start.
   Step 2: Read the value of N. (Nstudent'sinformation)
   Step 3: Create a doubly linked list. (DLL)
   Step 4: Display the status of DLL.
   Step 5: Count the number ofnodes.
   Step 6: Perform insertion at front of list.
   Step 7: Perform deletion at the front of the list.
   Step 8: Perform insertion at end of the list.
   Step 9: Perform deletion at the end of the list.
   Step 10: Demonstrate how doublylinked list can be used as double ended queue.
   Step 11: Stop.

Solution-1

```
#include<stdio.h>
#include<conio.h>
int MAX=4,count;
struct emp
{
        int ssn;
        char name[20];
```

```c
        chardept[10];
        chardesig[15];
        int sal;
        char phno[10];
        struct emp *left;struct emp *right;
};

typedef struct empNODE;

int countnodes(NODE*head)
{
        NODE*p;
        count=0;
        p=head;
        while(p!=NULL)
        {
                p=p->right;count++;
        }
        return count;
}

NODE *getnode(NODE*head)
{
        NODE *newnode;
        newnode=(NODE*)malloc(sizeof(NODE));
        newnode->right=newnode->left=NULL;
        printf("\nEnter SSN, Name, Dept,Designation, Sal, Ph.No\n");
        scanf("%d",&newnode->ssn);
        flushall();
        gets(newnode->name);
        flushall();
        gets(newnode->dept);
        flushall();
        gets(newnode->desig);
        scanf("%d",&newnode->sal);
        flushall();
        gets(newnode->phno);
        head=newnode;
        return head;
}

NODE* display(NODE*head)
{
        NODE*p;
        if(head==NULL)
        printf("\nNoEmployee data\n");
        else
        {
                p=head;
                printf("\n----EMPLOYEEDATA--- \n");
```

```c
                printf("\nSSN\tNAME\tDEPT\tDESINGATION\tSAL\t\tPh.NO.");
            while(p!=NULL)
            {
                    p->sal,p->phno);
            }
            printf("\n%d\t%s\t%s\t%s\t\t%d\t\t%s",p->ssn,p->name,p->dept,p->desig,p  =  p->right;

            printf("\nThe no. Ofnodes in list is: %d",count nodes(head))
}
        Return head;
}

  NODE* create(NODE*head)// creating & inserting at end.
{
        NODE*p,*newnode;
        p=head;
        if(head==NULL)
                {
                }
        else
                {
                Newnode=getnode(head);
                head=newnode;
                newnode=getnode(head);
                while(p->right!=NULL)
                {
                        p=p->right;
                }
                p->right=newnode;
                newnode->left=p;
                }
        Return head;
}

NODE* insert_end(NODE*head)
{
        if(countnodes(head)==MAX)
                printf("\nList isFull!!");
        else
                head=create(head);
        return head;
}
NODE* insert_front(NODE*head)
{
        NODE*p,*newnode;
        if(countnodes(head)==MAX)
        printf("\nList isFull!!");
        else
        {
                if(head==NULL)
```

```
                        {
                                Newnode=getnode(head);
                                head=newnode;          //set first nodeto be head
                        }
                        else
                        {
                        }
}

                        Newnode=getnode(head);
                        Newnode->right=head;
                        head->left=newnode;
                        head=newnode;
                        return head;
}
NODE* insert(NODE *head)
{
        int ch;do
        {
        printf("\n1.Insertat Front(First)\t2.Insert atEnd(Rear/Last)\t3.Exit");
        printf("\nEnteryour choice:");
        scanf("%d",&ch);
        switch(ch)
        {
                case 1: head=insert_front(head);
                        break;
                case 2: head=insert_end(head);
                        break;
                case 3: break;
        }
        head=display(head);
        }while(ch!=3);
        return head;
}

NODE* delete_front(NODE *head)
{
        NODE*p;
        if(head==NULL)
        printf("\nList is Empty(QUEUE)");
        else
                {
                }
        p=head;
        head=head->right;
        head->right->left=NULL;free(p);
        printf("\nFront(first)nodeis deleted");
        return head;
}

NODE* delete_end(NODE *head)
```

```c
{
        NODE*p, *q;
        p=head;
        while(p->right!=NULL)
        {
                p=p->right;    //Go upto -1 node whichyouwant to delete
        }
        q=p->left;
        q->right=NULL;
        p->left=NULL;
        free(p);//Delete last node...printf("\nLast(end) entryis deleted");returnhead;
}
NODE*del(NODE *head)
{
        int ch;
        do
        {
                printf("\n1.Delete fromFront(First)\t2. Deletefrom End(Rear/Last))\t3.Exit");
                printf("\nEnteryour choice:");
                scanf("%d",&ch);
                switch(ch)
                {

                case 1:head=delete_front(head);break;
                case 2:head=delete_end(head);break;
                case 3: break;
                }
                head=display(head);
        }while(ch!=3);
        return head;
}

NODE* queue(NODE *head)
{
        int ch,ch1,ch2;do
        printf("\nDLLused asDouble EndedQueue");
        printf("\n1.QUEUE-InsertatRear&DeletefromFront");
        printf("\n2.QUEUE-InsertatFront&Delete fromRear");
        printf("\n3.Exit");
        printf("\nEnteryour choice:");
        scanf("%d",&ch);
        switch(ch)
        {
                case 1:
                        do{
                        printf("\n1.Insertat Rear\t2.Delete fromFromFront\t3.Exit");
                        printf("\nEnteryour choice:");
                         scanf("%d",&ch1);
                          switch(ch1)
                          {
```

```c
                case1: head=insert_end(head); break;
                case 2: head=delete_front(head);break;
            case 3: break;
            }
            }while(ch1!=3);break;
    case 2:
     do{
    printf("\n1.InsertatFront\t2.Delete from Rear\t3.Exit");
printf("\nEnteryour choice:");
scanf("%d",&ch2);
switch(ch2)
{
        case1:head=insert_front(head);
        break;
        case2:head=delete_end(head);
        break;
        case 3: break;
}
}
}while(ch!=3);
}while(ch2!=3);
break;
case 3: break;
head=display(head);returnhead;
}
void main()
{
        int ch, i, n;NODE*head;
        head=NULL;
        clrscr();
        printf("\n----------EmployeeDatabase----------");do
        {
        printf("\n1.Create\t2.Display\t3.Insert\t4.Delete\t5.Queue\t6.Exit");
        printf("\nEnteryour choice:");
        scanf("%d",&ch);
        switch(ch)
        {
        case 1: printf("\nHow manyemployees datayouwant to create:");
            scanf("%d",&n);
            for(i=0;i<n;i++)
            head=create(head);//Call to Create node...
            break;
        case 2: head=display(head);  //Call to Display...
            break;
        case 3: head=insert(head);      //Call toInsert...
            break;
        case 4: head=del(head);         //Call to delete
            break;
        case 5: head=queue(head);
            break;
```

```
        case 6: exit(0);//Exit...
              break;
    }
    }while(ch!=6);
    }
```

OUTPUT:

----------EmployeeDatabase-----------
1.Create 2. Display 3.Insert 4. Delete 5. Queue 7. Exit
Enter your choice: 1

How many employees data you want to create: 2
Enter SSN, Name,Dept,Designation,Sal,Ph.No
1   KUMAR   CSE   INSTRUCTOR   8000   900099000

Enter SSN, Name,Dept,Designation,Sal,Ph.No
2   RAVI ISE   INSTRUCTOR   9000   900099111

1.Create 2. Display 3.Insert 4. Delete 5. Queue 7. Exit
Enteryourchoice: 2
----EMPLOYEE DATA----

SSN   NAMEDEPT DESINGATION   SAL   Ph.NO.
1   KUMAR   CSE   INSTRUCTOR   8000   900099000
2   RAVI ISE   INSTRUCTOR   9000   900099111

The no. of nodes in list is: 2

1. Create 2. Display 3.Insert 4. Delete   5. Queue 7. Exit
Enter your choice: 3

1.Insert at Front(First) 2.Insert at End (Rear/Last) 3.Exit
Enter your choice:1

Enter SSN, Name,Dept,Designation,Sal,Ph.No
3   JIM   CSE   ATTENDER 6000   900099333

----EMPLOYEE DATA----

SSN   NAMEDEPT DESINGATION   SAL   Ph.NO.
3   JIM   CSE   ATTENDER 6000   900099333
1   KUMAR   CSE   INSTRUCTOR   8000   900099000
2   JIM   CSE   INSTRUCTOR   9000   900099111

The no. of nodes in list is:3

1.Insert at Front(First) 2.Insert at End (Rear/Last) 3.Exit
Enter your choice:3

1. Create 2. Display 3.Insert 4. Delete   5. Queue 7. Exit

Enteryourchoice: 5
DLLused as Double Ended Queue
1.QUEUE-Insert at Rear & Delete from Front 2.QUEUE-Insert at Front & Delete from Rear 3.Exit
Enteryourchoice:3
1.Create 2. Display 3.Insert 4. Delete 5. Queue 7. Exit Enter your choice: 7

Solution-2

```c
#include<string.h>
int count=0;
struct node
{
struct node *prev; int
ssn,phno;
float sal;
char name[20],dept[10],desg[20];
struct node *next;
}*h,*temp,*temp1,*temp2,*temp4; void
create()
{
int ssn,phno; float
sal;
char name[20],dept[10],desg[20];
temp =(struct node *)malloc(sizeof(struct node)); temp-
>prev = NULL;
temp->next = NULL;
printf("\n Enter ssn,name,department, designation, salary and phno of employee : ");
scanf("%d %s %s %s %f %d", &ssn, name,dept,desg,&sal, &phno);
temp->ssn = ssn; strcpy(temp-
>name,name); strcpy(temp-
>dept,dept); strcpy(temp-
>desg,desg); temp->sal = sal;
temp->phno = phno;

count++;
}
void insertbeg()
{
if (h == NULL)
{
create();
h = temp; temp1 =
h;
}
```

```c
else
{
create();
temp->next = h;
h->prev = temp;
h = temp;
}
}
void insertend()
{
if(h==NULL)
{
create();
h = temp; temp1 =
h;
}
else
{
create();
temp1->next = temp; temp-
>prev = temp1; temp1 = temp;
}
}
void displaybeg()
{
temp2 =h;
if(temp2 == NULL)
{
printf("List empty to display \n");

return;
}
printf("\n Linked list elements from begining : \n");
while (temp2!= NULL)
{
printf("%d %s %s %s %f %d\n", temp2->ssn, temp2->name,temp2->dept,temp2->desg,temp2->sal,
temp2->phno );
temp2 = temp2->next;
}
printf(" No of employees = %d ", count);
}
int deleteend()
{
```

```c
struct node *temp; temp=h;
if(temp->next==NULL)
{
free(temp);
h=NULL; return
0;
} else
{
temp2=temp1->prev; temp2-
>next=NULL;
printf("%d %s %s %s %f %d\n", temp1->ssn, temp1->name,temp1->dept,
temp1->desg,temp1->sal, temp1->phno );
free(temp1);
}
count--;
return 0;
}
int deletebeg()
{
struct node *temp; temp=h;
if(temp->next==NULL)
{
free(temp);
h=NULL;


}
else
{
h=h->next;
printf("%d %s %s %s %f %d", temp->ssn, temp->name,temp->dept,
temp->desg,temp->sal, temp->phno );
free(temp);
}
count--;
return 0;
}
void main()
{
int ch,n,i;
h=NULL;
temp = temp1 = NULL;
printf("_____MENU_____\n");
printf("\n 1 - create a DLL of n emp");
```

```c
printf("\n 2 - Display from beginning");
printf("\n 3 - Insert at end");
printf("\n 4 - delete at end");
printf("\n 5 - Insert at beg");
printf("\n 6 - delete at beg");
printf("\n 7 - exit\n");
printf("_____\n");
while (1)
{
printf("\n Enter choice : ");
scanf("%d", &ch);
switch (ch)
{
case 1:
printf("\n Enter no of employees : ");
scanf("%d", &n);
for(i=0;i<n;i++)
insertend();
break;
case 2:
displaybeg();
break;
case 3:
insertend();
break;
case 4:
deleteend();
break;
case 5:
insertbeg();
break;
case 6:
deletebeg();
break;
case 7:
exit(0);
default:printf("wrong choice");
}
}
}
```

OUTPUT:

--------------------MENU--------------------

1 - create a DLL of n emp
2 - Display from beginning
3 - Insert at end
4 - delete at end
5 - Insert at beg
6 - delete at beg
7 - exit
- -
Enter choice : 1

Enter no of employees : 1

Enter ssn,name,department,
designation, salary and phno
of employee : 01 ABC IS E
AP 35000 28566220

Enter choice : 2
Linked list elements from begining :
Enter choice : 3

Enter
ssn,name,department,
designation, salary and
phno of employee : 02 PQR
IS E AP 30000 28555220

Enter choice : 2

Linked list elements from begining :
1 ABC CSE AP 35000.000000 28566220
Enter choice : 4
2 PQR CSE AP 30000.000000 28555220

Enter choice : 5

Enter ssn,name,department,
designation, salary and phno
of employee : 03 XYZ IS E
AP 40000 28444220

Enter choice : 7

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

Solution -3

```
#include<string.h>
int count=0;
struct node
{
struct node *prev;int ssn,phno;
float sal;
char name[20],dept[10],desg[20];
struct node *next;
}*h,*temp,*temp1,*temp2,*temp4;

void create()
{
int ssn,phno;
float sal;
char name[20],dept[10],desg[20];
temp =(struct node *)malloc(sizeof(struct node));
temp->prev = NULL;
temp->next = NULL;
printf("\n Enter ssn,name,department, designation, salary and phno of employee : ");
scanf("%d %s %s %s %f %d", &ssn, name,dept,desg,&sal, &phno);
temp->ssn = ssn;
strcpy(temp->name,name);strcpy(temp->dept,dept);
strcpy(temp->desg,desg);
temp->sal = sal;
temp->phno = phno;
count++;
}

void insertbeg()
{
if (h == NULL)
{
create();
 h = temp;
temp1 = h;
}
Else
{
create();
temp->next = h;
h->prev = temp;
h = temp;
}
}
void insertend()
{
if(h==NULL)
{
create();
 h = temp;
temp1 = h;
```

```
}
Else
{
create();
temp1->next = temp;
temp->prev = temp1;
temp1 = temp;
}
}
void displaybeg()
{
temp2 =h;
if(temp2 == NULL)
{
printf("List empty to display \n");
return;
}
printf("\n Linked list elements from begining : \n");
while (temp2!= NULL)
{
printf("%d %s %s %s %f %d\n", temp2->ssn, temp2->name,temp2->dept,temp2->desg,temp2->sal,
temp2->phno );
temp2 = temp2->next;
}
printf(" No of employees = %d ", count);
}
int deleteend()
{
struct node *temp;temp=h;
if(temp->next==NULL)
{
free(temp);
h=NULL;
return 0;
}
Else
{
temp2=temp1->prev;temp2->next=NULL;
printf("%d %s %s %s %f %d\n", temp1->ssn, temp1->name,temp1->dept,temp1->desg,temp1->sal,
temp1->phno );
free(temp1);}
count--; r
eturn 0;
}
int deletebeg()
{
struct node *temp;temp=h;
if(temp->next==NULL)
{
free(temp);
h=NULL;
}
{
```

```c
h=h->next;
printf("%d %s %s %s %f %d", temp->ssn, temp->name,temp->dept,temp->desg,temp->sal, temp->phno );
free(temp);
}
count--;
return 0;
}
void main()
{
int ch,n,i;
h=NULL;
temp = temp1 = NULL;
printf("MENU\n");
printf("\n 1 - create a DLL of n emp");
printf("\n 2 - Display from beginning");printf("\n 3 - Insert at end");
printf("\n 4 - delete at end");printf("\n 5 - Insert at beg");printf("\n 6 - delete at beg");
printf("\n 7 - exit\n");
printf("\n");
while (1)
{
printf("\n Enter choice : ");
scanf("%d", &ch);
switch (ch)
{
case 1:
printf("\n Enter no of employees : ");
scanf("%d", &n);
for(i=0;i<n;i++)
insertend();
break;
case2:
displaybeg();
break;
case 3:
insertend();
break;
case 4:
deleteend();
break;
case 5:
insertbeg();
break;
case 6:
deletebeg();
break;
case 7:
exit(0);
default:
printf("incorrect choice");
}
}
}
```

MENU
–Create a DLL of n emp
Display from beginning
Insert at end
Delete at end
Insert at beg
Delete at beg
exit

Enter choice : 1
Enter no of employees : 2
Enter ssn,name,department, designation, salary and phno of employee :1RAJ SALES MANAGER 15000 911
Enter ssn,name,department, designation, salary and phno of employee :2
RAVI HR ASST 10000 123
Enter choice : 2
Linked list elements from begining :
1 RAJ SALES MANAGER 15000.000000 911
2 RAVI HR ASST 10000.000000 123 No
of employees = 2Enter choice : 3
Enter ssn,name,department, designation, salary and phno of employee : 3RAM MARKET MANAGER 50000 111

Enter choice : 2
Linked list elements from begining :
1 RAJ SALES MANAGER 15000.000000 911
2 RAVI HR ASST 10000.000000 123
3 RAM MARKET MANAGER 50000.000000
111 No of employees = 3Enter choice : 4
3 RAM MARKET MANAGER 50000.000000
111 Enter choice : 2
Linked list elements from begining :
1 RAJ SALES MANAGER 15000.000000 911
2 RAVI HR ASST 10000.000000
123 No of employees = 2

Enter choice : 5
Enter ssn,name,department, designation, salary and phno of employee :0 ALEX EXE TRAINEE 2000 133
Enter choice : 2
Linked list elements from begining :
ALEX EXE TRAINEE 2000.000000 133
RAJ SALES MANAGER 15000.000000 911
2 RAVI HR ASST 10000.000000
123 No of employees = 3

Enter choice : 6
ALEX EXE TRAINEE 2000.000000 133

Enter choice : 2
Linked list elements from begining :
RAJ SALES MANAGER 15000.000000 911
2 RAVI HR ASST 10000.000000 123

No of employees = 2Enter choice : 7
Exit

/*9Q.Design,Develop andImplement a Program in C for the following operations on Singly Circular Linked List(SCLL)with header nodes

a. Represent and Evaluate a Polynomial P(x,y,z)=6x2y2z-4yz5+3x3yz+2xy5z-2xyz3

b. Find the sum of two polynomials POLY1(x,y,z)and POLY2(x,y,z)and store the result in POLYSUM(x,y,z)

Support the program with appropriate functions for each of the above operations.*/

Theory:

Circular LinkedList is a variation of Linked list in which the first element points to the last element and the last element points to the first element.Both Singly Linked List and Doubly Linked List can be made into a circular linked list.

Singly Linked List as Circular

In singly linkedlist, the next pointer of thelast node points to the first node.
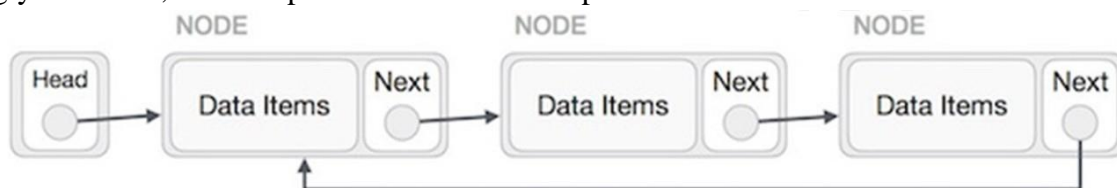
Let's find the sum of the following two polynomials

$$(3y^5-2y+y^4+2y^3+5) \text{ and } (2y^5+3y^3+2+7)$$

1) Write in Standard form $(3y^5 + y^4 + 2y^3 - 2y + 5) + (2y^5 + 3y^3 + 7y + 2)$

2) Arrange in columns of like terms and then add

$$3y^5 + y^4 + 2y^3 - 2y + 5$$
$$2y^5 \qquad\quad + 3y^3 + 7y + 2$$
$$\overline{5y^5 + y^4 + 5y^3 + 5y + 7}$$

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ALGORITHM:

Algorithm:polynomial_using_SCLL

```
1. Start
2. Readchoiceforpolynomialoperation
3. Switchchoice
```

1:readpolynomial1a=readpoly()
2:readpolynomial2b=readpoly()
3:print polynomial print(a)
4:printpolynomial2print(b)
5:addpolynomial1andpolynomial2 Andprintanswerc=polyadd(a,b)Print(c)
6:evaluatepolynomialCal)
7.exit

Algorithm:getnode()

Start
Createnewnodeandreturnit
Stop

Algorithm:readpoly()
        1.Start
        2.Read coefficient andexponents
        3.Askforcombinationifyesrepeat step2
4. stop

Algorithm:compare(a,b)
        1.Start
                ifa->x>b->xreturn1
                Else
                if a->y>b>yreturn1
                else
                ifa->z>b->zreturn1
                else
                ifa->x<b->xreturn-1
                else
                ifa->y<b->yreturn-1
                else
                ifa->z<b->zreturn-1
        2.Return 0
        3.stop

Algorithm:attach(ef,x1,y1,z1,ptr)
        1.start
        2.attachtoptr
        3.stop

Algorithm:cpadd(a,b)
        1.start
        2.compare(a-1:attach(b->coff,b->x,b->y,b->z,lastc)0:sum=a->coff+b->coff
        attach(sum,a->x,a->y,a->z,lastc)1.attach(a->coff,a->x,a->y,a->z,lastc)
        3.repeatstep2untilallcoefficientfroma,bprocessed4.stop

Algorithm:print(ptr)
        1.start
        2.displaycoefficientandexponents3.repeatstep2untilcur->link!=ptr
        3.stop

Algorithm:Cal(ptr)
        1.start
        2.readvaluesforx,yandz
        3.substitutevalueinpolynomialcalculateand
4.stop

SOLUTION-1

```
#include<stdio.h>
#include<stdlib.h>
#include<math.h>
structnode//polynomial node
{
        Int coef;intx,y,z;
        Struct node*link;
```

```
};
Typedef struct node*NODE;

NODE get node()//create anode
{
        NODEx;
        x=(NODE)malloc(sizeof(structnode));
        return x;
}//end of getnode

NODE readpoly()
{
        NODE temp,head,cur;
        char ch;
        head=getnode();//create a head node and set all valuesto-1itissimilar to
        FIRSTinSLLprogram
        head->coef=-1;head->x=-1;head->y=-1;head->z=-1;
        head->link=head;//self-reference
        do
        {
                temp=getnode();//create a polynomial node
                printf("\nEnter the coefficient and exponent in decreasing order");
                scanf("%d%d%d%d",&temp->coef,&temp->x,&temp->y,&temp->z);
                cur=head;
                while(cur->link!=head)//find the last node
                cur=cur->link;
                cur->link=temp;//connect new node to the last node
                temp->link=head;//point back to head
                printf("\nDo you want toenter more coefficients(y/n)");
                fpurge(stdin);//to clear the stdin buffer
                scanf("%c",&ch);
        }while(ch=='y'||ch=='Y');

        Return head;//return the polynomial list
}//end of readpoly

Int compare(NODE a,NODE b)//function to compare the A and B polynomial nodes
{
        if(a->x>b->x)
        return1;
        else
        if(a->x<b->x)
        return-1;
        elseif(a->y>b->y)
        return1;
        else
        if(a->y<b->y)
        return-1;
        else
```

```
            if(a->z>b->z)
            return1;
            else
            if(a->z<b->z)
            return-1;
            return0;
    }//end of compare


Void attach(int cf,int x1,int y1,int z1,NODE *ptr)//function to attach the A and B  polynomial node
to C Polynomial
{
            NODE temp;
            temp=getnode();
            temp->coef=cf;
            temp->x=x1;
            temp->y=y1;
            temp->z=z1;
            (*ptr)->link=temp;
            *ptr=temp;
}//end of attach


NODE add poly(NODEa,NODEb)//function  to add polynomial Aand  Bi.e,C=A+B
{
            NODE start a,c,last c;
            Int sum,done=0;
            Start a=a;
            a=a->link;
            b=b->link;
            c=getnode();//create list C to  storeA+B
            c->coef=-1;
            c->x=-1;
            c->y=-1;
            c->z=-1;
    lastc=c;
            do{
                    switch(compare(a,b))

                    {
                            Case-1:attach(b->coef,b->x,b->y,b->z,&lastc);
                    b=b->link;
                    break;
                            case 0:if(starta==a)
                    done=1;
                            else{
                            sum=a->coef+b->coef;
                            if(sum)attach(sum,a->x,a->y,a->z,&lastc);
                            a=a->link;b=b->link;
```

```
                    }
                    break;
                    case1:if(starta==a)done=1;
                    attach(a->coef,a->x,a->y,a->z,&lastc);
                    a=a->link;
                    break;
                }
            }
        while(!done);//repeate until not  donelast c>link=c;//point  back to head of C
        return c;//return answer
}


Void print(NODE ptr)//to print the polynomial
{
        NODE cur;
        cur=ptr->link;
        while(cur!=ptr)//To print from HEAD node till END node
        {


                printf("%d*x^%d*y^%d*z^%d",cur->coef,cur->x,cur->y,cur->z);
                cur=cur->link;//movetonextnode
                if(cur!=ptr)
                printf("+");
        }
}//end of print


Void evaluate(NODE ptr)//function to evaluate the final polynomial
{
        Int res=0;
        Int x,y,z,ex,ey,ez,cof;
        NODE cur;
        printf("\nEnter the values of  x,y,z");//read values of X,Yand Z
        scanf("%d",&x);
        scanf("%d",&y);
        scanf("%d",&z);
        cur=ptr->link;//start with HEAD
        while(cur!=ptr)//Repea tuntil the end of list
        {
                ex=cur->x;//exponent of xey=cur->y;//exponentofy
                ez=cur->z;//exponent to fz
                cof=cur->coef;//coefficient
                res+=cof*pow(x,ex)*pow(y,ey)*pow(z,ez);//compute result for each polynomial
        cur=cur->link;//move to next node
        }
        printf("\nresult:%d",res);
}//end of evaluate
```

```
Void main(void)
{
        Int i,ch;
        NODE a=NULL,b,c;
        while(1)
        {
                printf("\n1:Represent first polynomial A");
                printf("\n2:Represent Second polynomial B");
                printf("\n3:Display the polynomial A");
                printf("\n4:Display the polynomial B");
                printf("\n5:Add A&B polynomials");//C=A+B
                printf("\n6:Evaluate polynomial C");
                printf("\n7:Exit");
                printf("\nEnter your choice:");
                scanf("%d",&ch);
        switch(ch)
        {
case1:printf("\nEnter the elements of the polynomialA");
a=readpoly();
break;
case2:printf("\nEnter the element sof th epolynomial B");
b=readpoly();
break;
case 3: print(a);//display polynomial A
break;
case4:
                print(b);//display polynomial A
                break;
        case5:
c=addpoly(a,b);//C=A+B
                        printf("\nThe sum of two polynomialsis:");
                        print(c);//display polynomial C
                        printf("\n");
                        break;
case6:evaluate(c);//Evaluate polynomial C
break;
        case7:
                return;
        default:printf("\nInvalid choice!\n");
        }//end of switch
        }//end of while
}//end of main
```

Solution 2

```c
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include <math.h>
struct node
{
int coeff;
int expo;
struct node *ptr;
};
struct node *head1,*head2,*head3, *temp,*temp1,*temp2,*temp3,*list1,*list2,*list3;
struct node *dummy1,*dummy2;
void create_poly1(int , int);
void create_poly2(int , int);
void display();
void add_poly();
void eval_poly(int );
int n,ch;
int c,e,i;

void main()
{
        int x; list1=list2=NULL;
        printf("1.Create first polynomial\n2.Create Second Polynomial\n3.Display both the
        polynomials\n");
        printf("4.Add Polynomials\n5.Evaluate a Polynomial\n6.Exit\n");
        while(1)
        {
                printf("Enter choice\n");
                scanf("%d",&ch);
                switch(ch)
        {
                case 1: printf("Enter the number of terms\n");
                        scanf("%d",&n);
                        printf("Enter coefficient & power of each term\n");
                        for(i=0;i<n;i++)
                        {
                                scanf("%d%d",&c,&e);
                                create_poly1(c,e);
                        }
                        break;
                case 2: printf("Enter the number of terms\n");
                scanf("%d",&n);
                        printf("Enter coefficient & power of each term\n");
                        for(i=0;i<n;i++)
                        {
                                scanf("%d%d",&c,&e);
                                create_poly2(c,e);
                        }
                        break;
```

```
                    case3:Display();break;

        case4:add_poly();
                                break;

                        case 5:
                                printf("entere value for x\n");
                                scanf("%d",&x);
                                eval_poly(x);
                                break;
                        case6: exit(0);
        }
        }
        }
void create_poly1(int c, int e)
        {
                Dummy    1=(struct      node*)malloc(1*sizeof(struct
                node));
                dummy1->coeff=0;
                dummy1->expo=0;
                dummy1->ptr=list1;
                if(list1==NULL)
                {
                     list1->coeff=c;
                    list1->expo=e;
                    list1->ptr=list1;
                    head1=list1;
                    head1->ptr=dummy1;
                }
                else
                {
                    temp=(struct     node*)malloc(1*sizeof(struct
                    node));
                    temp->coeff=c;
                    temp->expo=e;
                    head1->ptr=temp;
                    temp->ptr=dummy1;
```

```c
void create_poly2(int c, int e)
{
        dummy2=(struct node*)malloc(1*sizeof(struct node));
        dummy2->coeff=0;
        dummy2->expo=0;
        dummy2->ptr=list2;
        if(list2==NULL)
        {
                list2=(struct node*)malloc(1*sizeof(struct node));
            list2->coeff=c;
              list2->expo=e;
              list2->ptr=list2;
              head2=list2;
              head2->ptr=dummy2;
        }
        else
        {
                temp=(struct node*)malloc(1*sizeof(struct node));
                 temp->coeff=c;
                temp->expo=e;
                head2->ptr=temp;
                temp->ptr=dummy2;
                head2=temp;
        }
}


void add_poly()

{
        temp1=list1;
        temp2=list2;
        while((temp1!=dummy1)&&(temp2!=dummy2))
        {
                temp=(struct node*)malloc(1*sizeof(struct node));
                 if(list3==NULL)
                {
                        list3=temp;
                         head3=list3;
                }
                if(temp1->expo==temp2->expo)
                {
                temp->coeff=temp1->coeff+temp2->coeff;
                temp->expo=temp1->expo;
                temp->ptr=list3;
                head3->ptr=temp;
                head3=temp;
                temp1=temp1->ptr;
        temp2=temp2->ptr;
                }
        else if(temp1->expo>temp2->expo)
        {
                temp->coeff=temp1->coeff;
         temp->expo=temp1->expo;
         temp->ptr=list3;
```

```c
                        head3->ptr=temp;
                        head3=temp;
                        temp1=temp1->ptr;
                }
                else
                {
                        temp->coeff=temp2->coeff;
                        temp->expo=temp2->expo;
                        temp->ptr=list3;
                        head3->ptr=temp;
                        head3=temp;
                        temp2=temp2->ptr;
                }
                }


                if(temp1==dummy1)
                {
                        while(temp2!=dummy2)
                        {
                                temp=(struct node*)malloc(1*sizeof(struct node));
                                temp->coeff=temp2->coeff;
                                temp->expo=temp2->expo;
                                temp->ptr=list3;
                                head3->ptr=temp;
                                head3=temp;
                         temp2=temp2->ptr;
                                }
                }
                if(temp2==dummy2)
                {
                        while(temp1!=dummy1)
                        {
                                temp=(struct node*)malloc(1*sizeof(struct node));
                                emp->coeff=temp1->coeff;
                        temp->expo=temp1->expo;
                         temp->ptr=list3;
                                head3->ptr=temp;
                                head3=temp;
                                temp1=temp1->ptr;
                        }
                }
                }
        void display()
        {
                temp1=list1; temp2=list2; temp3=list3;
                printf("\nPOLYNOMIAL 1:");
                while(temp1!=dummy1)
                {
                        printf("%dX^%d+",temp1->coeff,temp1->expo); temp1=temp1->ptr;
                }
                printf("\b ");
                printf("\nPOLYNOMIAL 2:");

                while(temp2!=dummy2)
```

```
{
printf("%dX^%d+",temp2->coeff,temp2->expo); temp2=temp2->ptr;
}
printf("\b ");
printf("\n\nSUM OF POLYNOMIALS:\n");
while(temp3->ptr!=list3)
{
        printf("%dX^%d+",temp3->coeff,temp3->expo); temp3=temp3->ptr;
}
printf("%dX^%d\n",temp3->coeff,temp3->expo);
}

void eval_poly(int x)
{
        int result=0; temp1=list1; temp2=list2;
        while(temp1!=dummy1)
        {
                result+=(temp1->coeff)*pow(x,temp1->expo); temp1=temp1->ptr;
        }
        printf("Polynomial 1 Evaluation:%d\n",result); result=0;
        while(temp2!=dummy2)
        {
                result+=(temp2->coeff)*pow(x,temp2->expo); temp2=temp2->ptr;
        }
        printf("Polynomial 2 Evaluation:%d\n",result);
}
```

OUTPUT:

```
 Enter your choice: 5

The sum of two polynomials is: 2*x^5*y^7*z^9 + 3*x^6*y^7*z^9 + 7*x^5*y^2*z^1 + 9
*x^5*y^3*z^1

1: Represent first polynomial A
2: Represent Second polynomial B
3: Display the polynomial A
4: Display the polynomial B
5: Add A & B polynomials
6: Evaluate polynomial C
7: Exit
 Enter your choice: 6

Enter the values of x, y,z 1 1 1

result: 21
1: Represent first polynomial A
2: Represent Second polynomial B
3: Display the polynomial A
4: Display the polynomial B
5: Add A & B polynomials
6: Evaluate polynomial C
7: Exit
 Enter your choice: 7
```

SOLUTION-3

```c
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
#include<math.h> typedef
struct node
{
int expo,coef; struct
node *next; }node;
node * insert(node *,int, int); node *
create();
node * add(node *p1,node *p2); int
eval(node *p1);
void display(node *head);
node *insert(node*head,int expo1,int coef1)
{
node *p,*q;
p=(node *)malloc(sizeof(node));
p->expo=expo1;
p->coef=coef1;
p->next=NULL;
if(head==NULL)
{
head=p;
head->next=head;
return(head);
}
if(expo1>head->expo)
{
p->next=head->next; head-
>next=p; head=p;
return(head);
}
if(expo1==head->expo)
{
head->coef=head->coef+coef1;
return(head);
}
q=head;
while(q->next!=head&&expo1>=q->next->expo) q=q-
>next;
if(p->expo==q->expo)
q->coef=q->coef+coef1; else
{
p->next=q->next; q-
>next=p;
}
```

```
return(head);
}
node *create()
{
int n,i,expo1,coef1; node
*head=NULL;
printf("\n\nEnter no of terms of polynomial==>");
scanf("%d",&n);
for(i=0;i<n;i++)
{
printf("\n\nEnter coef & expo==>");
scanf("%d%d",&coef1,&expo1);
head=insert(head,expo1,coef1);
}
return(head);
}
node *add(node *p1,node *p2)
{
node *p;
node *head=NULL;
printf("\n\n\nAddition of polynomial==>");
p=p1->next;
do
{
head=insert(head,p->expo,p->coef); p=p-
>next;
}
while(p!=p1->next); p=p2-
>next;
do
{
head=insert(head,p->expo,p->coef); p=p-
>next;
}while(p!=p2->next);
return(head);
}
int eval(node *head)
{
node *p; int
x,ans=0;
printf("\n\nEnter the value of x=");
scanf("%d",&x);
p=head->next;
do
{
ans=ans+p->coef*pow(x,p->expo); p=p-
>next;
```

```c
}while(p!=head->next);
return(ans);
}
void display(node *head)
{
node *p,*q;
int n=0; q=head-
>next; p=head->next;
do
{
n++; q=q->next;
}while(q!=head->next);

printf("\n\n\tThe polynomial is==>");
Do
{
if(n-1)
{
printf("%dx^(%d) + ",p->coef,p->expo);
p=p->next;
}
Else
{
printf(" %dx^(%d)",p->coef,p->expo);
p=p->next;
}
n--;
} while(p!=head->next);
}
void main()
{
int a,x,ch;
node *p1,*p2,*p3;
p1=p2=p3=NULL;
while(1)
{
printf("\n\t----------------<< MENU >>-------------- ");
printf("\n\tPolynomial Operations :");
printf(" 1.Add");
printf("\n\t\t\t2.Evaluate");
printf("\n\t\t\t3.Exit");
printf("\n\t_____");
printf("\n\n\n\tEnter your choice==>");
scanf("%d",&ch);
switch(ch)
{
case 1 :
```

```
p1=create();

display(p1);
p2=create();
display(p2);
p3=add(p1,p2);
display(p3);
break; case 2 :
p1=create();
display(p1);
a=eval(p1);
printf("\n\nValue of polynomial=%d",a); break;
case 3 :
exit(0); break;
default :
printf("\n\n\tinvalid choice"); break;
}
}
}
```

Output:

```
                 << MENU >>
       Polynomial Operations : 1.Add
                    2.Evaluate 3.Exit
       - - - - - - - - - - - - - - - - - - - - - - - - - - -

       Enter your choice==>1

Enter no of terms of polynomial==>3

Enter coef & expo==>1 2

Enter coef & expo==>3 4

Enter coef & expo==>5 6

     The polynomial is==>1x^(2) + 3x^(4) + 5x^(6)

Enter no of terms of polynomial==>3

Enter coef & expo==>6 5

Enter coef & expo==>4 3

Enter coef & expo==>2 1
```

The polynomial is==>2x^(1) + 4x^(3) + 6x^(5)

Addition of polynomial==>

The polynomial is==>2x^(1) + 1x^(2) + 4x^(3) + 3x^(4) + 6x^(5) + 5x^(6)

................<< MENU >>....................
Polynomial Operations : 1.Add
                2.Evaluate 3.Exit
- -

Enter your choice==>2

Enter no of terms of polynomial==>3

Enter coef & expo==>1 4
Enter coef & expo==>2 5

Enter coef & expo==>3 6
The polynomial is==>1x^(4) + 2x^(5) + 3x^(6)

Enter the value of x=3

Value of polynomial=2754
----------------<< MENU >>---------------
Polynomial Operations : 1.Add
                2.Evaluate 3.Exit
- -

Enter your choice==>3

Process returned 0 (0x0) execution time : 50.297 s
Press any key to continue.

/*10Q.Design,Develop and Implement a menu driven Program in C for the following operations on Binary Search Tree(BST)of Integers

    a.Create a BSTof N Integers: 6, 9,5,2, 8,15, 24,14, 7,8,5, 2
    b.Traverse the BST in Inorder,Preorder and PostOrder
    c.Search the BST for a given element(KEY) and report the appropriate message
    e.Exit.*/

Theory:

ABinarySearchTree(BST) is a tree in which all the nodes follow the below-mentioned properties−

- The left sub-tree of a node has a key less than or equal to its parent node's key.
- The right sub-tree of a node has a key greater than or equal to its parent node's key.

Thus,BST divides all its sub-trees into two segments; the left sub-tree and the right sub-tree and can be defined as−

left_subtree(keys)≤node(key)≤right_subtree(keys)

Representation

BST is a collection of nodes arranged in a way where they maintain BST properties. Each node has akey and an associated value. While searching, the desired key is compared to the keys in BST and iffound,theassociatedvalueis retrieved.

FollowingisapictorialrepresentationofBST−
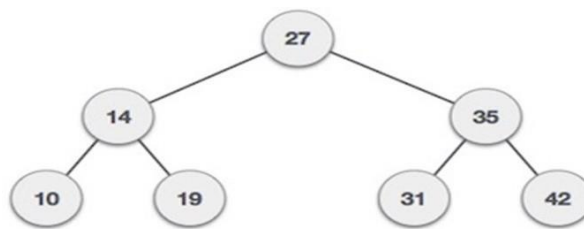
We observe that the root node key(27)has all less-valued keys on the left sub-tree and the higher valued keys on the right sub-tree.

Basic Operations

Following arethe basic operations of atree−

- **Search** −Searches an element in a tree.
- **Insert**−Inserts an element in a tree.
- **Pre-orderTraversal** −Traverses a tree in a pre-order manner.
- **In-orderTraversal**−Traverses a tree in an in-order manner.
- **Post-orderTraversal**−Traverses a tree in a post-order manner.

Traversal is a process to visit all the nodes of a tree and may print their values too. Because, all nodes are connected via edges(links) we always start from the root(head) node.That is,we cannot randomly access a node in a tree.There are three ways which we use to traverse a tree−
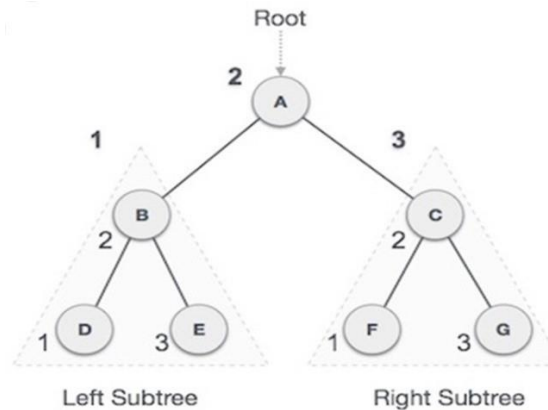
- In-orderTraversal
- Pre-orderTraversal
- Post-orderTraversal

Generally,we traverse a tree to search or locate a given item or key in the tree or to print all the values it contains.

In-orderTraversal

In this traversal method,the left sub tree is visited first,then the root and later the right sub-tree.We should always remember that every node may represent a subtree itself.

If a binary tree is traversed **in-order**,the output will produce sorted key values in an ascending

order.

We start from **A**, and following in-order traversal, we move to its left subtree **B**. **B** is also traversed in-order. The processgoeson until all the nodesare visited. The output of inorder traversal of thistreewillbe−

        D→B→ E→A→F→ C→G

Pre-orderTraversal

In this traversal method, the root node is visited first, then the left subtree and finally the right subtree.We start from **A**, and following pre-order traversal, we first visit **A** itself and then move to its left subtree **B**.**B** is also traversed pre-order.The process goes on until all the nodes are visited.The output of pre-order traversal of this tree will be−

        A→B→ D→E→C→ F→G

Post-orderTraversal

In this traversal method, the root node is visited last, hence the name. First we traverse the left subtree,thentherightsubtreeandfinallytherootnode.We start from **A**, and following pre-order traversal, we first visit the left subtree **B**. **B** is also traversed post-order.The process goes on until all the nodes are visited. The output of post-order traversal of this tree will be−

        D→E→ B→F→G→ C→A

Algorithm:

Algorithm:Binary_Search_Tree_operations
1. Start
2. Read choice for BSToperations
3.Switch ch
    case1:Read n elements one by one and insert the m
           into tree
      insert(item,root)
    case2:Traversal(root)
    case3:Search(root)
    case4:Exit4.Stop

Algorithm:insert(item,root)
    1.Start
    2.Create node
           temp=getnode()
           temp>info=item
    3. IfrootisNULL
           Set temp as root
           Other wise compare
           temp>info with root
           if t is lesser move left
           otherwise
           remove towards right
           insert_node
    4. Repeat step2 until you find leaf node
    5.Stop

Algorithm:Pre(root)

    1. Start
    2. Ifroot!=NULL
             Print root pre(root->llink)
             pre(root->rlink)
    3. Stop

    Algorithm:Post(root)
    1.Start
    2. ifroot!=NULL
          post(root>llink)
          post(root>rlink)
          print root
    3. Stop

    Algorithm:In(root)
    1.Start
    2. ifroot!=NULL
         in(root>llink)
         print root
         in(root->rlink)
    3. Stop

    Algorithm:Traversal(root)
    1.Start
    2.pre(root)
    3.post(root)
    4.in(root)
    5.Stop

Algorithm:Search(root)
    1.Read key element to be inserted
    2.if key=root->info
          Print successful search else
          Ifkey>root->info
          root=root>rlink
          elseifkey<root->info

```
                root=root>llink
        else
            print unsuccessful search
```

Solution-1

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

int flag=0;
typedef struct BST
{
int data;
struct BST *lchild, *rchild;
} node;
void insert(node *, node *);
void inorder(node *); void
preorder(node *); void
postorder(node *);
node *search(node *, int, node **);
void main()
{
int choice;
int ans=1; int key;
node *new_node, *root, *tmp, *parent;
node *get_node();
root = NULL;
printf("\nProgram For Binary Search Tree "); do {
printf("\n1.Create");
printf("\n2.Search");
printf("\n3.Recursive Traversals");
printf("\n4.Exit");
printf("\n Enter your choice :");
scanf("%d", &choice);
switch (choice)
case 1: do
{
new_node = get_node(); printf("\nEnter
The Element ");
scanf("%d", &new_node->data);
if (root == NULL) /* Tree is not Created */
root = new_node;
else
insert(root, new_node);
printf("\n Want To enter More Elements?(1/0)");
scanf("%d",&ans);
```

```
}
while (ans);
 break;


case 2:
printf("\n Enter Element to be searched :");
scanf("%d", &key);
tmp = search(root, key, &parent);
if(flag==1)
{
printf("\nParent of node %d is %d", tmp->data, parent->data);
}
else
{
printf("\n The %d Element is not Present",key);
}
flag=0;
break;
case 3:
if (root == NULL)
printf("Tree Is Not Created");
else {
printf("\nThe Inorder display : ");
inorder(root);
printf("\nThe Preorder display : ");
preorder(root);
printf("\nThe Postorder display : ");
postorder(root);
}
break;
}
} while (choice != 4);
}
/* Get new Node */
node *get_node()
{
node *temp;
temp = (node *) malloc(sizeof(node));
temp->lchild = NULL;
temp->rchild = NULL; return
temp;
}
/*
This function is for creating a binary search tree */
void insert(node *root, node *new_node)
{
if (new_node->data < root->data)
```

```
{
if(root->lchild == NULL)
root->lchild = new_node;
else
insert(root->lchild, new_node);
}
if (new_node->data > root->data)
{
if (root->rchild == NULL)
root->rchild = new_node; else
insert(root->rchild, new_node);
}
}
/*
This function is for searching the node from binary Search Tree */
node *search(node *root, int key, node **parent)
{
node *temp;
temp = root;
while (temp != NULL)
{ if (temp->data == key)

{
printf("\n The %d Element is Present", temp->data); flag=1;
return temp;
}
*parent = temp;
if(temp->data > key)
temp = temp->lchild;
else
temp = temp->rchild;
}
return NULL;
}
/*
This function displays the tree in inorder fashion */
void inorder(node *temp)
{
if (temp != NULL)
{
inorder(temp->lchild);
printf("%d\t", temp->data);
inorder(temp->rchild);
}
}
/*
This function displays the tree in preorder fashion */
```

```
void preorder(node *temp)
{
if (temp != NULL)
{
 printf("%d\t", temp->data);
preorder(temp->lchild);
preorder(temp->rchild);
}
}
/*
This function displays the tree in postorder fashion
*/
void postorder(node *temp)
{
if (temp != NULL)
{
postorder(temp->lchild);
postorder(temp->rchild);
printf("%d\t", temp->data);
}
}
```

Output:

```
Program For Binary Search Tree
1.Create
2.Search
3.Recursive Traversals 4.Exit
Enter your choice :1

Enter The Element 10

Want To enter More Elements?(1/0)1

Enter The Element 20

Want To enter More Elements?(1/0)1

Enter The Element 30

Want To enter More Elements?(1/0)1

Enter The Element 40

Want To enter More Elements?(1/0)1

Enter The Element 50
```

Want To enter More Elements?(1/0)1
Enter The Element 60

Want To enter More Elements?(1/0)1

Enter The Element 70

Want To enter More Elements?(1/0)0

1.Create
2.Search
3.Recursive Traversals
4.Exit
Enter your choice :2

Enter Element to be searched :50

The 50 Element is Present
Parent of node 50 is 40 1.Create
2.Search
3.Recursive Traversals
4.Exit
Enter your choice :2

Enter Element to be searched :55

 The 55 Element is not Present
1.Create
2.Search
3.Recursive Traversals
4.Exit
Enter your choice :3

The Inorder display : 10   20   30   40   50   60   70

The Preorder display : 10   20   30   40   50   60   70

The Postorder display : 70   60   50   40   30   20   10
1.Create
2.Search
3.Recursive Traversals 4.Exit
Enter your choice :4

Process returned 4 (0x4) execution time : 88.500 s
Press any key to continue.

Solution 2:

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

struct BST
{
        int data;
        struct BST *lchild;
        struct BST *rchild;
};
typedef struct BST * NODE;

NODE get_node()
{
        NODE temp;
        temp = (NODE) malloc(sizeof(struct BST));
        temp->lchild  = NULL;
        temp->rchild  = NULL;
        return temp;
}

void insert(NODE root, NODE newnode);
void inorder(NODE root);
void preorder(NODE root);
void postorder(NODE root);
void search(NODE root, int key);

void insert(NODE root, NODE newnode)
{
   /*Note: if newnode->data == root->data it will be skipped. No duplicate nodes are allowed */

        if (newnode->data < root->data)
        {
                if (root->lchild  == NULL)
                        root->lchild  = newnode;
                else
                        insert(root->lchild,  newnode);
        }

        if (newnode->data > root->data)
        {
                if (root->rchild  == NULL)
                        root->rchild = newnode;
                else
                        insert(root->rchild,  newnode);
        }
}

void search(NODE root, int key)
{
        NODE cur;
        if(root == NULL)
        {
```

```
        printf("\nBST  is empty.");
```

```c
                return;
        }
        cur = root;
        while  (cur != NULL)
        {
                if (cur->data == key)
                {
                        printf("\nKey element %d is present in BST", cur->data); return;
                }
                if (key < cur->data)
                        cur = cur->lchild;
                else
                        cur = cur->rchild;
        }

        printf("\nKey element %d is not found in the BST", key); }

void inorder(NODE root)
{
        if(root != NULL)
        {
                inorder(root->lchild);
                printf("%d ", root->data);
                inorder(root->rchild);
        }
}

void preorder(NODE root)
{
        if (root != NULL)
        {
                printf("%d ", root->data);
                preorder(root->lchild);
                preorder(root->rchild);
        }
}

void postorder(NODE root)
{
        if (root != NULL)
        {
                postorder(root->lchild);
                postorder(root->rchild);
                printf("%d  ", root->data);
        }

}

void main()
{
        int ch, key, val, i, n;
        NODE root = NULL, newnode;
        while(1)
        {
```

```
printf("\n~~~~BST  MENU~~~~");
```

```
                        printf("\n1.Create a BST");
                        printf("\n2.Search");
                        printf("\n3.BST Traversals: ");
                        printf("\n4.Exit");
                        printf("\nEnter your choice: ");
                        scanf("%d",  &ch);
                        switch(ch)
                        {
                case 1:          printf("\nEnter the number of elements: ");
                                 scanf("%d", &n);
                                 for(i=1;i<=n;i++)
                                 {
                                         newnode = get_node();
                                         printf("\nEnter The value: ");
                                         scanf("%d",  &val);
                                         newnode->data = val;
                                         if (root == NULL)
                                                 root = newnode;
                                             else
                                                 insert(root, newnode);
                                 }
                                 break;
                case 2:          if (root == NULL)
                                         printf("\nTree  Is Not Created");
                                 else
                                 {
                                         printf("\nThe Preorder display : ");
                                         preorder(root);
                                         printf("\nThe Inorder display : ");
                                         inorder(root);
                                         printf("\nThe Postorder display : ");
                                         postorder(root);
                                 }
                                 break;

                case 3:          printf("\nEnter Element to be searched: ");
                                 scanf("%d", &key);
                                 search(root, key);
                                 break;

                case 4:    exit(0);
                        }
                }
}
```

ALGORITHM:

Step 1: Start.
Step 2: Create a Binary Search Tree for N elements.
Step 3: Traverse the tree in inorder.
Step 4: Traverse the tree in preorder

Step 6: Traverse the tree inpostorder.

Step 7: Search the given key element in theBST.
Step 8: Delete an element fromBST.
Step 9: Stop

Solution 3:

```c
#include    <stdio.h>
#include    <stdlib.h>
struct BST
{
int data;
struct BST *left;
struct BST *right;
};
typedef struct BST NODE;
NODE *node;

NODE* createtree(NODE *node, int data)
{
if (node == NULL)
{
        NODE *temp;
        temp=(NODE*)malloc(sizeof(NODE));
        temp->data = data;
        temp->left = temp->right = NULL;
        return temp;
}
if (data < (node->data))
{
        node->left = createtree(node->left, data);
}
else if (data > node->data)
{
        node -> right = createtree(node->right, data);
}
return node;
}

NODE* search(NODE *node, int data)
{
        if(node == NULL)
        printf("\nElement not found");
        else if(data < node->data)
        {
                node->left=search(node->left, data);
        }
        else if(data > node->data)
        {
                node->right=search(node->right, data);
        }
        else
            printf("\nElement found is: %d",node->data);
    return node;

}
```

```
void inorder(NODE *node)
{
if(node != NULL)
{
        inorder(node->left);
        printf("%d\t",node->data);
        inorder(node->right);
}
}
void preorder(NODE *node)
{
        if(node != NULL)
        {
                printf("%d\t", node->data);
                preorder(node->left);
                preorder(node->right);
        }
}

void postorder(NODE *node)
{
if(node != NULL)
{
        postorder(node->left);
        postorder(node->right);
        printf("%d\t", node->data);
}
}

NODE* findMin(NODE *node)
{
        if(node==NULL)
        {
        returnNULL;
        }
        if(node->left)
                return findMin(node->left);
        else
                return node;
}


NODE* del(NODE *node, int data)
{
        NODE *temp;
        if(node == NULL)
        {
                printf("\nElement not found");
        }
        else if(data < node->data)
        {
                node->left = del(node->left, data);
        }
        else if(data > node->data)
        {
                node->right = del(node->right, data);
```

```
}
```

```c
        else
        {
/* Now We can delete this node and replace with either minimum element in the right sub tree or
maximum element in the left subtree */
        if(node->right && node->left)
        {
/* Here we will replace with minimum element in the right sub tree */
         temp = findMin(node->right);
        node -> data = temp->data;
/* As we replaced it with some other node, we have to delete that node */
        node -> right = del(node->right, temp->data);
}
else
{
/* If there is only one or zero children then we can directly remove it from the tree and connect its
parent to its child */
        temp = node;
        if(node->left == NULL)
                node=node>right;
        else
        if(node->right ==NULL)
                node = node->left;
        free(temp);     /* temp is longer required */
}
}
returnnode;
}
voidmain()
{
        int data, ch, i,
        n; NODE
        *root=NULL;
        clrscr();
        while (1)
        {
                printf("\n1.Insertion in Binary Search Tree")
                printf("\n2.Search Element in Binary Search Tree");
                printf("\n3.Delete Element in Binary Search Tree");
                printf("\n4.Inorder\n5.Preorder\n6.Postorder\n7.Exit");
                printf("\nEnter your choice: ");
                 scanf("%d", &ch);
                switch (ch)
                {
                        case 1:
                                printf("\nEnter N value: " );
                                scanf("%d",&n);
```

```
                        printf("\nEnter the values to create BST
                        like(6,9,5,2,8,15,24,14,7,8,5,2)\n");
                        for(i=0; i<n;i++)
                        {
                        scanf("%d", &data);
                        root=createtree(root, data);
                        }
                        break;
                case 2:
                        printf("\nEnter the element to search: ");
                        scanf("%d", &data);
                        break;
                 case 3:printf("\nEnter the element to delete: ");
                         scanf("%d", &data);
            root=del(root, data);
                    break;
   case4:


        printf("\nInorder Traversal: \n");
        inorder(root);
        break;

      case5:

            printf("\nPreorder Traversal: \n");
            preorder(root);
            break;
```

case 6:

```
printf("\nPostorder Traversal: \n");
postorder(root);
    break;
case 7: k;

}
}
}
exit(0);
default
        printf ("\nWrongoption");
        break;
```

OUTPUT

```
1. Create BST of N Integers
2. BST Traversal
3. Binary Search
4. Exit
Enter Your Choice: 1

 Enter number elements : 12
Enter the item to be inserted
6
Enter the item to be inserted
9
Enter the item to be inserted
5
Enter the item to be inserted
2
Enter the item to be inserted
8
Enter the item to be inserted
15
Enter the item to be inserted
24
Enter the item to be inserted
14
Enter the item to be inserted
7
Enter the item to be inserted
8
Enter the item to be inserted
5
Enter the item to be inserted
2
```

```
1. Create BST of N Integers
2. BST Traversal
3. Binary Search
4. Exit
Enter Your Choice: 2


PREORDER traversal
6       5       2       9       8       7       15      14      24

INORDER traversal
2       5       6       7       8       9       14      15      24

POSTORDER traversal
2       5       7       8       14      24      15      9       6
1. Create BST of N Integers
2. BST Traversal
3. Binary Search
4. Exit
Enter Your Choice: 3
enter the element to be searched
24
Found key 24 in tree

1. Create BST of N Integers
2. BST Traversal
3. Binary Search
4. Exit
Enter Your Choice: 3
enter the element to be searched
30
Key not found
```

```
1. Create BST of N Integers
2. BST Traversal
3. Binary Search
4. Exit
Enter Your Choice: 4
```

PROGRAM-11

/*11Q.Design,Develop and Implement a Program in C for the following operations on Graph (G)of Cities

a. Create a Graph of N cities using Adjacency Matrix.

b. Print all the nodes reachable from a given starting node in a digraph using DFS/BFS method.*/
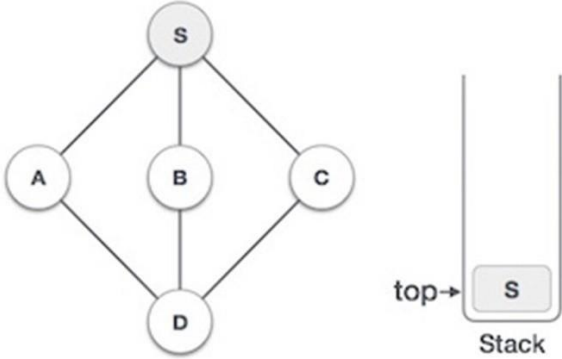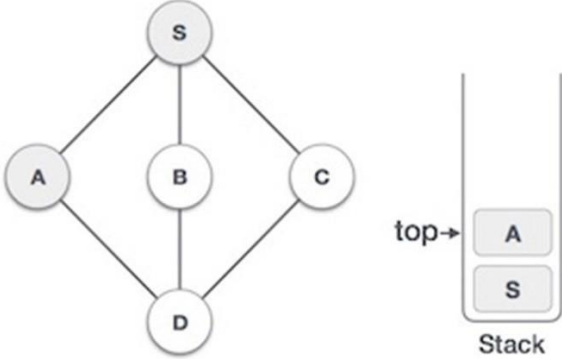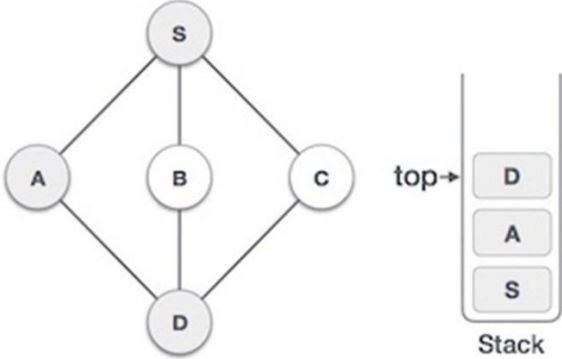
Depth First Search(DFS) algorithm traverses a graph in a depth ward motion and uses a stack to remember to get the next vertex to start a search,when a dead end occurs in any iteration.
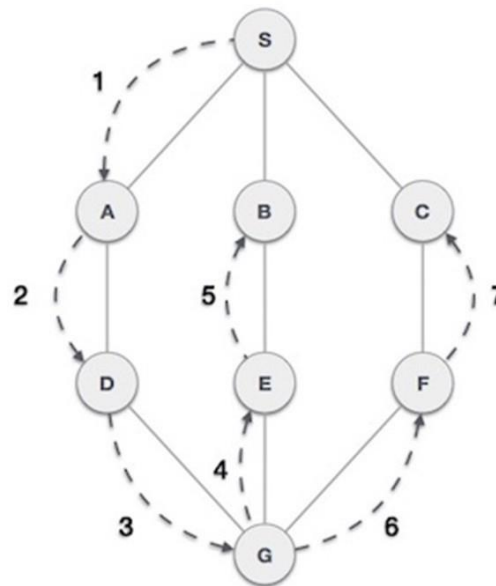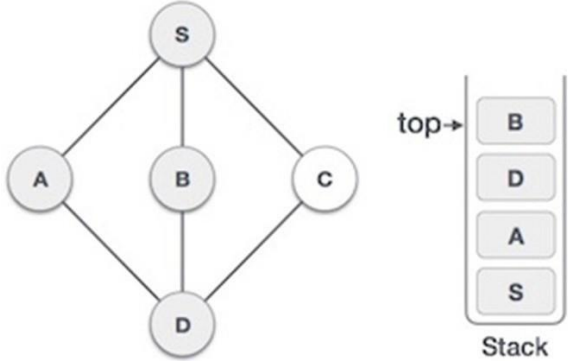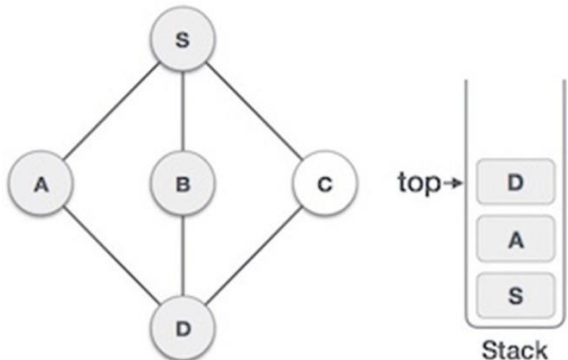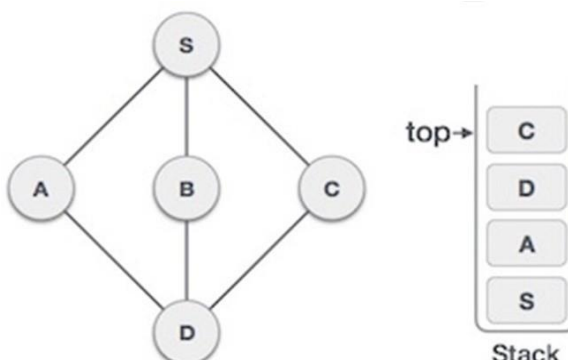
As in the example given above,DFS algorithm traverses from A to B to C to D first then to E,then to F and lastly to G. It employs the following rules.

- **Rule1**−Visit the adjacent unvisited vertex.Mark it as visited.Display it.Push it In a stack.
- **Rule2**−If no adjacent vertex is found,pop up a vertex from the stack.(It will pop up all the Vertices from the stack,which do not have adjacent vertices.)
- **Rule3**−Repeat Rule1 and Rule2 until the stack is empty.

Step	Traversal	Description
1.		Initialize the stack.

2.		Mark **S** as visited and put it onto the stack.Explore any unvisited adjacent node from **S**.We have three nodes and we can pick any of them. For this example,we shall take the node in analphabetical order.
3.		Mark **A** as visited and put iton to the stack.Explore any unvisited adjacent node from A. Both **S** and **D** are adjacent To **A** but we are concerned for unvisited nodes only.
4.		Visit **D** and mark itas visited and put onto the stack.Here,we Have **B** and **C** nodes,which are adjacent to **D** and both are unvisited.However, we shall again choose in analphabetical order.

5.		We choose **B**, mark it as visited and put onto the stack. Here **B** does not have any unvisited adjacent node.So,we pop **B** from the stack.
6.		We check the stack top for return to the previous node and check if it has any unvisited nodes.Here,we find **D** to be on the top of the stack.
7.		Only unvisited adjacent node is from **D** is **C** now. So we visit **C**,mark it as visited and put it onto the stack.

Algorithm:
Algorithm Graph-Of-Cities
1. Start
2. Read no of cities
3. Read adjacent matrix for cities
4. Read choice for graph operations
5. Switch choice
        Case1:Read source vertex

Reachability(v)
Print reachable nodes from source vertex

Case2:Connectivity(1)
If all vertex are visited then print graph is connected
else   Graph is disconnected

Case3:Exit

Algorithm:Reachability(v)
1. Start
2. Repeat until n
   if(a[v][i] and! visited[i])
   pushs[++top]=i;
   if(top>=0)
     then   visited(s[top])=1
reachability(s[top--])
3. Stop

Algorithm:Connectivity(r)
1. Start
2. Reapt until n.
   if(a[v][i] and !reach[i])print v to I
   connectivity connectivity(i)
3. Stop.

SOLUTION-1

```
#include<stdio.h>
Inta[20][20],q[20],visited[20],reach[10];intn,i,j,count,f=0,r=-1;

Void bfs(int v)//Reachability using BreadthFirstSearch
{
        for(i=1;i<=n;i++)
            if(a[v][i]&&!reach[i])//check weather node is reached
            q[++r]=i;//if not add it TO Queue
                if(f<=r)//check for non empty Queue
                {
```

```
                q[f]]=1;//
                bfs(q[f++]);//recursive call B
}




    printf("\nPostorder Traversal: \n");
postorder(root);
    break;

}
}
}
                exit(0);

}//end of BSF


  voiddfs(intv)//Connectivity using DepthFirstSearch

  {
        inti;
        visited[v]=1;//set source is visited
        for(i=1;i<=n;i++)
        {
            if(a[v][i]&&!visited[i])//check  weather node is visited


                {
                        printf("\n%d>%d",v,i);//if not print count++ visited
                        count dfs(i);//recursive call DFS
                }
            }
  }//end of DFS

  Void main()
  {
        Int v,choice;
        printf("\nEnter the number of cities:");
         scanf("%d",&n);
        printf("\nEnter graph data in matrix form:\n");f
        or(i=1;i<=n;i++)
            for(j=1;j<=n;j++)
                scanf("%d",&a[i][j]);//read adjacency matrix
                while(1)
        {
            printf("\n1. Test for reachability") ;
```

```
            printf("\n2.      Test      for      connectivity")
            ;printf("\n3.Exit");
            printf("\nEnter Your Choice:");
            scanf("%d",&choice);
            switch(choice)
            {
                  case1:printf("Enter the source vertex:");
                  scanf("%d",&v);
if((v<1)||(v>n))//check for valid source entry
                                printf("\nEnter a valid source vertex");

else//if valid begin test for reachability
                                  {

                                  for(i=1;i<=n;i++)//begin with assuming allc ities

                                  reach[i]=0;
                                  reach[v]=1;//source is reached
                                  bfs(v);//cal BFS to check reachability
                                  printf("The reachable nodes from node%d:\n",v);
                                  for(i=1;i<=n;i++)//display reachable cities from

                                  if(reach[i]&&i!=v)
                                                printf("node%d\n",i);
                                  }
                                  break;

            case2:
                        for(i=1;i<=n;i++)//begin with assuming all cities are not connected
                        visited[i]=0;
                        printf("ENTER the source vertex");
                        count=0;
                         scanf("%d",&v);//read source city

                        dfs(v);//calDFS to check connectivity

                        if(count==n-1)
                            printf("\nGraph is connected\n");
                        else
                            printf("\nGraph is notconnected");
                        break;
            case3:return;
            default:printf("\nEnter proper Choice");
        }//end of switch
    }//end of while
  }//end of main
```

Solution 2:

ALGORITHM:

Step 1: Start.
Step 2: Input the value of N nodes of the graph
Step 3: Create a graph of N nodes using adjacency matrix representation.
 Step 4: Print the nodes reachable from the starting node using BFS.
Step 5: Check whether graph is connected or not using DFS.
Step 6: Stop.

PROGRAM CODE:

```
#include <stdio.h>
#include <stdlib.h>
int a[20][20],q[20],visited[20],reach[10],n,i,j,f=0,r=-1,count=0;
void bfs(int v)
{
        for(i=1;i<=n;i++)
        if(a[v][i] && !visited[i]) q[++r]=i;
        if(f<=r)
        {
                visited[q[f]]=1;
                bfs(q[f++]);
        }
}
void dfs(int v)
{
int i; reach[v]=1;
for(i=1;i<=n;i++)
{
        if(a[v][i] && !reach[i])
        {
                printf("\n %d->%d",v,i);
                count++;
                dfs(i);
        }
}
}

void main()
{
```

```c
int v, choice;
printf("\n Enter the number of vertices:");
scanf("%d",&n);

for(i=1;i<=n;i++)
{
        q[i]=0;
        visited[i]=0;

}
for(i=1;i<=n-1;i++)
reach[i]=0;
printf("\n Enter graph data in matrix form:\n");
for(i=1;i<=n;i++)
for(j=1;j<=n;j++)
        scanf("%d",&a[i][j]);
printf("1.BFS\n 2.DFS\n 3.Exit\n");
scanf("%d",&choice);
switch(choice)
{
        case 1:
            printf("\n Enter the starting vertex:");
            scanf("%d",&v);
            bfs(v);
            if((v<1)||(v>n))
            {
                printf("\n Bfs is not possible");
            }
            else
            {
            printf("\n The nodes which are reachable from %d:\n",v);
            for(i=1;i<=n;i++)
                if(visited[i]) printf("%d\t",i);
            }
            break;

        case 2:

                dfs(1);

                 if(count==n-1)
             printf("\n Graph is connected");
              else
                    printf("\n Graph is not connected");
                     break;
```

```
        case 3: exit(0);
            }
}
```

Solution 3:

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

void bfs(int v);
void dfs(int  v);

int a[50][50], n, visited[50];
int q[20], front = -1,rear = -1;
int s[20], top = -1, count=0;

void creategraph()
{
        int i, j;
         printf("\nEnter the number of vertices in graph: ");
        scanf("%d", &n);
        printf("\nEnter the adjacency matrix:\n");
        for(i=1; i<=n; i++)
                for(j=1; j<=n; j++)
                        scanf("%d",  &a[i][j]);
}

void bfs(int v)
{
        int i, cur;
        visited[v] = 1;
        q[++rear] = v;
        printf("\nNodes reachable from starting vertex %d are: ", v);
        while(front!=rear)
        {
                cur = q[++front];
                for(i=1;i<=n;i++)
                {
                if((a[cur][i]==1)&&(visited[i]==0))
                        {
                                q[++rear]=i;
                                visited[i]=1;
                                printf("%d  ", i);
                        }
                }
        }
```

```
}

void dfs(int v)
{
        int i;
        visited[v]=1;
        s[++top] = v;
        for(i=1;i<=n;i++)
        {
                if(a[v][i]  == 1&& visited[i]  == 0 )
                {
                        dfs(i);
                        count++;
                }
        }
}
int main()
{
        int ch, start, i, j;
        creategraph();
        printf("\n\n~~~Menu~~~~");
        printf("\n==>1. BFS: Print all nodes reachable from a given starting node");
        printf("\n==>2. DFS: Print all nodes reachable from a given starting node");
        printf("\n==>3:Exit");
        printf("\nEnter your choice: ");
        scanf("%d",  &ch);
        switch(ch)
        {
                case 1:
                                for(i=1;i<=n;i++)
                                        visited[i]  = 0;
                                 printf("\nEnter the starting vertex: ");
                                 scanf("%d",  &start);
                                 bfs(start);
                                 for(i=1;i<=n;i++)
                                 {
                                         if(visited[i]  == 0)
                                          printf("\nThe  vertex that is not reachable is %d", i);
                                 }
                                 break;
                case 2:

                                for(i=1;i<=n;i++)
                                        visited[i]  = 0;
                                 printf("\n Enter the starting vertex:\t");
                                 scanf("%d",  &start);
```

```
                        dfs(start);
                        printf("\nNodes reachable from starting vertex %d are:\n", start);
                        for(i=1; i<=count; i++)
                                printf("%d\t",  s[i]);
                        break;
             case 3: exit(0);
             default: printf("\nPlease  enter valid choice:");
       }
}
```

OUTPUT:

PROGRAM-12

12. **Given a File of N employee records with a set K of Keys(4-digit) which uniquely determinethe records in file F. Assume that file F is maintained in memory by a Hash Table(HT) of mmemory locations with Lasthesetofmemoryaddresses (2-digit) of locations in HT. Let the keys in K and addresses in L are Integers. Design and develop a Program in C that uses Hash functionH: K -> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any)using linear probing**

Theory:

Hash Table is a data structure which stores data in an associative manner. In a hash table, data is stored in an array format, where each data value has its own unique index value. Access of data becomes very fast if we know the index of the desired data.

Thus, it becomes a data structure in which insertion and search operations are very fast irrespective ofthe size of the data. Hash Table uses an array as a storage medium and uses hash technique to generate an index where an element is to be inserted or is to be located from.

Hashing

Hashing is a technique to convert a range of key values into a range of indexes of an array. We're going to use modulo operator toget a range of key values. Consider an example of hash table of size 20, and the following items are to be stored.Item are in the (key,value)format.

Sr.No.	Key	Hash	ArrayIndex
1	1	1%20 =1	1
2	2	2%20 =2	2
3	42	42%20=2	2
4	4	4%20 =4	4
5	12	12%20=12	12
6	14	14%20=14	14
7	17	17%20=17	17
8	13	13%20=13	13
9	37	37%20=17	17

Linear Probing

As we can see, it may happen that the hashing technique is used to create an already used index of thearray. In such a case, we can search the next empty location in the array by looking into the next cell until we find an empty cell.This technique is called linear probing.

BasicOperations

Following are the basic primary operations of a hash table.

- **Search** –Searches an element in a hash table.
- **Insert**−inserts an element in a hash table.
- **Delete**−Deletes an element from a hash table.

Sr.No.	Key	Hash	ArrayIndex	AfterLinearProbing,ArrayIndex
1	1	1%20=1	1	1
2	2	2%20=2	2	2
3	42	42%20=2	2	3
4	4	4%20=4	4	4
5	12	12%20=12	12	12
6	14	14%20=14	14	14
7	17	17%20=17	17	17
8	13	13%20=13	13	13
9	37	37%20=17	17	18

Algorithm:

Algorithm:HashTable_Linear Probing

1.start

2.read choice for HashTable operations

3.Switch choice

        Case1:linear_prob(a,num)

        Case2:display(a)

        Case3:return

4.stop

Algorithm:linear_prob(a,num)
1. start
2. repeat until ans='y
3. 'read 4 digit number
   Find key=create(num)
   Ifa[key]=-1

         then
               a[key]=num
   otherwise
            display Ccollision C detected
            repeat until max
            ifa[i]!=-1count++
               if count=max
      then
          display(a)return
        repeat from key+1 to max
        ifa[i]=-1
           then
                 a[i]=num
                 flag=1
               repeat until key and flag=0
        ifa[i]=-1

               then   a[i]=num
               flag=1
     read choice 'y/n'
   3.stop

Algorithm:create(num)
  1.start
  2.key=num%103
  3.stop

Algorithm:display(a)
1. Start
2. Repeat until max displaya[i]
3. stop

SOLUTION-1

```
#include<stdio.h>
#defineMAX10

Void linear_prob(inta[MAX],intnum)
{
        Int flag,i,key,count;
        Char ans;
        do
        {
                flag=0;
                count=0;
                printf("\nEnter 4 digit Key:");
                scanf("%4d",&num);//readanumber
                key=num%10;//generate single digit key forgiven number if(a[key]==1)//check for
                empty entry in Hasht able

                        [key]=num;//if yes
        Else  //if entry exits  then avoid collision
                {
                        printf("\nCollision Detected...!!!\n");i=0;
                        while(i<MAX)//check for next available empty location in HT
                        {
                                if(a[i]!=-1)
                                count++;//count empty locationi n HT
                                i++;
                        }//end of while
                        if(count==MAX)//if HT is full then display HT and return
                        {
                          printf("\nHashtable is full\n");
                          display(a);//Display HT
                          return;
                }//endofif
                printf("Collision avoided successfully using LINEAR PROBING\n");
                for(i=key+1;i<MAX;i++)//if there is empty space after key in HT then make a entry in HT
                        if(a[i]==-1)
                        {
                        a[i]=num;
```

```c
                        flag=1;
                        break;
                        }//end of if
                i=0;

                while((i<key)&&(flag==0)) //check for emptys pace before key in HT then make a
    entry in HT
                {
                        if(a[i]==-1)
                        {
                                a[i]=num;
                                flag=1;
                                break;
                        }//end of ifi
                        ++;
                }//end o fwhile
        }//end of else
        printf("\nDo you wish to continue ?(y/n)");
        fpurge(stdin);
        scanf("%c",&ans);
        }
        while(ans=='y'||ans=='Y');//end of do while
}//end of linearprobe

Void display(inta[MAX]) //display the HT
{
        Int i;
        printf("\nthe hashtable is\n Key\t Value");
        for(i=0; i<MAX;i++)
                printf("%d\t%d\n",i,a[i]);
}//end of display

Void main()
    {
        Int  a[MAX],num,i,choice;
        for(i=0;i<MAX;i++)/ /initialize HTwith no entries a[i]=-1;
        while(1)
            {
                printf("Collision handling by LinearProbing");
                printf("\n1.Insert into Hashtable");
```

```
                    printf("\n2.Display Hashtable");
                    printf("\n3.Exit");
                    printf("\nEnter your Choice:");s
                    canf("%d",&choice);
                    switch(choice)
                    {
                        case1:linear_prob(a,num);
                                    break;
                        case2:display(a);
                                    break;
                         case3:return;
                        default:printf("\nInvalid Choice");
                    }//end of switch
                }//end of while
        }//end of main
```

Solution 2

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

int key[20], n, m;
int *ht, hashindex;
int elecount = 0;

void createHashTable()
{
        int i;
        ht = (int*)malloc(m*sizeof(int));
        if(ht  == NULL)
                printf("\nUnable  to create the hash table");
        else
                    for(i=0; i<m; i++)
                            ht[i] = -1;
 }


void insertIntoHashTable(int  key)
{
        hashindex = key % m;
        while(ht[hashindex]  != -1)
        {
                hashindex = (hashindex+1)%m;
```

```c
        }
        ht[hashindex] = key;
        elecount++;
 }

void displayHashTable()
{
        int i;
        if(elecount  == 0)
        {

                printf("\nHash Table is empty");
                return;
        }
        printf("\nHash Table contents are:\n\n ");
        for(i=0; i<m; i++)
                printf("\nT[%d]  --> %d ", i, ht[i]);
}
void main()
{
        int i;
     printf("\nEnter  the number of employee     records (N) :    ");

        scanf("%d",   &n);
        printf("\nEnter  the four digit    values        (K) of 'N' Employee Records:\n ");
        for(i=0; i<n;   i++)
        scanf("%d",   &key[i]);
        printf("\nEnter the two digit memory locations (m) for hash table: ");
        scanf("%d",   &m);
        createHashTable();
        printf("\nInserting   key values  of Employee records into  hash table….. ");
        for(i=0; i<n;   i++)
        {
                if(elecount  == m)
                {
                        printf("\nHash table is full. Cannot insert the %d record key value", i+1);
                        break;
                }
                insertIntoHashTable(key[i]);
        }
        displayHashTable();
}
```

Solution 3

ALGORITHM:

Step 1: Start.
Step 2: Given a File of N employee records with a set K of Keys (4-digit) which uniquely determine the records in file F.
Step 3: Assume that file F is maintained in memory by a Hash Table(HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.
Step 4: Let the keys in K and addresses in L are Integers
Step 5: Hash function H: K ®L as H(K)=K mod m (remainder method)
Step 6: Hashing as to map a given key K to the address space L, Resolve the collision (if any) is using linear probing.
Step 7: Stop.

```c
#include <stdio.h>
#include <stdlib.h>
#define MAX 100 int
create(int);
void display (int[]);
void main()
{
        int
        a[MAX],num,key,i;
        int ans=1;
        printf(" collision handling by linear probing : \n");
        for (i=0;i<MAX;i++)
        {
                a[i] = -1;
        }
        do
        {
                printf("\n Enter  the data");
                scanf("%4d", &num); key=create(num);
                linear_prob(a,key,num);
                printf("\n Do you wish to continue ? (1/0) ");
                scanf("%d",&ans);
}while(ans);
display(a);
}
```

```c
int create(int num)
{
int key;
key=num%100;
return key;

}

void linear_prob(int a[MAX], int key, int num)
{
    int flag, i, count=0;
     flag=0;
     if(a[key]== -1)
     {
         a[key] = num;
}
else
{
         printf("\nCollision Detected...!!!\n");
         i=0;
         while(i<MAX)
{
                 if (a[i]!=-1)
                 count++; i++;
         }
printf("Collision avoided successfully using LINEAR PROBING\n");
if(count == MAX)
{
         printf("\n Hash table is full");
         display(a);
         exit(1);
}
for(i=key+1; i<MAX; i++)
if(a[i] == -1)
{
         a[i] = num;
         flag =1;
         break;
}
//for(i=0;i<key;i++) i=0;
while((i<key) && (flag==0))
{
         if(a[i] == -1)
         {

                 a[i] = num;
                 flag=1;
```

```
                  break;
        }
i++;
}
}
}

void display(int a[MAX])
{
        int i,choice;
        printf("1.Display ALL\n 2.Filtered Display\n");
        scanf("%d",&choice);
        if(choice==1)
        {
            printf("\n the hash table is\n");
            for(i=0; i<MAX; i++)
            printf("\n %d %d ", i, a[i]);
        }
        else
        {

        printf("\n the hash table is\n");
        for(i=0; i<MAX; i++) if(a[i]!=-1)
        {
        printf("\n %d %d ", i, a[i]);
        continue;
}
}
}
```

OUTPUT:
collision handling by linear probing :

Enter the data: 1
 Do you wish to continue ? (1/0) 1

Enter the data: 2

 Do you wish to continue ? (1/0) 1

Enter the data: 3

 Do you wish to continue ? (1/0) 1

Enter the data: 4

Do you wish to continue ? (1/0) 1

Enter the data: 2

Collision Detected...!!!
Collision avoided successfully using LINEAR PROBING

 Do you wish to continue ? (1/0) 0 1.Display
ALL
2. Filtered Display

Enter Your Choice:2

the hash table is

```
  1    1
  2    2
  3    3
  4    4
  5    2
```
Process returned -1 (0xFFFFFFFF) execution time : 18.141 s
Press any key to continue

Content Beyond Syllabi
1. *Write a C Program to check whether two given lists are containing the same data.

```c
#include  <stdio.h>
#include <stdlib.h>
struct node
{
int num;
struct node *next;
};
void feedmember(struct node **);
int compare (struct node *, struct node *);
void release(struct node **);
int main() {
struct node *p = NULL;
struct node *q = NULL;
int result;
printf("Enter data into first list\n");
feedmember(&p);
printf("Enter data into second list\n");
feedmember(&q);
result = compare(p, q);
if (result == 1) {
printf("The 2 list are equal.\n");
}
else {
printf("The 2 lists are unequal.\n");
}
release (&p);
release (&q);
return 0;
}
int compare (struct node *p, struct node *q) {
while (p != NULL && q != NULL)
{
if (p->num != q-> num) {
return 0;
}
else
{
p = p->next;
q = q->next;
}
}
if (p != NULL || q != NULL) {
return 0;
}
else {
return 1;
```

```c
}
}
void feedmember (struct node **head)
{
int c, ch;
struct node *temp;
do {
printf("Enter number: ");
scanf("%d", &c);
temp = (struct node *)malloc(sizeof(struct node));
temp->num = c;
temp->next = *head;
*head = temp;
printf("Do you wish to continue [1/0]: ");
scanf("%d", &ch);
}while (ch != 0);
printf("\n");
}
void release (struct node **head) {
struct node *temp = *head;
while ((*head) != NULL)
{
(*head) = (*head)->next;
free(temp);
temp = *head;
}
}
```

INPUT/ OUTPUT
Enter data into first list
Enter number: 12
Do you wish to continue [1/0]: 1
Enter number: 3
Do you wish to continue [1/0]: 1
Enter number: 28
Do you wish to continue [1/0]: 1
Enter number: 9
Do you wish to continue [1/0]: 0
Enter data into second list
Enter number: 12
Do you wish to continue [1/0]: 1
Enter number: 3
Do you wish to continue [1/0]: 1
Enter number: 28
Do you wish to continue [1/0]: 1
Enter number: 9
Do you wish to continue [1/0]: 0
The 2 list are equal.

2.Write a C program to count the number of nodes in the binary search tree.

```c
#include < stdio.h >
#include < conio.h >
#include < alloc.h >
#define new_node (struct node*)malloc(sizeof (struct node))
struct node { int data; struct node *lchild;
struct node *rchild;
};
struct node *create_bin_rec();
void print_bin_pre_rec(struct node *t);
void cnt_nodes(struct node *t, int *l, int *nl);
void main()
{
struct node *root;
int leaf,nonleaf;
clrscr();
printf("\nCreate a binary tree \n");
root = create_bin_rec();
printf("\n Binary tree is ");
print_bin_pre_rec(root);
leaf = nonleaf = 0;
cnt_nodes(root,&leaf,&nonleaf);
printf("\n Total no. of leaf nodes are : %d ",leaf);
printf("\n Total no. of nonleaf nodes are : %d ",nonleaf);
printf("\n Total no. of nodes are : %d ", (leaf+nonleaf));
 } //
 main struct node *create_bin_rec()
{
int data;
struct node *t;
printf("\nData ( -1 to exit ) : ");
scanf("%d",&data);
if( data == -1) return(NULL);
 else
 {
t = new_node;
t->data = data;
 t->lchild =create_bin_rec();
```

```c
t->rchild =create_bin_rec(); return(t);
}
else
}
 create void print_bin_pre_rec(struct node *t)
{
if( t != NULL)
{
printf("%4d",t->data);
print_bin_pre_rec(t->lchild);
print_bin_pre_rec(t->rchild);
} //if
}
// print bin pre rec
void cnt_nodes(struct node *t, int *l, int *nl)
 {
 if( t != NULL)
 {
 if( t->lchild == NULL && t->rchild == NULL)
(*l)++;
else
(*nl)++;
cnt_nodes(t->lchild,l,nl);
cnt_nodes(t->rchild,l,nl);
} // if } // cnt nodes
```

output
Create binary tree
 Data (-1 to exit) 10
 Data (-1 to exit) 20
Data (-1 to exit) -1
Binary tree is 10 20
Total no. of leaf nodes are 1
Total no. of non leaf nodes are 1
Total no. of nodes are 2

VIVAQUESTIONS:

1. What is the need of data structures in programming?
2. Which are the basic data structures?
3. Differentiate between data structures and datatypes?
4. Differentiate between linear and nonlinear data structures?
5. What do you mean by pointer?
6. How to add two polynomials?
7. What is stack datastructure?
8. What is queue datastructure?
9. What are the applications of stack?
10. What are the applications of queue?
11. What is circular queue?
12. What is linked list?
13. What are the applications of linkedlist?
14. What are trees?
15. Differentiate graph and tree?
16. Differentiate binary tree and binary searchtree?
17. Types of binarytrees.
18. Differences between Static allocation and dynamic allocation.
19. Difference between malloc() and calloc()?
20. Define DataStructures
21. Difference between Stacks and Queues.
22. What is dangling pointer.
23. Define complete binarytree
24. Define array,what are the advantages and disadvantages of array.
25. What is the drawback of Queues,
26. What is drawback of Circular Queue
27. Define tree traversal
28. What is file?
29. Difference between late binding and early binding.
30. Define recursion
31. Define structure.
32. Differentiate between Structure and Union.