



**Visvesvaraya Technological University**

(State University of Government of Karnataka as per the VTU Act ,1994)

"Jnana Sangama" Belagavi – 590018 ,Karnataka ,India.



**Department of Computer Science and Engineering**

## **LABAROTARY JOURNAL**

**Name :**

**USN :**

**Semester : III**

**Subject : DATA STRUCTURES LABORATORY**

**Subject Code : BCSL305**

**Course Name : Computer Science and Engineering**

**Academic Year: 2024-25**



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## Department of Computer Science and Engineering Programme: B. Tech in CSE

### CERTIFICATE

This is to certify that Mr/Ms \_\_\_\_\_ with USN \_\_\_\_\_ studying in III semester CSE has satisfactorily completed all laboratory assignments of the course **DATA STRUCTURES LABORATORY** with course code **BCSL305** during the academic year 2024 - 2025.

Faculty in-charge  
Prof. Megha S. Kulkarni

Chairperson

Name of the examiner

1. \_\_\_\_\_
2. \_\_\_\_\_

Signature of the examiner with date

\_\_\_\_\_  
\_\_\_\_\_

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2	<p>Develop a Program in C for the following operations on Strings.</p> <p>a. Read a main String (STR), a Pattern String (PAT) and a Replace String (REP)</p> <p>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.</p>		
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9	<p>Develop a Program in C for the following operations on Singly Circular Linked List (SCLL) with header nodes</p> <ol style="list-style-type: none"> <li>Represent and Evaluate a Polynomial <math>P(x,y,z) = 6x^2y^2z - 4yz^5 + 3x^3yz + 2xy^5z - 2xyz^3</math></li> <li>Find the sum of two polynomials <math>POLY1(x,y,z)</math> and <math>POLY2(x,y,z)</math> and store the result in <math>POLYSUM(x,y,z)</math>. Support the program with appropriate functions for each of the above operations</li> </ol>		
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11	<p>Develop a Program in C for the following operations on Graph(G) of Cities</p> <ol style="list-style-type: none"> <li>Create a Graph of N cities using Adjacency Matrix.</li> <li>Print all the nodes reachable from a given starting node in a digraph using DFS/BFS method</li> </ol>		
12	<p>Given a File of N employee records with a set K of Keys (4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT. Let the keys in K and addresses in L are Integers. Develop a Program in C that uses Hash function <math>H: K \rightarrow L</math> as <math>H(K) = K \bmod m</math> (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</p>		

1. Develop a Program in C for the following:
  - A. Declare a calendar as an array of 7 elements (A dynamically Created array) to represent 7 days of a week. Each Element of the array is a structure having three fields. The first field is the name of the Day (A dynamically allocated String), the second field is the date of the Day (A integer), the third field is the description of the activity for a particular day (A dynamically allocated String).
  - B. Write functions create(), read() and display(); to create the calendar, to read the data from the keyboard and to print weeks activity details report on screen.

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

#define NUM_DAYS_IN_WEEK 7
// Structure to represent a day
typedef struct
{
    char *acDayName;
    int iDate;
    char *acActivity;
} DAYTYPE;
void fnFreeCal (DAYTYPE *);
void fnDispCal (DAYTYPE *);
void fnReadCal (DAYTYPE *);
DAYTYPE *fnCreateCal();

int main()
{
    // Create the calendar
    DAYTYPE *weeklyCalendar = fnCreateCal();
    // Read data from the keyboard
    fnReadCal (weeklyCalendar);
    //display the week activity details
    fnDispCal(weeklyCalendar);
    // Free allocated memory
    fnFreeCal (weeklyCalendar);
    return 0;
}
DAYTYPE *fnCreateCal ()
{
    DAYTYPE *calendar = (DAYTYPE *)malloc( NUM_DAYS_IN_WEEK *sizeof(DAYTYPE));
    for (int i = 0; i < NUM_DAYS_IN_WEEK; i++)
    {
        calendar[i].acDayName = NULL;
        calendar[i].iDate = 0;
        calendar[i].acActivity = NULL;
    }
    return calendar;
}
```

```
void fnReadCal (DAYTYPE *calendar)
{
char cChoice;
for (int i = 0; i < NUM_DAYS_IN_WEEK; i++)
{
printf("Do you want to enter details for day %d [Y/N]: ", i + 1);
scanf("%c", &cChoice);
getchar();
if (tolower(cChoice) == 'n')
continue;
printf("Day Name: ");
char nameBuffer[50];
scanf("%s", &nameBuffer);
calendar[i].acDayName = strdup (nameBuffer); // Dynamically allocate and copy the string
printf("Date: ");
scanf("%d", &calendar[i].iDate);
printf("Activity: ");
char activityBuffer[100];
scanf("%S", &activityBuffer); // Read the entire line including spaces
calendar[i].acActivity = strdup (activityBuffer);
printf("\n");
getchar(); //remove trailing enter character in input buffer
}
}

void fnDispCal (DAYTYPE *calendar)
{
printf("\nWeek's Activity Details:\n");
for (int i = 0; i < NUM_DAYS_IN_WEEK; i++)
{
printf("Day %d:\n", i + 1);
if (calendar[i].iDate == 0)
{
printf("No Activity\n\n");
continue;
}
printf(" Day Name: %s\n", calendar[i].acDayName);
printf(" Date: %d\n", calendar [i].iDate);
printf(" Activity: %s\n\n", calendar[i].acActivity);
}
}

void fnFreeCal (DAYTYPE *calendar)
{
for(int i = 0; i < NUM_DAYS_IN_WEEK; i++)
{
free (calendar[i].acDayName);
free (calendar[i].acActivity);
}
free(calendar);
}
```

**OUT PUT:**

Do you want to enter details for day 1 [Y/N]: y Day Name: sunday Date: 11 Activity: sports Do you want to enter details for day 2 [Y/N]: y Day Name: monday Date: 12 Activity: International conference Do you want to enter details for day 3 [Y/N]: Day Name: Date: n Activity: Do you want to enter details for day 4 [Y/N]: n Do you want to enter details for day 5 [Y/N]: n Do you want to enter details for day 6 [Y/N]: n Do you want to enter details for day 7 [Y/N]: n Week's Activity Details: Day 1:	Day Name: Sunday Date: 11 Activity: s Day 2: Day Name: Monday Date: 12 Activity: I Day 3: No Activity Day 4: No Activity Day 5: No Activity Day 6: No Activity Day 7: No Activity
---	---

**2. Develop a Program in C for the following operations on Strings.**

- A. Read a main String (STR), a Pattern String (PAT) and a Replace String (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.**

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
int main()
{
    char acMainStr[200], acSrchStr[30], acRepStr[30], acResStr[200], acCopyStr[200];
    int i=0, j=0, k=0, l, iMtchCnt, iStop, len, iNumOfMatch=0;

    printf("\nEnter the main string :\n");
    scanf(" %[^\\n]", acMainStr);

    printf("\nEnter the Pattern string :\n");
    scanf(" %[^\\n]", acSrchStr);
    printf("\nEnter the Replace string :\n");
    scanf(" %[^\\n]", acRepStr);
    strcpy(acCopyStr, acMainStr);
    for(i=0; i<(strlen(acMainStr)-strlen(acSrchStr)+1); i++)
    {
        iMtchCnt = 0;
        for(j=0; j<strlen(acSrchStr); j++)
        {
            if(acMainStr[i+j] == acSrchStr[j])
            {
                iMtchCnt++;
            }
            else
            {
                break;
            }
        }
        if(iMtchCnt == strlen(acSrchStr)) //Check if number of character matches equals length of
pattern string
        {
            iNumOfMatch++; //update number of total matches by 1
            for(k=0; k<i; k++)
            {
                acResStr[k] = acMainStr[k]; //copy till the ith character where the match occurred
            }
            iStop = k + strlen(acSrchStr); //point from where rest of the original string has to be copied
            acResStr[k] = '\\0';
            strcat(acResStr, acRepStr); // append the replacement string
            len = strlen(acResStr);
            for(k=iStop, l=0; acMainStr[k] != '\\0'; k++, l++) //copy rest of original string
```



```
        {
            acResStr[len+1] = acMainStr[k];
        }
        acResStr[len+1] = '\0';
        strcpy(acMainStr,acResStr);
    }
}
printf("\nInput Text :\n");
printf("%s\n",acCopyStr);
if(iNumOfMatch > 0)
{
    printf("\n%d matches occurred\n\nText after replacing matched patterns is shown below\n",
iNumOfMatch);
    printf("\n%s\n",acResStr);
}
else
{
    printf("\nPattern String not found in Text\n");
}
return 0;
}
```

**OUT PUT:**

Enter the main string :  
Abaaab  
Enter the Pattern string :  
ab  
Enter the Replace string :  
ba  
Input Text :  
abaaab  
2 matches occurred  
Text after replacing matched patterns is shown below  
baaaba

**3. Develop a menu driven Program in C for the following operations on STACK of Integers (Array Implementation of Stack with maximum size MAX)**

- a. Push an Element on to 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**

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

#define MAX 4

bool fnStkFull(int);
bool fnStkEmpty(int);
void fnPush(int [], int, int*);
int fnPop(int [], int*);
void fnDisplay(int[], int);
int fnPeek(int [], int);
bool fnChkPalindrome(int);

int main(void)
{
    int stkArray[MAX];
    int top = -1;
    int iElem, iChoice;
    for(;;)
    {
        printf("\nSTACK OPERATIONS\n");
        printf("=====");
        printf("\n 1.Push\n 2.Pop\n 3.Display\n 4.Peek\n 5.CheckPalindrome\n\n");
        printf("6.DemonstrateOverflow\n 7.Demonstrate Underflow\n 8.EXIT\n");
        printf("Enter your choice\n");
        scanf("%d",&iChoice);
        switch(iChoice)
        {
            case 1: if(!fnStkFull(top))
            {
                printf("\nEnter element to be pushed onto the stack\n");
                scanf("%d", &iElem);
                fnPush(stkArray, iElem, &top);
            }
            else
            {
                printf("\nStack Overflow\n");
            }
        }
        break;
    }
}
```

```
        case 2: if(!fnStkEmpty(top))
        {
            iElem = fnPop(stkArray, &top);
            printf("\nPopped Element is %d\n", iElem);
        }
        else
        {
            printf("\nStack Underflow\n");
        }
        break;

        case 3: if(fnStkEmpty(top))
        {
            printf("\nStack Empty\n");
        }
        else
        {
            fnDisplay(stkArray, top);
        }

            break;

        case 4: if(!fnStkEmpty(top))
            {
                iElem = fnPeek(stkArray, top);
                printf("\nElement at the top of the stack is %d\n", iElem);
            }
            else
                printf("\nEmpty Stack\n");
            break;

        case 5: printf("\nEnter number to be checked for a palindrome : ");
        scanf("%d", &iElem);
        if(fnChkPalindrome(iElem))
        {
            printf("\n%d is a palindrome\n", iElem);
        }
        else
        {
            printf("\n%d is not a palindrome\n", iElem);
        }
        break;

        case 6: if(!fnStkFull(top))
            printf("\nThere are currently %d elements in Stack\nPush %d elemnts for Stack to overflow",
top+1, MAX - (top+1));
            while(!fnStkFull(top))
            {
                printf("\nEnter an element : ");
                scanf("%d", &iElem);
```

```
    fnPush(stkArray, iElem, &top);
}
printf("\nStack Overflow cannot push elements onto the stack\n");
break;

    case 7: if(!fnStkEmpty(top))
        printf("\nThere are currently %d elements in Stack\nPop out %d elemnts for Stack to Underflow",
top+1, MAX - (top+1));
        while(!fnStkEmpty(top))
        {
            iElem = fnPop(stkArray, &top);
            printf("\nPopped Element is %d\n", iElem);
        }
        printf("\nStack Underflow cannot pop elements from the stack\n");
        break;

    case 8: exit(1);

        default: printf("\nWrong choice\n");
    }
}
return 0;
}

bool fnStkFull(int t)
{
    return ((t == MAX-1) ? true : false);
}

bool fnStkEmpty(int t)
{
    return ((t == -1) ? true : false);
}

void fnPush(int stk[], int iElem, int *t)
{
    *t = *t + 1;
    stk[*t] = iElem;
}

int fnPop(int stk[], int *t)
{
    int iElem;
    iElem = stk[*t];
    *t = *t - 1;

    return iElem;
}
```

```
void fnDisplay(int stk[], int t)
{
    int i;

    printf("\nStack Contents are: \n");
    for(i = t ; i > -1; --i)
    {
        printf("\t%d\n", stk[i]);
    }
    printf("Stack has %d elements\n", t+1);
}
```

```
int fnPeek(int stk[], int t)
{
    return stk[t];
}
```

```
bool fnChkPalindrome(int iVal)
{
    int palStk[10];
    int t = -1, iDig, iRev = 0;

    int iCopy = iVal;

    while(iCopy != 0)
    {
        iDig = iCopy % 10;
        fnPush(palStk, iDig, &t);
        iCopy /= 10;
    }
    int p = 0;
    while(p <= t)
    {
        iDig = palStk[p];
        iRev = iRev * 10 + iDig;
        p++;
    }
    if(iRev == iVal)
        return true;
    else
        return false;
}
```

**OUT PUT:****STACK OPERATIONS**

=====

- 1.Push
- 2.Pop
- 3.Display
- 4.Peek
- 5.CheckPalindrome
- 6.DemonstarteOverflow
- 7.Demonstarte Underflow
- 8.EXIT

Enter your choice

1

Enter element to be pushed onto the stack

8

**STACK OPERATIONS**

=====

- 1.Push
- 2.Pop
- 3.Display
- 4.Peek
- 5.CheckPalindrome
- 6.DemonstarteOverflow
- 7.Demonstarte Underflow
- 8.EXIT

Enter your choice

3

Stack Contents are:

8

Stack has 1 elements

**STACK OPERATIONS**

=====

- 1.Push
- 2.Pop
- 3.Display
- 4.Peek
- 5.CheckPalindrome
- 6.DemonstarteOverflow
- 7.Demonstarte Underflow
- 8.EXIT

Enter your choice

1

Enter element to be pushed onto the stack

6

**STACK OPERATIONS**

=====

- 1.Push
- 2.Pop
- 3.Display
- 4.Peek
- 5.CheckPalindrome

- 6.DemonstarteOverflow
- 7.Demonstarte Underflow
- 8.EXIT

Enter your choice

5

Enter number to be checked for a palindrome :

1331

1331 is a palindrome

**STACK OPERATIONS**

=====

- 1.Push
- 2.Pop
- 3.Display
- 4.Peek
- 5.CheckPalindrome
- 6.DemonstarteOverflow
- 7.Demonstarte Underflow
- 8.EXIT

Enter your choice

2

Popped Element is 6

**STACK OPERATIONS**

=====

- 1.Push
- 2.Pop
- 3.Display
- 4.Peek
- 5.CheckPalindrome
- 6.DemonstarteOverflow
- 7.Demonstarte Underflow
- 8.EXIT

Enter your choice

**4. Develop 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.**

```
#include <stdio.h>
#include <ctype.h>
#include <stdlib.h>
#include <string.h>
#define STK_SIZE 10
void fnPush(char [], int*, char);
char fnPop(char [], int*);
int fnPreced(char);
int main()
{
    int i, j=0;
    char acExpr[50], acStack[50], acPost[50], cSymb;
    int top = -1;
    printf("\nEnter a valid infix expression : \n");
    scanf("%s", acExpr);
    fnPush(acStack, &top, '#');
    for(i=0;acExpr[i]!='\0'; ++i)
    {
        cSymb = acExpr[i];
        if(isalnum(cSymb))
        {
            acPost[j++] = cSymb;
        }
        else if(cSymb == '(')
        {
            fnPush(acStack, &top, cSymb);
        }
        else if(cSymb == ')')
        {
            while(acStack[top] != '(')
            {
                acPost[j++] = fnPop(acStack, &top);
            }
            fnPop(acStack, &top);
        }
        else
        {
            while(fnPreced(acStack[top]) >= fnPreced(cSymb))
            {
                if((cSymb == '^') && (acStack[top] == '^'))
                    break;
                acPost[j++] = fnPop(acStack, &top);
            }
            fnPush(acStack, &top, cSymb);
        }
    }
}
```

```
}
}
while(acStack[top] != '#')
{
acPost[j++] = fnPop(acStack, &top);
}
acPost[j] = '\0';
printf("\nInfix Expression is :%s\n", acExpr);
printf("\nPostfix Expression is :%s\n", acPost);
return 0;
}
void fnPush(char Stack[], int *t , char elem)
{
*t = *t + 1;
Stack[*t] = elem;
}
char fnPop(char Stack[], int *t)
{
char elem;
elem = Stack[*t];
*t = *t -1;

return elem;
}
int fnPrecd(char ch)
{
int iPrecdVal;
switch(ch)
{
case '#': iPrecdVal = -1; break;
case '(': iPrecdVal = 0; break;
case '+':
case '-': iPrecdVal = 1; break;
case '%':
case '*':
case '/': iPrecdVal = 2; break;
case '^': iPrecdVal = 3; break;
}
return iPrecdVal;
}
```

**OUT PUT:**

Enter a valid infix expression :

A\*(B+D)/E-F\*(G+H/K)

Infix Expression is : A\*(B+D)/E-F\*(G+H/K)

Postfix Expression is : ABD+\*E/FGHK/+\*-



**5. Develop a Program in C for the following Stack Applications****a. Evaluation of Suffix expression with single digit operands and operators: +, -, \*, /, %, ^**

```
#include <stdio.h>
void push(int [], int*, int);
int pop(int [], int*);
int main()
{
    int iastack[50], i, op1, op2, res;
    char expr[50], symb;
    int top = -1;
    printf("\nEnter a valid postfix expression : \n");
    scanf("%s", expr);
    for(i=0; i<strlen(expr); i++)
    { symb = expr[i];
      if(isdigit(symb))
      {
          push(iastack, &top, symb-'0');
      }
      else
      {
          op2 = pop(iastack, &top);
          op1 = pop(iastack, &top);
          switch(symb)
          { case '+': res = op1 + op2;
            break;
            case '-': res = op1 - op2;
            break;
            case '*': res = op1 * op2;
            break;
            case '/': res = op1 / op2;
            break;
            case '%': res = op1 % op2;
            break;
            case '^': res = (int)pow(op1 , op2);
            break;
          }
          push(iastack, &top, res);
      }
      res = pop(iastack, &top);
      printf("\nValue of %s expression is : %d\n", expr, res);
      return 0;
    }
    void push(int Stack[], int *t , int elem)
    {
        *t = *t + 1;
        Stack[*t] = elem;
    }
```

```
int pop(int Stack[], int *t)
{
    int elem;
    elem = Stack[*t];
    *t = *t - 1;
    return elem;
}
```

**OUT PUT:**

Enter a valid postfix expression :

456565+-/\*()

Value of 456565+-/\*() expression is : -5

**5. Develop a Program in C for the following Stack Applications**  
**b. Solving Tower of Hanoi problem with n disks**

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

**OUT PUT:**

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

**6. Develop 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 on to 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.**

```
#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>
#define SIZE 5
void insert(char [], int*, int*, char);
char del(char[], int*, int*);
void display(char [], int, int);
bool qfull(int, int);
bool qempty(int, int);
int main()
{
    char q[SIZE];
    int f = -1, r = -1;
    int ch;
    char elem;
    for(;;)
    {
        printf("\nQueue Operations\n");
        printf("=====");
        printf("\n1.Qinsert\n2.Qdelete\n3.Qdisplay\n4.Exit\n");
        printf("Enter your choice\n");
        scanf("%d",&ch);
        getchar();
        switch(ch)
        {
            case 1: if(!qfull(f,r))
            {
                printf("\nEnter an element : ");
                scanf("%c", &elem);
                insert(q, &f, &r, elem);
            }
            else
            {
                printf("\nQueue is Full\n");
            }
            break;

            case 2: if(!qempty(f, r))
            {
```

```
elem = del(q, &f, &r);
printf("\nDeleted element is %c\n", elem);
}
else
{
printf("\nQueue is Empty\n");
}
break;
case 3: if(!qempty(f, r))
{
printf("\nContents of the Queue is \n");
display(q, f, r);
}
else
{
printf("\nQueue is Empty\n");
}
break;
case 4: exit(0);
default: printf("\nInvalid choice\n");
break;
}
}
return 0;
}
bool qfull(int fr, int rr)
{
if((rr+1) % SIZE == fr)
return true;
else
return false;
}
bool qempty(int fr, int rr)
{
if(fr == -1)
return true;
else
return false;
}
void insert(char queue[], int *f, int *r, char val)
{
if(*r == -1)
{
*f = *f + 1;

*r = *r + 1;
}
else
*r = (*r + 1)%SIZE;
```

```
queue[*r] = val;
}
char del(char queue[], int *f, int *r)
{
char el;
el = queue[*f];
if(*f == *r)
{
*f = -1;
*r = -1;
}
else
{
*f = (*f + 1)%SIZE;
}
return el;
}
void display(char queue[], int fr, int rr)
{
int i;
if(fr<=rr)
{
for(i=fr; i<=rr; i++)
{
printf("%c\t", queue[i]);
}
printf("\n");
}
else
{
for(i=fr; i<=SIZE-1; i++)
{
printf("%c\t", queue[i]);
}
for(i=0; i<=rr; i++)
{
printf("%c\t", queue[i]);
}
printf("\n");
}
}
```

**OUT PUT:**

Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 1 Enter an element : 5 Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 1 Enter an element : 15 Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice Invalid choice Queue Operations =====	1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 1 Enter an element : 85 Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice Invalid choice Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 3 Contents of the Queue is 5    1    8 Queue Operations ===== 1.Qinsert
2.Qdelete 3.Qdisplay 4.Exit Enter your choice 2 Deleted element is 5 Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 3 Contents of the Queue is 1    8 Queue Operations =====	Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 2 Deleted element is 8 Queue Operations ===== 1.Qinsert 2.Qdelete 3.Qdisplay 4.Exit Enter your choice 3 Queue is Empty

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

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
struct node
{
char usn[11], name[40], prog[4];
int sem;
char ph[11];
struct node *link;
};
typedef struct node* PTR;
PTR get(void);
void freeN(PTR);
PTR insrear(PTR);
PTR delfront(PTR);
PTR insfront(PTR);
PTR delrear(PTR);
void disp(PTR);
int main()
{
PTR first = NULL;
int ch, num, i;
printf("\nEnter the number of Students N : ");
scanf("%d", &num);
for(i=0;i<num;i++)
{
printf("\nEnter Data for Node %d :\n", i+1);
first = insfront(first);
}
for(;;)
{
printf("\nQUEUE OPERATIONS\n");
printf("=====");
printf("\n1.Insert Front\n2.Insert Rear\n3.Delete Front\n4.Delete Rear\n5.Display\n6.Exit\n");
printf("\nEnter your choice\n");
scanf("%d",&ch);

switch(ch)
{
case 1: first = insfront(first);
```



```
break;
case 2: first = insrear(first);
break;
case 3: first = delfront(first);
break;
case 4: first = delrear(first);
break;
case 5: disp(first);
break;
case 6: exit(0);
}
}
return 0;
}
PTR get()
{
PTR newborn;
newborn = (PTR)malloc(sizeof(struct node));
if(newborn == NULL)
{
printf("\nMemory Overflow");
exit(0);
}
printf("\nEnter USN : ");
scanf("%s",newborn->usn);
printf("\nEnter name : ");
scanf("%s",newborn->name);
printf("\nEnter Program name : ");
scanf("%s", newborn->prog);
printf("\nEnter semester : ");
scanf("%d",&newborn->sem);
printf("\nEnter Phone no : ");
scanf("%s",newborn->ph);
return newborn;
}
void freeN(PTR x)
{
free(x);
}

PTR insrear(PTR first)
{
PTR temp,cur;
temp = get();
temp->link = NULL;
if(first == NULL)
return temp;
cur = first;
while(cur->link != NULL)
```

```
{
cur = cur->link;
}
cur->link = temp;
return first;
}
PTR delfront(PTR first)
{
PTR temp;
if(first == NULL)
{
printf("\nSLL is empty cannot delete\n");
return first;
}
temp = first;
first = first->link;
printf("\nNode deleted is %s\n",temp->name);
freeN(temp);
return first;
}
void disp(PTR first)
{
PTR curr;
int count = 0;
if(first == NULL)
{
printf("\nSLL is empty\n");
return;
}
printf("\nThe contents of SLL are :\n");
curr = first;
printf("\nUSN\t\tName\tProgram\tSem\tPhone num");
while(curr != NULL)
{
printf("\n%10s\t%s\t%s\t%d\t%s",curr->usn, curr->name, curr->prog, curr->sem, curr->ph);

curr = curr->link;
count++;
}
printf("\n\nSLL has %d nodes\n", count);
}
PTR insfront(PTR first)
{
PTR temp;
temp = get();
temp->link = NULL;
temp->link = first;
first = temp;
return first;
}
```

```

}
PTR delrear(PTR first)
{
PTR cur, prev;
if(first == NULL)
{
printf("\nSLL is empty cannot delete\n");
return first;
}
prev = NULL;
cur = first;
if(cur->link == NULL)
{
printf("\nNode deleted for %s\n",cur->name);
freeN(cur);
return NULL;
}
while(cur->link != NULL)
{
prev = cur;
cur = cur->link;
}
prev->link = cur->link;
printf("\nNode deleted for %s\n",cur->name);
freeN(cur);
return first;
}

```

**OUT PUT:**

Enter the number of Students N : 3  
 Enter Data for Node 1 :  
 Enter USN : 2VX22CB1  
 Enter name : ABCD  
 Enter Program name : CSBS  
 Enter semester : 3  
 Enter Phone no : 231456  
 Enter Data for Node 2 :  
 Enter USN : 2VX22CB2  
 Enter name : LKJH  
 Enter Program name : CSBS  
 Enter semester : 3  
 Enter Phone no : 861547  
 Enter Data for Node 3 :  
 Enter USN : XYZ  
 Enter name : SDFG  
 Enter Program name : CSBS  
 Enter semester : 3  
 Enter Phone no : 723549  
 QUEUE OPERATIONS

=====

5.Display  
 6.Exit  
 Enter your choice  
 5  
 The contents of SLL are :  

USN	Name	Program	Sem	Phone num
XYZ	SDFG	CSBS	3	723549
2VX22CB2	LKJH	CSBS	3	861547
2VX22CB1	ABCD	CSBS	3	231456

 SLL has 3 nodes  
 QUEUE OPERATIONS  
 =====  
 1.Insert Front  
 2.Insert Rear  
 3.Delete Front  
 4.Delete Rear  
 5.Display  
 6.Exit  
 Enter your choice  
 3  
 Node deleted is SDFG

1.Insert Front 2.Insert Rear 3.Delete Front 4.Delete Rear	
Node deleted for ABCD QUEUE OPERATIONS =====	Enter your choice 1 Enter USN : 2VXCB6 Enter name : MNOP Enter Program name : CSBS Enter semester : 3 Enter Phone no : 921437 QUEUE OPERATIONS =====
1.Insert Front 2.Insert Rear 3.Delete Front 4.Delete Rear 5.Display 6.Exit Enter your choice 5 The contents of SLL are : USN      Name    Program Sem    Phone num 2VX22CB2    LKJH    CSBS    3    861547 SLL has 1 nodes  QUEUE OPERATIONS =====	1.Insert Front 2.Insert Rear 3.Delete Front 4.Delete Rear 5.Display 6.Exit Enter your choice 5 The contents of SLL are : USN      Name    Program Sem    Phone num 2VX22CB6    MNOP    CSBS    3    921437 2VX22CB2    LKJH    CSBS    3    861547 SLL has 2 nodes  QUEUE OPERATIONS =====
1.Insert Front 2.Insert Rear 3.Delete Front 4.Delete Rear 5.Display 6.Exit QUEUE OPERATIONS =====	1.Insert Front 2.Insert Rear 3.Delete Front 4.Delete Rear 5.Display 6.Exit
1.Insert Front 2.Insert Rear 3.Delete Front 4.Delete Rear 5.Display 6.Exit Enter your choice 2 Enter USN : 2VX22CB5 Enter name : GHIJK Enter Program name : CSBS Enter semester : 3 Enter Phone no : 618534 Enter your choice	

**8. Develop 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**

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
struct node
{
int usn;
char name[30], dept[4], desig[30], ph[11];
int sal;
struct node *plink;
struct node *nlink;
};
typedef struct node* NODE;
NODE getn(void);
void freen(NODE);
NODE insrear(NODE);
NODE delfront(NODE);
NODE insfront(NODE);
NODE delrear(NODE);
void disp(NODE);
int main()
{
NODE first = NULL;
int ch, num, i;
printf("\nEnter the number of Employees N : "); scanf("%d", &num);
for(i=0;i<num;i++)
{
printf("\nEnter Data for Node %d :\n", i+1);
first = insrear(first);
}
for(;;)
{
printf("\nDLL OPERATIONS\n");
printf("=====");

printf("\n1.Insert Rear\n2.Delete Front\n3.Insert Front\n4.Delete Rear\n5.Display\n6.Exit\n");
printf("\nEnter your choice\n");
scanf("%d",&ch);
switch(ch)
{
case 1: first = insrear(first);
```

```
break;
case 2: first = delfront(first);
break;
case 3: first = insfront(first);
break;
case 4: first = delrear(first);
break;
case 5: disp(first);
break;
case 6: exit(0);
}
}
return 0;
}
NODE getn()
{
NODE newborn;
newborn = (NODE)malloc(sizeof(struct node));
if(newborn == NULL)
{
printf("\nMemory Overflow");
exit(0);
}
printf("\nEnter SSN : ");
scanf("%d",&newborn->usn);
printf("\nEnter name : ");
scanf("%s",newborn->name);
printf("\nEnter Department : ");
scanf("%s", newborn->dept);
printf("\nEnter Designation : ");
scanf("%s", newborn->desig);
printf("\nEnter Salary : ");
scanf("%d",&newborn->sal);
printf("\nEnter Phone no : ");
scanf("%s",newborn->ph);
return newborn;
}

void freen(NODE x)
{
free(x);
}
NODE insrear(NODE first)
{
NODE temp,cur;
temp = getn();
temp->plink = temp->nlink = NULL;
if(first == NULL)
return temp;
```

```
cur = first;
while(cur->nlink != NULL)
{
    cur = cur->nlink;
}
cur->nlink = temp;
temp->plink = cur;
return first;
}
NODE insfront(NODE first)
{
    NODE temp;
    temp = getn();
    temp->plink = temp->nlink = NULL;
    temp->nlink = first;
    first = temp;
    return first;
}
NODE delrear(NODE first)
{
    NODE cur, prev;
    if(first == NULL)
    {
        printf("\nDLL is empty\n");
        return first;
    }

    cur = first;
    if(cur->nlink == NULL)
    {
        printf("\nNode deleted for %s\n",cur->name);
        free(cur);
        return NULL;
    }
    while(cur->nlink != NULL)
    {
        cur = cur->nlink;
    }
    prev = cur->plink;
    prev->nlink = NULL;
    printf("\nNode deleted for %s\n",cur->name);
    free(cur);
    return first;
}
NODE delfront(NODE first)
{
    NODE temp;
    if(first == NULL)
    {
```

```
printf("\nDLL is empty\n");
return first;
}
if(first->nlink == NULL)
{
printf("\nNode deleted for %s\n",first->name);
freen(first);
return NULL;
}
temp = first;
first = first->nlink;
first->plink = NULL;
printf("\nNode deleted for %s\n",temp->name);
freen(temp);
return first;
}
```

```
void disp(NODE first)
{
NODE curr;
int count = 0;
if(first == NULL)
{
printf("\nDLL is empty\n");
return;
}
printf("\nThe contents of DLL are :\n");
curr = first;
printf("\nSSN\tName\tDept\tDesignation\tSalary\t\tPhone No");
while(curr != NULL)
{
printf("\n%-5d\t%s\t%s\t%s\t%-7d\t%-11s",curr->usn, curr->name, curr->dept, curr->desig,
curr->sal, curr->ph);
curr = curr->nlink;
count++;
}
printf("\n\nDLL has %d nodes\n", count);
}
```



**OUT PUT:**

<div>Enter the number of Employees N : 1</div> <div>Enter Data for Node 1 :</div> <div>Enter SSN : 125</div> <div>Enter name : sky</div> <div>Enter Department : cse</div> <div>Enter Designation : aim</div> <div>Enter Salary : 50000</div> <div>Enter Phone no : 68252</div> <div>DLL OPERATIONS</div> <div>=====</div> <div>1.Insert Rear</div> <div>2.Delete Front</div> <div>3.Insert Front</div> <div>4.Delete Rear</div> <div>5.Display</div> <div>6.Exit</div> <div>Enter your choice</div> <div>5</div> <div>The contents of DLL are :</div> <table><tr><th>SSN</th><th>Name</th><th>Dept</th><th>Designation</th><th>Salary</th></tr><tr><td></td><td></td><td></td><td>Phone No</td><td></td></tr><tr><td>125</td><td>sky</td><td>cse</td><td>aim</td><td>50000</td></tr><tr><td></td><td></td><td></td><td>68252</td><td></td></tr><tr><td>126</td><td>jkl</td><td>cse</td><td>aim</td><td>80000</td></tr><tr><td></td><td></td><td></td><td>5689652</td><td></td></tr></table> <div>DLL has 2 nodes</div> <div>DLL OPERATIONS</div> <div>=====</div> <div>1.Insert Rear</div> <div>2.Delete Front</div> <div>3.Insert Front</div> <div>4.Delete Rear</div> <div>5.Display</div> <div>6.Exit</div> <div>Enter your choice</div> <div>1</div>	SSN	Name	Dept	Designation	Salary				Phone No		125	sky	cse	aim	50000				68252		126	jkl	cse	aim	80000				5689652		
SSN	Name	Dept	Designation	Salary																											
			Phone No																												
125	sky	cse	aim	50000																											
			68252																												
126	jkl	cse	aim	80000																											
			5689652																												
<div>Enter your choice</div> <div>5</div> <div>The contents of DLL are :</div> <table><tr><th>SSN</th><th>Name</th><th>Dept</th><th>Designation</th><th>Salary</th></tr><tr><td></td><td></td><td></td><td>Phone No</td><td></td></tr><tr><td>126</td><td>jkl</td><td>cse</td><td>aim</td><td>80000</td></tr><tr><td></td><td></td><td></td><td>5689652</td><td></td></tr><tr><td>678</td><td>asd</td><td>cse</td><td>aim</td><td>54000</td></tr><tr><td></td><td></td><td></td><td>485658</td><td></td></tr></table> <div>DLL has 2 nodes</div> <div>DLL OPERATIONS</div> <div>=====</div> <div>1.Insert Rear</div> <div>2.Delete Front</div> <div>3.Insert Front</div> <div>4.Delete Rear</div> <div>5.Display</div> <div>6.Exit</div>	SSN	Name	Dept	Designation	Salary				Phone No		126	jkl	cse	aim	80000				5689652		678	asd	cse	aim	54000				485658		<div>Enter SSN : 678</div> <div>Enter name : asd</div> <div>Enter Department : cse</div> <div>Enter Designation : aim</div> <div>Enter Salary : 54000</div> <div>Enter Phone no : 485658</div> <div>DLL OPERATIONS</div> <div>=====</div> <div>1.Insert Rear</div> <div>2.Delete Front</div> <div>3.Insert Front</div> <div>4.Delete Rear</div> <div>5.Display</div> <div>6.Exit</div> <div>Enter your choice</div> <div>2</div> <div>Node deleted for sky</div> <div>DLL OPERATIONS</div>
SSN	Name	Dept	Designation	Salary																											
			Phone No																												
126	jkl	cse	aim	80000																											
			5689652																												
678	asd	cse	aim	54000																											
			485658																												

Enter your choice

4

Node deleted for asd

DLL OPERATIONS

=====

1.Insert Rear

2.Delete Front

3.Insert Front

4.Delete Rear

5.Display

6.Exit

=====

1.Insert Rear

2.Delete Front

3.Insert Front

4.Delete Rear

5.Display

6.Exit

Enter your choice

5

The contents of DLL are :

SSN	Name	Dept	Designation	Salary	Phone No
126	jkl	cse	aim	80000	5689652

DLL has 1 nodes

DLL OPERATIONS

=====

1.Insert Rear

2.Delete Front

3.Insert Front

4.Delete Rear

5.Display

6.Exit

Enter your choice

3

Enter SSN : 485

Enter name : xuv

Enter Department : cse

Enter Designation : aim

Enter Salary : 78000

Enter Phone no : 461655

DLL OPERATIONS

=====

1.Insert Rear

2.Delete Front

3.Insert Front

4.Delete Rear

5.Display

6.Exit

Enter your choice

5

The contents of DLL are :

SSN	Name	Dept	Designation	Salary	Phone No
485	xuv	cse	aim	78000	461655
126	jkl	cse	aim	80000	5689652

DLL has 2 nodes

**9. Develop a Program in C for the following operations on Singly Circular Linked List (SCLL) with header nodes****a. Represent and Evaluate a Polynomial**

$$P(x,y,z) = 6x^2y^2z - 4yz^5 + 3x^3yz + 2xy^5z - 2xyz^3$$

**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**

```
#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>
#include <math.h>
struct polyt
{
    int cf,px, py,pz;
    struct polyt* next;
};
typedef struct polyt* PTR;
PTR insert(PTR poly, int cf, int px, int py, int pz)
{
    PTR cur;
    PTR nn = (PTR)malloc(sizeof(struct polyt));
    nn->cf = cf;
    nn->px = px;
    nn->py = py;
    nn->pz = pz;
    nn->next = NULL;
    cur = poly;
    while(cur->next != poly)
    {
        cur = cur->next;
    }
    cur->next = nn;
    nn->next = poly;
    return poly;
}

void disp(PTR poly)
{
    if (poly->next == poly)
    {
        printf("Polynomial is empty.\n");
        return;
    }
    PTR cur = poly->next;
    do
    {
        printf("%dx^%dy^%dz^%d ", cur->cf, cur->px, cur->py, cur->pz);
```

```
cur = cur->next;
if (cur != poly)
{
printf("+ ");
}
} while (cur != poly);
printf("\n");
}
int evaluate(PTR poly, int x, int y, int z)
{
int result = 0;
if (poly->next == poly)
{
return result;
}
PTR cur = poly->next;
do
{
int termValue = cur->cf;
termValue *= pow(x, cur->px);
termValue *= pow(y, cur->py);
termValue *= pow(z, cur->pz);
result += termValue;
cur = cur->next;
} while (cur != poly);
return result;
}

bool fmatch(PTR p1, PTR p2)
{
bool match = true;
if(p1->px != p2->px)
match = false;
if(p1->py != p2->py)
match = false;
if(p1->pz != p2->pz)
match = false;
return match;
}

PTR add(PTR poly1, PTR poly2, PTR polySum)
{
PTR cur1 = poly1->next;
PTR cur2 = poly2->next;
do
{
polySum = insert(polySum, cur1->cf, cur1->px, cur1->py, cur1->pz);
cur1 = cur1->next;
} while(cur1 != poly1);
do
```

```
{
cur1 = polySum->next;
bool matchfound = false;
do
{
if(fmatch(cur1, cur2))
{
cur1->cf += cur2->cf;
matchfound = true;
break;
}
cur1 = cur1->next;
} while(cur1 != polySum);
if(!matchfound)
{
polySum = insert(polySum, cur2->cf, cur2->px, cur2->py, cur2->pz);
}
cur2 = cur2->next;
} while(cur2 != poly2);
return polySum;
}
```

```
int main()
{
PTR poly1 = (PTR)malloc(sizeof(struct polyt));
poly1->next = poly1;
PTR poly2 = (PTR)malloc(sizeof(struct polyt));
poly2->next = poly2;
PTR polySum = (PTR)malloc(sizeof(struct polyt));
polySum->next = polySum;
poly1 = insert(poly1, 6, 2, 2, 1);
poly1 = insert(poly1, 4, 0, 1, 5);
poly1 = insert(poly1, 3, 3, 1, 1);
poly1 = insert(poly1, 2, 1, 5, 1);
poly1 = insert(poly1, 2, 1, 1, 3);
// Display the polynomial P(x, y, z)
printf("POLY1(x, y, z) = ");
disp(poly1);
// Read and evaluate the second polynomial POLY2(x, y, z)
// Represent the polynomial P(x, y, z) = xyz + 4x^3yz
poly2 = insert(poly2, 1, 1, 1, 1); // Example term
poly2 = insert(poly2, 4, 3, 1, 1);
// Display the second polynomial POLY2(x, y, z)
printf("POLY2(x, y, z) = ");
disp(poly2);
// Add POLY1(x, y, z) and POLY2(x, y, z) and store the result in POLYSUM(x, y, z)
polySum = add(poly1, poly2, polySum);
// Display the sum POLYSUM(x, y, z)
printf("\nPOLYSUM(x, y, z) = ");
```

```
disp(polySum);  
// Evaluate POLYSUM(x, y, z) for specific values  
int x = 1, y = 2, z = 3;  
int res = evaluate(polySum, x, y, z);  
printf("\nResult of POLYSUM(%d, %d, %d): %d\n", x, y, z, res);  
return 0;  
}
```

**OUT PUT :**

$$\text{POLY1}(x, y, z) = 6x^2y^2z^1 + 4x^0y^1z^5 + 3x^3y^1z^1 + 2x^1y^5z^1 + 2x^1y^1z^3$$
$$\text{POLY2}(x, y, z) = 1x^1y^1z^1 + 4x^3y^1z^1$$
$$\text{POLYSUM}(x, y, z) = 6x^2y^2z^1 + 4x^0y^1z^5 + 7x^3y^1z^1 + 2x^1y^5z^1 + 2x^1y^1z^3 + 1x^1y^1z^1$$
$$\text{Result of POLYSUM}(1, 2, 3): 2364$$

**10. Develop a menu driven Program in C for the following operations on Binary Search Tree (BST) of Integers . a. Create a BST of N Integers: 6, 9, 5, 2, 8, 15, 24, 14, 7, 8, 5, 2 b. Traverse the BST in Inorder, Preorder and Post Order c. Search the BST for a given element (KEY) and report the appropriate message d. Exit**

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
int info;
struct node *lbranch;
struct node *rbranch;
};
typedef struct node* NODEPTR;
NODEPTR fnGetNode(void);
void fnFreeNode(NODEPTR x);
NODEPTR fnInsertNode(int, NODEPTR);
void fnInOrder(NODEPTR);
void fnPreOrder(NODEPTR);
void fnPostOrder(NODEPTR);
void fnSearchBST(NODEPTR, int);
int main()
{
NODEPTR root = NULL;
int iChoice, iItem, i, iNum;
printf("Create a BST of N Integers \n");
printf("\nEnter the number N : ");
scanf("%d", &iNum);
printf("\nEnter %d numbers\n", iNum);
for(i=0;i<iNum;i++)
{
scanf("%d", &iItem);
root = fnInsertNode(iItem,root);
}
for(;;)
{
printf("\n1.Inorder traversal\n2.Preorder traversal");
printf("\n3.Postorder traversal\n4.Search\n5.Exit\n");

printf("\nEnter your choice : ");
scanf("%d",&iChoice);
switch(iChoice)
{
case 1: if(root ==NULL)
{
printf("\nTree is Empty\n");
}
else
{

```

```
printf("\nInorder Traversal is :\n");
fnInOrder(root);
printf("\n");
}
break;
case 2: if(root ==NULL)
{
printf("\nTree is Empty\n");
}
else
{
printf("\nPreorder Traversal is :\n");
fnPreOrder(root);
printf("\n");
}
break;
case 3: if(root ==NULL)
{
printf("\nTree is Empty\n");
}
else
{
printf("\nPostorder Traversal is :\n");
fnPostOrder(root);
printf("\n");
}
break;
case 4: printf("\nEnter the element to be searched : ");
scanf("%d", &iItem);

fnSearchBST(root, iItem);
break;
case 5: exit(0);
default: printf("Wrong choice\n");
break;
}
}
return 0;
}
NODEPTR fnGetNode(void)
{
NODEPTR x;
x = ( NODEPTR ) malloc (sizeof(struct node));
if(x == NULL)
{
printf("\nOut of Memory");
exit(0);
}
return x;
```



```
}
void fnFreeNode(NODEPTR x)
{
    free(x);
}
NODEPTR fnInsertNode(int iItem,NODEPTR root)
{
    NODEPTR temp,prev,cur;
    temp = fnGetNode();
    temp->info = iItem;
    temp->lbranch = NULL;
    temp->rbranch = NULL;
    if(root == NULL)
        return temp;

    prev = NULL;
    cur = root;
    while(cur != NULL)
    {
        prev = cur;
        if(iItem == cur->info)
        {
            printf("\nDuplicate items not allowed\n");
            fnFreeNode(temp);
            return root;
        }
        cur = (iItem < cur->info)? cur->lbranch: cur->rbranch;
    }
    if(iItem < prev->info)
        prev->lbranch = temp;
    else
        prev->rbranch = temp;
    return root;
}
void fnPreOrder(NODEPTR root)
{
    if(root != NULL)
    {
        printf("%d\t",root->info);
        fnPreOrder(root->lbranch);
        fnPreOrder(root->rbranch);
    }
}
void fnInOrder(NODEPTR root)
{
    if(root != NULL)
    {
        fnInOrder(root->lbranch);
```

```
printf("%d\t",root->info);
fnInOrder(root->rbranch);
}
}
void fnPostOrder(NODEPTR root)
{
if(root != NULL)
{
fnPostOrder(root->lbranch);
fnPostOrder(root->rbranch);
printf("%d\t",root->info);
}
}
void fnSearchBST(NODEPTR root, int iElem)
{
if(root != NULL)
{
if(iElem < root->info)
fnSearchBST(root->lbranch, iElem);
else if(iElem > root->info)
fnSearchBST(root->rbranch, iElem);
else
printf("\n%d is found in the BST\n",iElem);
}
else
{
printf("\n%d is not found in the BST\n",iElem);
}
}
```

**OUTPUT:**

reate a BST of N Integers

Enter the number N : 3

Enter 3 numbers

2

1

3

- 1.Inorder traversal
- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 1

Inorder Traversal is :

1    2    3

- 1.Inorder traversal
- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 2

Preorder Traversal is :

2    1    3

- 1.Inorder traversal
- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 3

Postorder Traversal is :

1    3    2

- 1.Inorder traversal
- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 4

Enter the element to be searched : 3

3 is found in the BST

- 1.Inorder traversal
- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 4

Enter the element to be searched : 9

9 is not found in the BST

- 1.Inorder traversal

- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 4

Enter the element to be searched : 8

8 is not found in the BST

- 1.Inorder traversal
- 2.Preorder traversal
- 3.Postorder traversal
- 4.Search
- 5.Exit

Enter your choice : 5

Process returned 0 (0x0) execution time : 50.895 s  
Press any key to continue.

**11. Develop 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**

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

const int MAX = 100;
const int SIZE = 10;
void fnBreadthFirstSearchReach(int vertex, int g[MAX][MAX], int v[MAX], int n);

typedef struct
{
    int iaItems[10];
    int iFront;
    int iRear;
}QUEUE;

void fnQInsert(QUEUE *stQueue, int elem);
int fnQDelete(QUEUE *stQueue);
int fnQFull(QUEUE *stQueue);
int fnQEmpty(QUEUE *stQueue);

int main(void)
{
    int graph[MAX][MAX];
    int visited[MAX];
    int numVert, startVert, i,j;

    printf("Enter the number of vertices : ");
    scanf("%d", &numVert);
    printf("Enter the adjacency matrix :\n");
    for (i=0; i<numVert; i++)
        visited[i] = 0;
    for (i=0; i<numVert; i++)
        for (j=0; j<numVert; j++)
            scanf("%d", &graph[i][j]);
    printf("Enter the starting vertex : ");
    scanf("%d", &startVert);
    fnBreadthFirstSearchReach(startVert-1,graph,visited,numVert);
    printf("Vertices which can be reached from vertex %d are :-\n",startVert);
    for (i=0; i<numVert; i++)
        if (visited[i])
            printf("%d ",i+1);
    printf("\n");
    return 0;
}
```

```
void fnBreadthFirstSearchReach(int vertex, int g[MAX][MAX], int v[MAX], int n)
{
    QUEUE stQueue;
    stQueue.iFront = 0;
    stQueue.iRear = -1;
    int frontVertex, i;
    v[vertex] = 1;
    fnQInsert(&stQueue, vertex);
    while (!fnQEmpty(&stQueue))
    {
        frontVertex = fnQDelete(&stQueue);
        for (i=0; i<n; i++)
        {
            if (g[frontVertex][i] && !v[i])
            {
                v[i] = 1;
                fnQInsert(&stQueue, i);
            }
        }
    }
}
```

```
void fnQInsert(QUEUE *stQueue, int iItem)
{
    if(fnQFull(stQueue))
        printf("\nQueue Overflow\n");
    else
    {
        stQueue->iRear++;
        stQueue->iaItems[stQueue->iRear] = iItem;
    }
}
```

```
int fnQDelete(QUEUE *stQueue)
{
    int item;
    if(fnQEmpty(stQueue))
        printf("\nQueue Underflow\n");
    else
        if(stQueue->iRear == stQueue->iFront)
        {
            item = stQueue->iaItems[stQueue->iFront];
            stQueue->iRear=-1;
            stQueue->iFront=0;
        }
}
```

```
        else
        {
            item = stQueue->iItems[stQueue->iFront++];
        }
        return item;
    }
}
```

```
int fnQFull(Queue *stQueue)
{
    if(stQueue->iRear == SIZE-1)
        return 1;
    else
        return 0;
}
```

```
int fnQEmpty(Queue *stQueue)
{
    if(stQueue->iRear == stQueue->iFront-1)
        return 1;
    else
        return 0;
}
```

**OUTPUT:**

```
Enter the number of vertices : 4
Enter the adjacency matrix :
0 1 0 1
0 0 1 0
0 0 0 1
0 0 0 0
Enter the starting vertex : 2
Vertices which can be reached from vertex 2 are :-
2 3 4
```

```
Process returned 0 (0x0)   execution time : 38.759 s
Press any key to continue.
```

---

**b) Print all the nodes reachable from a given starting node in a digraph using DFS/BFS method**

```
#include <stdio.h>
const int MAX = 100;
void fnDepthFirstSearch(int currentVertex, int v[MAX], int g[MAX][MAX], int n);

int main(void)
{
    int i,j,k;
    int visited[MAX];
    int graph[MAX][MAX];
    int numVert, Vert;
    printf("Enter the number of vertices : ");
    scanf("%d", &numVert);
    for (i=0; i<numVert; i++)
        visited[i] = 0;
    printf("Enter the adjacency matrix :\n");
    for (i=0; i<numVert; i++)
        for (j=0; j<numVert; j++)
            scanf("%d", &graph[i][j]);
    printf("Enter the source vertex : ");
    scanf("%d", &Vert);
    fnDepthFirstSearch(Vert,visited,graph,numVert);
    for (k=0; k<numVert; k++)
    {
        if(visited[k])
        {
            printf("\nVertex %d is reachable\n", k+1);
        }
        else
        {
            printf("\nVertex %d is not reachable\n", k+1);
        }
    }

    return 0;
}

void fnDepthFirstSearch(int currentVertex, int v[MAX], int g[MAX][MAX], int n)
{
    int i;
    v[currentVertex] = 1;
    for (i=0; i<n; i++)
    {
        if (g[currentVertex][i] && !v[i])
            fnDepthFirstSearch(i,v,g,n);
    }
}
```



**OUTPUT:**

Enter the number of vertices : 4

Enter the adjacency matrix :

0 1 0 1

0 0 1 0

0 0 0 1

0 0 0 0

Enter the source vertex : 1

Vertex 1 is not reachable

Vertex 2 is reachable

Vertex 3 is reachable

Vertex 4 is reachable

Process returned 0 (0x0) execution time : 35.956 s

Press any key to continue.

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

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

#define MAX_NUM_EMPLOYEES 100 // Maximum number of employees
#define MAX_HASH_TABLE_SIZE 50 // Maximum size of the hash table

// Define the structure for an employee record
typedef struct
{
    int iKey; // 4-digit key
    char cName[50];
}EMPLOYEE;

// Define the hash table as an array of employee pointers
EMPLOYEE* stHashTable[MAX_HASH_TABLE_SIZE];

int fnCompHash(int, int);
void fnInsRecord(EMPLOYEE*, int);
EMPLOYEE* fnSrchRecord(int, int);

int main()
{
    int m; // Size of the hash table
    printf("Enter the size of the hash table (m): ");
    scanf("%d", &m);

    // Initialize the hash table with NULL pointers
    for (int i = 0; i < m; i++)
    {
        stHashTable[i] = NULL;
    }

    FILE* file = fopen("employee.txt", "r");
    if(file == NULL)
    {
        printf("Error opening file.\n");
        return 1;
    }

    int n = 0;
    EMPLOYEE emp;
```

```
while(fscanf(file, "%d %s", &emp.iKey, emp.cName) != EOF)
{
    EMPLOYEE* newEmp = (EMPLOYEE*)malloc(sizeof(EMPLOYEE));
    newEmp->iKey = emp.iKey;
    strcpy(newEmp->cName, emp.cName);
    fnInsRecord(newEmp, m);
    n++;
}

fclose(file);

int iSrchKey;
printf("Enter a key to search for an employee record: ");
scanf("%d", &iSrchKey);

EMPLOYEE* found = fnSrchRecord(iSrchKey, m);
if(found != NULL)
{
    printf("Employee found with key %d:\n", found->iKey);
    printf("Name: %s\n", found->cName);
}
else
{
    printf("Employee with key %d not found.\n", iSrchKey);
}

return 0;
}

void fnInsRecord(EMPLOYEE* emp, int m)
{
    int index = fnCompHash(emp->iKey, m);

    // Linear probing if collisions happen
    while(stHashTable[index] != NULL)
    {
        index = (index + 1) % m;
    }

    stHashTable[index] = emp;
}

int fnCompHash(int iKey, int m)
{
    return iKey % m;
}

EMPLOYEE* fnSrchRecord(int iKey, int m)
{

```

```
int index = fnCompHash(iKey, m);

// Linear probing
while(stHashTable[index] != NULL)
{
    if(stHashTable[index]->iKey == iKey)
    {
        return stHashTable[index];
    }
    index = (index + 1) % m;
}
return NULL; // Employee record not found
}
```

**OUTPUT:**

Enter the size of the hash table (m): 24  
Enter a key to search for an employee record: 2387  
Employee found with key 2387:  
Name: aman  
Process returned 0 (0x0) execution time : 48.206 s  
Press any key to continue.